New York State Department of Environmental Conservation
Division of Water
Bureau of Water Compliance, 4th Floor
625 Broadway, Albany, New York 12233-3506
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Alexander B. Grannis
Commissioner

July 14, 2009

Mr. Roy Tysvaer, P.E.
Director
Wastewater Treatment and Water Quality
Bureau of Engineering Design and Construction
NYC Department of Environmental Protection
96-05 Horace Harding Expressway
Corona, New York 11368

Dear Mr. Tysvaer:

Re: DEC Case #CO2-20000107-8, 2005 Order on Consent (CSO Order)
Appendix A, III. Inner Harbor CSO, B.1.
Gowanus Canal Waterbody/Watershed Facility Plan Report

The New York State Department of Environmental Conservation (Department) has completed its review of the Final Gowanus Canal Waterbody/ Watershed Facility Plan (WWFP) Report dated August 2008, the New York City Department of Environmental Protection (DEP) responses to Department comments dated December 18, 2008 and the Addendum to the August 2008 Gowanus Canal WWFP Report dated April 2009. All submittals were made in accordance with the above- referenced CSO Order, Appendix A, III.B.1.

The Department acknowledges that a public meeting was held at P.S. 58 in Brooklyn, New York on February 12, 2008, to present the Gowanus Canal WWFP. A Responsiveness Summary was prepared and is appended to the Gowanus Canal WWFP at Appendix H to address public comments and questions. In response to further Department comments, an Addendum was issued for the Gowanus Canal WWFP. The Department hereby approves the Gowanus Canal WWFP including the April 2009 Addendum. Please find enclosed stamped copies of the covers of the approved WWFP and Addendum. All components of the WWFP, including the implementation schedules shown below, are now incorporated by reference and are now an enforceable part of the CSO Order as per Section III.F. Please note that the Post Construction Compliance Monitoring Program (PCMP) specified in Section 8.5 of the approved Gowanus Canal WWFP will be subject to further review as the construction projects progress toward completion and as the Gowanus Canal Long Term Control Plan (LTCP) is developed.

The projects contained in the approved WWFP are incorporated into Appendix A of the CSO Order with the following milestones:

III. Inner Harbor CSO	
G. Flushing Tunnel Modernization	
1. Notice to Proceed to Construction	February 2010
2. Construction Completion	September 2014
H. Gowanus Pump Station Reconstruction	
1. Notice to Proceed to Construction	February 2010
2. Construction Completion	September 2014
I. Dredging of Gowanus Canal*	
1. Submittal of All Dredging Permit Applications	December 2010
2. Notice to Proceed with Dredging	Within 3 years of final permit issuance
3. Complete Dredging	Within 5 years of final permit issuance

* The Department and USEPA will evaluate the proposed dredging of Gowanus Canal through their role in the permitting process to ensure that the project is not inconsistent with the Superfund remedial program objectives.

The Gowanus Canal LTCP is scheduled to be submitted to the Department within six months of the date of this approval. The Department will continue to work with the DEP in development of the LTCP and strive to identify regulatory options to ensure compliance with Water Quality Standards and the Clean Water Act. Pursuant to the Memorandum of Understanding between the Department and DEP dated January 14, 2005 and attached to the CSO Order, the Department will commence the regulatory review process for submissions under the long term control planning process no later than 60 days following the date on which the DEP issues the last notice to proceed to construction for the above CSO projects.

The DEP will submit an application to the Department for a SPDES variance pursuant to 6NYCRR Part 702.17 to operate the pump station, CSO facility and flushing tunnel six months prior to the start-up of the new facilities or as a part of the LTCP, whichever comes first. The application shall include operation and maintenance plans for the pump station, CSO facilities, and flushing tunnel. The Department may propose a modification to the SPDES permit for the Red Hook WPCP, which would require monitoring and reporting of measurable operations at the Gowanus Pump Station and flushing tunnel to ensure that the facility operates in accordance with the design approved by the Department. The modified permit would also incorporate the PCMP as previously discussed. The monitoring requirements will become effective upon start-up of the enhanced pump station and flushing tunnel. Monitoring results will be reviewed by the Department to determine whether the WWFP, and ultimately the LTCP, when approved, are achieving a level of water quality that is protective of the highest attainable use of the Gowanus Canal. During each 5-year SPDES permit/ long term control planning cycle, the DEP will continue to review and evaluate any ongoing causes of water quality impairment and the need to take additional action.

If you have any questions concerning the above, please contact Mr. Gary E. Kline, P.E., Section Chief, NYC Municipal Compliance Section, at 518-402-9655.

Sincerely,

Joseph DiMura, P.E.
Director
Bureau of Water Compliance

Enclosures
cc w/Encl.: G. Kline, P.E.
S. McCormick, P.E.
R. Adair, Esq.
R. Schick, P.E., DER
R. Elburn, P.E., Region 2
T. Burns, P.E., NYS EFC
J. Gratz, P.E., USEPA
K. Mahoney, P.E., NYCDEP
K. Clarke, P.E., NYCDEP
D. Chao, P.E., NYCDEP
H. Donnelly, Esq., NYCDEP

NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION

DEP

City-Wide Long Term CSO Control Planning Project

Gowanus Canal Waterbody/Watershed Facility Plan Report

Addendum

New York State Department of Environmental Conservation
This report for Inner Harbor CSO, Gowanus Canal Waterbody/Watershed Facility Plan Report. Appendix A, III. B. 1.
is hereby approved subject to the provisions of the Environmental Conservation Law and Order on consent (CSO Order) DEC Case # CO2 - 20000107-8,
Date July 14, 2009, By: ______ P.E.
New York State Commissioner of Environmental Conservation Designated Representative
Recommended by: Susan S. McCormick

STATE OF NEW YORK
PETER J. YOUNG
LICENSED PROFESSIONAL ENGINEER
NO. 07170

The City of New York
Department of Environmental Protection
Bureau of Engineering Design and Construction

April 2009

ADDENDUM TO THE AUGUST 2008 GOWANUS CANAL WATERBODY/WATERSHED FACILITY PLAN REPORT

APRIL 2009

The modifications and additions provided in this document supersede the language in the August 2008 Gowanus Canal Waterbody/Watershed Facility Plan. Each item is identified first by document location, then by type (addendum, erratum, clarification).

New York State Department of Environmental Conservation
This report for Inner Harbors CSO, Addendum to Gowanus Canal Waterbody/Watershed Facility Plan Report, Appendix A, III. B. 1.
is hereby approved subject to the provisions of the Environmental Conservation Law and Order on consent (CSO Order) DEC Case # CO2 - 20000107-8.
Date July 14, 2009. By: [signature] P.E.
New York State Commissioner of Environmental Conservation Designated Representative
Recommended by: Susan McCormick

The City of New York

DEPARTMENT OF ENVIRONMENTAL PROTECTION

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Bureau of Engineering Design & Construction

APR 0 6 2009

Mr. Joseph DiMura, P.E.
Director
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New York State Department of Environmental Conservation
625 Broadway, 4th Floor
Albany, New York 12233-3506

RE: Order on Consent (CSO Order)
DEC Case #CO2-20000107-8
Appendix A, III. Inner Harbor CSO, B.1. Gowanus Canal Waterbody/Watershed Facility Plan Report Addendum

Dear Mr. DiMura:

Thank you for reviewing and commenting on the Final Gowanus Canal Waterbody/Watershed (WB/WS) Facility Plan Report submitted by the New York City Department of Environmental Protection (DEP) on August 29, 2008. Attached for your approval is an Addendum that addresses comments received from your staff via email on December 19, 2008 and during subsequent technical discussions. This submittal is intended to resolve all outstanding issues for the Gowanus Canal WB/WS Facility Plan Report and to be sufficient for DEC to complete its approval process.

DEP looks forward to receiving DEC's final approval of the Gowanus Canal WB/WS Facility Plan Report and Addendum. As always, please do not hesitate to contact me regarding any questions you may have.

Very truly yours,

Roy Tysvaer, P.E., Director
Wastewater Treatment and Water Quality

Waterbody/Watershed Facility Plan Distribution List

With Attachment

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Dorothy Chao
Heather Donnelly
Denzil Taffe
Stanley Joseph
Julie Stein

ADDENDUM TO THE AUGUST 2008 GOWANUS CANAL WATERBODY/WATERSHED FACILITY PLAN REPORT

MARCH 2009

The modifications and additions provided in this document supersede the language in the August 2008 Gowanus Canal Waterbody/Watershed Facility Plan. Each item is identified first by document location, then by type (addendum, erratum, clarification).

Executive Summary

Page ES-7, 1st paragraph. Clarification: The report provides a probable total project cost (PTPC) of $257.1 million for the plan, including $83.2 million for the Modernization of the Gowanus Canal Flushing Tunnel and $151.7 million for the Reconstruction of the Gowanus Wastewater Pumping Station. The PTPC is a project total used to show each alternative under consideration on the same basis, and includes design and construction management fees, potential amenities and change orders, and other contingencies which are added to the engineer's estimate available at the time. NYCDEP received bids in February 2009 for the Flushing Tunnel and Pumping Station, and were within an acceptable range of the engineer's estimate, slightly under the allocated budget amount.

Section 1

Page 1-14, 2nd paragraph of Section 1.2.5, 1st line. Erratum: replace "January 15" *with* "January 14"

Page 1-14, 2nd paragraph of Section 1.2.5, 3rd from last line. Erratum: replace "January 7" *with* "April 14"

Section 2

There are no addenda, errata, or clarifications for Section 2.

Section 3

Page 3-23, 2nd paragraph of Section 3.4.3, 2nd from last line. Erratum: replace "like cycle" *with* "life cycle"

Section 4

There are no addenda, errata, or clarifications for Section 4.

Section 5

Page 5-3, Table 5-1. Erratum: replace Flushing CS4-4 end date "Dec 2004" *with* "May 2007"

Page 5-3, Table 5-1. Erratum: replace Hendrix Creek Dredging start date "Jun 2007" *with* "Aug 2009"

Page 5-3, Table 5-1. Erratum: replace Hendrix Creek Dredging end date "Jun 2010" *with* "Aug 2011"

Page 5-4, Section 5.3 in entirety. Clarification: as of August 2008, the most recent available BMP Annual Report was for calendar year 2007.

Page 5-13, 1st paragraph of Section 5.4.2, Addendum: After 1st sentence, insert "This project was undertaken in connection with the settlement of an enforcement action taken by New York State and DEC for violations of New York State law and DEC regulations."

Page 5-17, Section 5.8.1 in entirety. Clarification: The schedule of completion for the Inner Harbor CSO Facility Plan is as follows: Phase I was completed in March 2006; Phase II is currently under construction and provides for in-line storage at two locations; Phase III is included under the City-Wide SCADA program and has been under construction since November 2007.

Page 5-29, Section 5.9.3 in entirety. Clarification: the construction schedule was modified subsequent to the public participation phase of the approval process in response to delays in contractor procurement.

Page 5-30, Section 5.11 in entirety. Errata: replace entire section with the following:

[Begin Section 5.11 Insert]

5.11 NEW YORK CITY SUSTAINABILITY INITIATIVES

Sustainable stormwater management usually involves replicating the natural water balance and stormwater dynamics through the design of natural ecological processes and functions, and controlling stormwater at the source. The technologies that serve this goal are referred to as stormwater best management practices (BMPs), and include a wide range of techniques that can capture stormwater, remove urban pollutants, reduce runoff volumes and peak flows, and return stormwater to the landscape and subsurface in a manner beneficial to the environment (see Section 7.2.2). Low-impact development (LID) refers to the land use approach that integrates various stormwater management practices in an attempt to minimize the changes to the natural environment that the built environment has, and has alternately been referred to as Green Site Design (GSD) or more generically as simply "green solutions." Distributive by design, stormwater BMPs must be applied over a large area in order to achieve significant runoff attenuation. In densely developed, ultra-urban cities such as New York City, it is easiest to incorporate green solutions into new construction.

Green solutions, including various BMPs and feasible implementation strategies, are currently being evaluated through the NYCDEP Bureau of Environmental Planning and Assessment and the Mayor's Office of Long-Term Planning and Sustainability. The Mayor's Office established the BMP Interagency Task Force to incorporate BMPs into the design and construction of projects as part of PlaNYC 2030. The Interagency Task Force assisted the development of the Sustainable Stormwater Management Plan, a comprehensive analysis of the costs and benefits of source controls, which was submitted to City Council in December 2008 per Local Law 5. NYCDEP participated in the Interagency Task Force and substantially supported the development of the Stormwater Management Plan. NYCDEP is also evaluating regulatory changes that could require BMPs for new development, and will have a contractor on board in 2009 to design and construct BMP pilot projects, evaluate watershed specific BMP effects, and develop a New York City specific urban BMP design manual (see Section 5.11.1). The following subsections detail these and other stormwater management initiatives the City has recently undertaken. Although many initiatives are City-wide in nature, several initiatives explicitly identify Gowanus Canal for targeted pilot programs, and the remainders have broad implications within the Gowanus Canal watershed as the City continues to refine its policies and practices pertaining to stormwater management.

5.11.1 Jamaica Bay Watershed Protection Plan

On June 30, 2005, the New York City Council passed Local Law 71 (LL 71) of 2005 to require the development of a watershed protection plan for Jamaica Bay. The legislation required NYCDEP to "assess the technical, legal, environmental and economical feasibility" of a variety of protection measures as part of the Jamaica Bay Watershed Protection Plan (JBWPP) development process, the objective of which is to restore and maintain the water quality and ecological integrity of the Bay though a comprehensive watershed approach. The Final JBWPP was submitted to the City Council on October 1, 2007, and annual JBWPP updates are expected in October of 2008 and 2010.

The JBWPP included a myriad of ecological restoration and water quality improvement strategies, and new and emerging techniques previously unaddressed, such as stream bank protection, stream buffers, other BMPs, enforcement, access and use restrictions, freshwater ponds, urban runoff management, and expansion of community use and participation. A set of recommendations for restoring and protecting desired uses of Jamaica Bay and its watershed were generated. Collectively, these pilot studies, regulatory initiatives, public outreach efforts, and technical innovations will begin to address water quality and ecological issues facing Jamaica Bay, promoting sustainability in New York City based on sound development and infrastructure practices at multiple levels. Many of the recommendations in the JBWPP are outside NYCDEP's authority or mission, and NYCDEP's support for these projects must be considered in the context of other agency mandates. The financial plan for the Bay has not been fully developed.

The first JBWPP update was submitted to City Council in October 2008, and included status reports on the implementation of many strategies identified in the JBWPP and the status information presented below for stormwater BMPs.

5.11.2 BMP Pilots, Design Manual and Watershed Planning

Following the development of the JBWPP, NYCDEP developed a contract to implement BMP strategies throughout the City. NYCDEP selected a contractor for an upcoming NYCDEP BMP contract, anticipated to start in 2009. A significant portion of the contract includes multiple stormwater BMP pilot projects that will be used to evaluate the efficacy of each BMP, maintenance needs, schedules, and uncertainties associated New York City-specific climate and site conditions (local geology, cold weather limitations, construction costs, maintenance requirements, etc.). The results of these pilots will be used to guide future development practices, and the development of a BMP design manual and watershed planning analyses. The specific pilots in the contract included:

- Three locations in the Bronx at which stormwater BMP retrofits for open space and other land uses will be evaluated;
- New York City Housing Authority (NYCHA) complex will test the ability to redirect runoff to existing pervious surfaces and encourage on-site stormwater infiltration;
- A porous pavement pilot to investigate different types of porous pavement and potential maintenance issues associated with the use of porous pavement;
- Two locations in southeast Queens along North and South Conduit Avenues that will be used to quantify the benefits of tree plantings and other BMPs for stormwater management;
- Two 10,000 square-foot, publicly owned rooftops will be retrofitted with blue roofs to evaluate retrofitting existing structures;
- The distribution of 1,000 55-gallon capacity rain barrels to gauge public acceptance of and interest in this technology, with focused distribution in the Jamaica Bay watershed (250 of which were distributed during the spring and summer of 2007).

The BMP Design Manual, to be developed under the same contract, will provide specific guidance for designing and constructing BMPs based on New York City conditions and the regulatory environment. The BMP Design Manual will identify specifically how to design and install effective BMPs in New York City, addressing different land use and building classifications, local climate conditions, and the regulatory environment. The manual will include the pilot and demonstration projects as examples and is anticipated to have an online, interactive access portal that can be used to tailor a stormwater control to specific site conditions.

Another noteworthy component of the contract is the development of watershed plans for up to four watersheds including the Gowanus Canal that will be based on a comprehensive water quality and ecological approach. These watershed plans will identify BMP, restoration, and other low-impact/decentralized strategies for addressing multiple water quality and ecosystem goals.

5.11.3 PlaNYC 2030

On Earth Day in 2007, Mayor Bloomberg announced a comprehensive City-wide set of initiatives focused on environmental stewardship called PlaNYC 2030. By dividing the urban environment into its fundamental components (land, water, transportation, energy, and air), PlaNYC enabled New York City to identify and execute actions that would lead to a more sustainable city. PlaNYC identified specific initiatives to promote BMP implementation, including the formation of an interagency BMP Task Force, development of pilot projects for promising BMPs, and providing incentives for green roofs. The BMP Interagency Task Force met regularly during 2007 and 2008 to discuss feasible mechanisms for distributed stormwater control through the design and construction of different agency projects within the City's right-of-way, open space, and public and private developments. The Task Force held several public meetings to receive the input of diverse stakeholders citywide. The pilot projects identified in PlaNYC (e.g., improved tree pit design and roadway vegetated swales) will be implemented by NYCDEP along with other stormwater BMP pilot projects as part of several contracts described below. Finally, the State Legislature recently approved a green roof tax abatement program (Bill Number A11226) to encourage construction and maintenance of green roofs in the City. The amount of the abatement would be $4.50 per square foot of green roof, limited to the lesser of $100,000 or the building's tax liability for the year in which the abatement is taken. The bill was officially written as law in fall 2008 with a sunset date of March 15, 2013.

5.11.4 Sustainable Stormwater Management Plan

The City Council passed Local Law 5 in 2008 requiring the Mayor's Office of Long-Term Planning and Sustainability to develop a City-wide Sustainable Stormwater Management Plan, the goals of which are to reduce stormwater volume, improve water quality, and enhance the use and enjoyment of the city's waterbodies for recreational activities. The specific requirements of the plan focus on defining cost-effective stormwater management measures for different types of properties or areas in the city, along with a prioritization of measures and timeline for implementation. A substantial public participation and public education program obtained public input during the development of the plan. Specific requirements for signage, public notification for location and occurrence of CSOs, and other education activities were also included. The draft plan was issued as required on October 1, 2008 to the mayor, speaker of the council, and the public; the final was issued December 1, 2008. The Plan provides a framework for testing, assessing, and implementing pilot installations to control stormwater at its source, as well as strategies to supplement existing stormwater control efforts, develop innovative and cost-effective source controls, and secure funding for future implementation. NYCDEP lent substantial support to the development of the Plan. The law expects a four-year review cycle, with reports every other October beginning in 2010.

5.11.5 Environmental Benefit Projects

In connection with the settlement of an enforcement action taken by New York State and DEC for violations of New York State law and DEC regulations, NYCDEP submitted a Nitrogen Consent Judgment Environmental Benefit Project (EBP) Plan to NYSDEC in January 2007 that proposed a stormwater pilot study in the Jamaica Bay drainage area. This project will use Nitrogen Consent Judgment EBP funds to conduct a three year pilot study program to implement and monitor several stormwater treatment technologies and volume reduction stormwater BMPs for potential application within the Jamaica Bay watershed. The goals of Jamaica Bay Watershed

Section 7

Page 7-10, Section 7.2.2, Errata: Replace Green Solutions / Low Impact Development subsection in entirety with the following:

[Begin Section 7.2.2 Insert]

- Green Solutions/Low Impact Development – For the purposes of this WB/WSFP, "green solutions" encompasses a range of techniques that includes stormwater best management practices (BMPs) and low impact development (LID). The goal of green solutions is to mimic predevelopment site hydrology to capture, infiltrate, evaporate, and detain runoff to reduce both the volume of stormwater generated by a site and its peak overflow rate, thereby improving the quality of the stormwater. Green solutions are promising, and their potential benefits extend beyond stormwater management to include habitat restoration, heat island mitigation, and urban aesthetics.

  Data are available to assess the cost and benefits of green solutions to undeveloped sites. However, few studies have been conducted for applying green solutions to urban areas such as New York City, where high-density development, existing infrastructure, and land acquisition issues tend to counterbalance the environmental benefits of implementation. In addition, input and acceptance by numerous City agencies will be necessary, including the Department of Parks and Recreation, the Department of Transportation, and the Department of Buildings.

  Common green solutions are described below:

  - Bioretention (rain garden) – a planting bed or landscaped area used to hold runoff and to allow it to infiltrate.

  - Filter Strips – a band of vegetation located between the runoff location and the receiving channel or waterbody. Overland flow over the filter strip allows infiltration and filtering of storm water.

  - Vegetated Buffers – a strip of vegetation around such areas as water bodies to provide a means to rain to infiltrate into the soil. This slows and disperses storm water and allows some trapping of sediment.

  - Grassed Swales – depressions designed to collect, treat, and retain runoff from a storm event. Swales can be designed to be dry or wet (with standing water) between rain events. Wet swales typically contain water tolerant vegetation and use natural processes to remove pollutants.

Stormwater Pilot Project include documenting the quality of New York City stormwater and refining the specific capture rates and treatment efficiencies that may be expected locally. Once this information has been gathered, effective Green Site Design stormwater strategies would be developed for potential future applications.

The project is expected to cost approximately $1.75 million and will include infiltration swales for street-side and parking lot applications, parking lot curb water capture systems, enhanced tree pits, and a commercial green roof / blue roof comparison installation. The EBP is being conducted through an innovative collaborative effort between NYCDEP and the Gaia Institute. NYCDEP entered into a contract with the Gaia Institute to complete the pilot study. The Gaia Institute is a 501(c)3 not-for-profit corporation located on City Island in the Bronx that explores how human activities can be attenuated to increase ecological productivity, biodiversity, environmental quality, and economic well being.

In connection with the settlement of an enforcement action taken by New York State and DEC for violations of New York State law and DEC regulations, NYCDEP also submitted a CSO EBP Plan for NYSDEC approval in March 2008 that is expected to partially mitigate the impacts of stormwater and CSO discharges in the New York Harbor Estuary through stormwater BMP implementation. Practices such as bioinfiltration swales, enlarged street tree pits with underground water storage, constructed wetlands, and others would be evaluated. The CSO EBP Plan proposes pilots in the Bronx, Flushing, and Gowanus watersheds. Gowanus Canal was selected as one of the representative watersheds within which to further evaluate BMP performance based on its particular characteristics. NYCDEP intends to establish a Request for Grant (RFG) program that will enable local stakeholder groups to submit proposals for effective stormwater management projects that meet the objectives of capturing and treatment of stormwater (e.g., reduction of stormwater entering sewer system) within the watersheds covered by the CSO EBP Plan. The RFG process will be structured to allow for a variety of proposals for both small and larger groups. A total of $1,450,000 will be used for projects within the Gowanus Canal watershed. To help expedite these projects, it is anticipated that NYCDEP will follow the procedures similar to that of the Nitrogen Consent Order EBP program, and that a Memorandum of Understanding (MOU) will be developed between NYCDEP and the individual grant applicants. The Gowanus watershed field survey analyses were recently completed, and detailed information resulting from the analyses will be submitted to NYSDEC for review and comment prior to the start of the RFG process. In early 2009, NYCDEP will perform public outreach to encourage environmental groups to submit grant proposals that meet the criteria agreed upon. NYCDEP and NYSDEC are currently reviewing eligibility grant guidelines and certain submission requirements, including the submittal of designs at least 120 days ahead of starting any work. The three-year minimum monitoring duration will extend the schedule out to 2013 before final results can be expected.

5.11.6 Other NYCDEP Initiatives

NYCDEP has also worked closely with the City Planning Commission (CPC), Department of City Planning (DCP) and the Department of Housing, Preservation and Development (HPD) to review proposed rezonings in areas adjacent to the Canal including the proposed rezoning and development at 363-365 Bond Street bounded by Carroll and Second

Streets, and Gowanus Green bounded by Smith and Fifth Streets. Each of these rezonings propose to change the current zoning from predominately manufacturing districts to Special Mixed-Use Districts that would include new residential units, commercial space, community facilities, and publicly-accessible waterfront open space along the Canal. NYCDEP has provided comments and discussed stormwater and water conservation measures with DCP and HPD to address existing infrastructure and water quality concerns in the Gowanus Canal drainage area. On February 6, 2009, DCP distributed for public review the draft scope of work for the larger area-wide rezoning of a 25-block area surrounding the head end of the Gowanus Canal that would also effectively change the area from manufacturing zoning districts to multi-use zoning districts. These rezonings are also being reviewed to reflect and ensure consistency with NYCDEP's proposed Gowanus Facilities Upgrade, as described previously in Section 5.

As a part of the construction activities to take place under this WB/WSFP, the following BMP strategies will be implemented at the Gowanus Facilities Site:

- A 1,700 square foot green roof will be constructed atop the pump station building to handle approximately 5% of the site runoff.
- Bio-retention, pervious pavers and other landscaped areas will be constructed on portions of the site and planted with engineered soils and vegetation for an additional 2,350 square feet of pervious surface to receive approximately 35% of the site runoff.

5.11.7 BMP Code Review Task Force

A detailed review of New York City's existing codes and regulations is being performed in an attempt to identify potential code revisions that could be recommended to promote BMP implementation. NYCDEP convened various staff from different bureaus and offices within the agency—Bureau of Environmental Planning and Analysis, Bureau of Water and Sewer Operations, Legal Office and Office of Strategic Projects—and other City agencies—Department of Buildings, Law Department and Mayor's Office of Long-Term Planning and Sustainability—to conduct the review. The Task Force identified opportunities for revisions that would encourage BMP installation based on a review of BMP regulations and practices in other urban municipalities such as Portland, Philadelphia, Chicago, and Seattle. As described in the Mayor's Sustainable Stormwater Management Plan, new stormwater requirements are anticipated by the end of 2009.
[End Section 5.11 Insert]

Section 6

Page 6-10, 2nd paragraph of Section 6.7, 2nd line. Erratum: replace "NYCDEP or the NYSDEC" *with* "NYCDEP and NYSDEC"

Page 6-11, 1st paragraph of Section 6.8, 1st line. Erratum: replace "DEP" *with* "NYSDEC"

- Rain Barrels – a barrel placed at the end of a roof downspout to capture and hold runoff from roofs. The water in the barrel must be manually emptied onto the ground, or it can be put to beneficial use to water vegetation. The barrel top typically has a completely sealed lid and a downspout diverter to direct overflow back to the roof leader.

- Cisterns – an oversized or underground tank that stores rain water from roofs for non-potable reuse.

- Subsurface Open Bottom Detention Systems – an excavated trench backfilled with stone, perforated pipes or manufactured storm chambers to create a subsurface basin or trench that provides storage for water, allows stormwater to infiltrate, and releases water to the sewer system at a controlled rate.

- Blue Roofs – the practice of constructing rooftop detention to temporarily store and gradually drain rainwater off a building's rooftop via a controlled flow roof drain.

- Rooftop Green Roofs – the practice of constructing pre-cultivated vegetation mats on rooftops to capture rainfall, thereby reducing runoff and CSO.

- Increased Tree Cover – planting trees in the City to capture a portion of rainfall.

- Permeable Pavements – a type of surface material that reduces runoff by allowing precipitation to infiltrate through the paving material and into the earth.

Green solutions are distributive in nature (i.e., constructed within individual properties or in right-of-ways). The time necessary for enough of these source control measures to be in place and to have a substantial impact on stormwater inflows to the combined sewers is significantly longer than implementing more traditional CSO abatement approaches. In urban areas, it is not reasonable to demolish existing development or infrastructure just for the purpose of green solutions alone. It is generally accepted that green solutions are reasonable to apply with new development or construction within an urban area. Trenches excavated for street and sidewalk construction allow substantial BMP construction cost savings and municipal codes or rules for new development allow green solutions to be incorporated as part of site plans and building design and minimize potential economic hardship for property owners. In the case of existing development, significant participation and cooperation of business and private property owners as well as additional evaluations are necessary.

NYCDEP and other agencies, as described in the Mayor's Sustainable Stormwater Management Plan, will be conducting a number of pilot studies to assess the effectiveness of BMPs in New York City's urban environment. While there are numerous published studies about stormwater BMPs from other municipalities, various public agencies, and environmental organizations, there is a critical data gap of specific information related to the effectiveness and appropriateness of the use of these technologies within New York City.

The pilot projects will start to fill that data gap by conducting multi-year studies to implement and monitor innovative stormwater treatment and volume reduction BMP technologies. The pilot projects will include the design, construction and monitoring of various BMPs to reduce runoff and associated stormwater pollutant loadings into the City's combined and storm sewers. Runoff will be directed into swales, wetlands, and BMPs rather than to combined and storm sewers discharging to waterbodies. As part of the pilot studies, stormwater capture volume and pollutant removal rates of each of the technologies will be documented. Once these technologies are proven to be effective, a wider citywide application of these technologies would be evaluated. See Section 5.11 for more detailed information about current NYCDEP pilot projects and evaluations of green solutions.

The anticipated environmental benefits of identifying Green Site Design (GSD) or BMPs for use in New York City can be grouped into three categories. The first category relates to the capture of the "first flush" of stormwater that contains the highest concentration of nitrogen, other nutrients and urban pollutants and reduce these discharges to the City's sewer system and surrounding waterbodies. The second category relates to reducing the volume of stormwater entering the combined sewer system. A reduction in the volume of stormwater entering the combined sewer system will also increase the ability of the City's WPCPs to properly treat a greater volume of sanitary wastewater and reduce the volume of sanitary wastewater discharged in CSOs. The third category relates to returning stormwater to the landscape and subsurface environments in order to benefit ecological communities and provide opportunities for open space.

The timeline for the study and evaluation of the green solutions further described in Section 5.11 will extend beyond the Consent Order milestones for delivery of approvable Waterbody/Watershed Facility Plans to NYCDEC; as a result, further evaluation of Source or Inflow Controls in the Gowanus Canal Waterbody/Watershed Facility Plan is not possible. However, green solutions will continue to undergo the rigorous level of evaluation necessary for programmatic implementation by the City of New York through parallel planning efforts as described in detail in Section 5. NYCDEP will provide updates on these evaluations and will incorporate the most promising technologies into the CSO program where possible, cost-effective, and environmentally beneficial. Any solution satisfying these criteria would be included through a future modification when the WB/WS plan is converted to a Drainage Basin Specific Long Term Control Plan, a 5-year update of a Drainage Basin Specific Long Term Control Plan or in the subsequent City-Wide Long Term Control Plan.

[End Section 7.2.2 Insert]

Page 7-15, last paragraph of Section 7.2.4, 4th from last line. Erratum: replace "December" *with* "April"

Section 8

Section 8.1. Clarification: The probable total project cost (PTPC) of $257.1 million for the plan includes $83.2 million for the Modernization of the Gowanus Canal Flushing Tunnel and $151.7 million for the Reconstruction of the Gowanus Wastewater Pumping Station. The PTPC is a project total used to show each alternative under consideration on the same basis, and includes design and construction management fees, potential amenities and change orders, and other contingencies which are added to the engineer's estimate available at the time. NYCDEP received bids in February 2009 for the Flushing Tunnel and Pumping Station, and were within an acceptable range of the engineer's estimate, slightly under the allocated budget amount.

Page 8-4, 2nd Paragraph of Section 8.1.3, Addendum: After 1st sentence, insert "Although not included in any of the CSO reductions discussed in this report, modeling suggests that the increased controlling elevations of the screening and outfall gates included in the final design issued for construction bids in January 2009 induces in-line storage in upstream combined sewers and may reduce CSO an additional 16 MG in a typical year."

Page 8-12, Figure 8-5, Clarification: Note that the construction schedule was modified subsequent to the public participation phase of the approval process in response to delays in contractor procurement for items A and B.

Page 8-12, Figure 8-5, Erratum: Replace "June 2010" *Milestone for Submittal of Dredging Permit Applications under item E with* "December 2010".

Page 8-13, 4th Paragraph of Section 8.4, Erratum: Replace "June 2010" *in 3rd sentence with* "December 2010".

Section 9

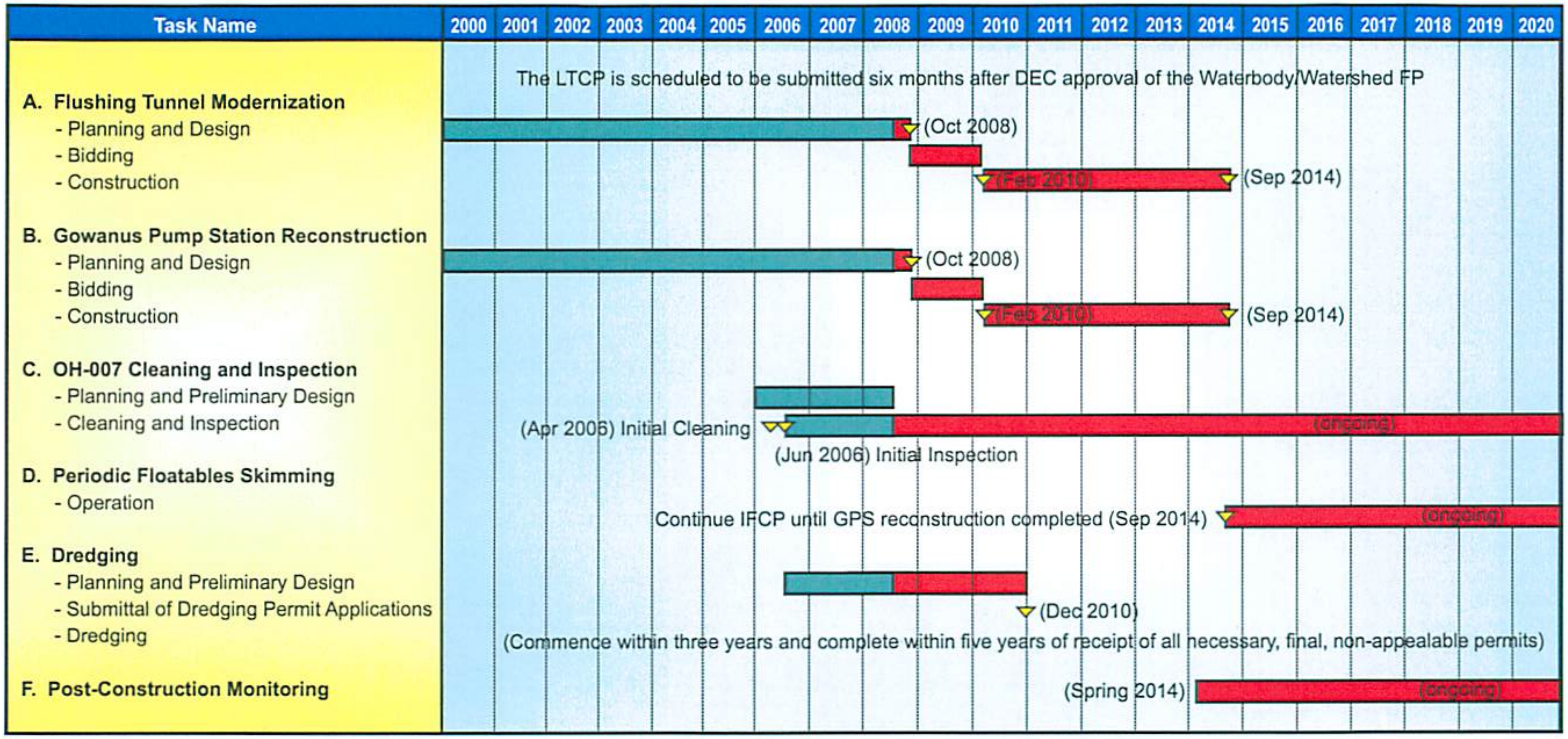
Page 9-10, last paragraph of Section 9.1.6, 3rd from last line. Erratum: replace "Waterbody / Watershed Facility Plan" *with* "CSOs"

Section 10

There are no addenda, errata, or clarifications for Section 10.

Section 11

There are no addenda, errata, or clarifications for Section 11.



Gowanus Waterbody/Watershed Facility Plan
Implementation Schedule

FIGURE 8-5

City-Wide Long Term CSO Control Planning Project

Gowanus Canal Waterbody/Watershed Facility Plan Report

The City of New York
Department of Environmental Protection
Bureau of Engineering Design and Construction

August 2008

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EXECUTIVE SUMMARY

The New York City Department of Environmental Protection (NYCDEP) has prepared this Gowanus Canal Waterbody/Watershed Facility Plan Report as required by the Administrative Order on Consent between the NYCDEP and the New York State Department of Environmental Conservation (NYSDEC). Designated as DEC Case #CO2-20000107-8 (January 14, 2005, most recently updated and signed on April 14, 2008) and also known as the Combined Sewer Overflow (CSO) Consent Order, the Administrative Consent Order requires the NYCDEP to submit an "approvable Waterbody/Watershed Facility Plan" for Gowanus Canal to the NYSDEC by June 2007. After submitting a draft report in August 2006 and receiving NYSDEC comments in April 2007, NYCDEP requested and received NYSDEC approval for an extension to finalize the Plan report by September 30, 2007. After receiving public comments through mid-March of 2008 and a second round of comments from NYSDEC on April 23, 2008, NYCDEP requested and received NYSDEC approval for an extension to incorporate changes into the Plan report by August 31, 2008.

Gowanus Canal is one of 18 waterbodies that together encompass the entirety of the waters of the City of New York. The CSO Consent Order also requires that, by 2017, the NYCDEP complete a final, City-wide CSO Long-Term Control Plan (LTCP) incorporating the plans for all watersheds within the City of New York.

Purpose

The purpose of this Waterbody/Watershed Facility Plan is to take the first step toward development of an LTCP for this waterbody. This Plan assesses the ability of the existing New York City CSO Facility Plan for Gowanus Canal to provide compliance with the existing water quality standards. Where these facilities will not result in full attainment of the existing standards, additional alternatives are evaluated.

Context

This report represents the Waterbody/Watershed Plan for Gowanus Canal. This is one element of the City's extensive multiphase approach to CSO control that was started in the early 1970s. As described in more detail in Section 5, New York City has been investing in CSO control for decades. Elements already part of the City's CSO program and listed in the 2005 CSO Consent Order amount to over $2.1 billion of infrastructure investment. This does not include millions spent annually on control of CSOs through the Nine Minimum Controls that have been in place since 1994.

Regulatory Setting

This Waterbody/Watershed Plan has been developed in fulfillment of the 2005 CSO Consent Order requirements. This Plan represents one in a series of 18 Waterbody/Watershed plans that will be developed prior to development of a final LTCP for the City. All 18 Waterbody/Watershed plans contain all the elements required by the USEPA of an LTCP.

Goal of Plan

The goal of this Waterbody/Watershed Facility Plan is to achieve the current water-quality standards applicable to Gowanus Canal. Implementation of the Plan is expected to reduce CSO discharges to the Gowanus Canal to eliminate odors, greatly reduce floatables and improve dissolved oxygen concentrations to meet the existing water-quality standards. The LTCP to be developed subsequent to this Waterbody/Watershed Facility Plan will support a possible upgrade of water-quality standards to support secondary-contact recreation, thus supporting the Clean Water Act goals of fishable and swimmable water quality. This Plan assesses the effectiveness of CSO controls to attain water quality that complies with NYSDEC water-quality standards, and considers controls now in place within New York City, or are required by the Consent Order to be put in place. This Waterbody/Watershed Facility Plan also assesses additional, cost-effective CSO control alternatives or strategies (i.e., water quality standards revisions) that can be employed to provide attainment with the water-quality standards.

Adaptive Management Approach

Post-construction compliance monitoring (including modeling), discussed in detail in Section 8, is an integral part of this Plan and provides the basis for adaptive management for Gowanus Canal. Post-construction compliance monitoring will commence prior to implementation of CSO controls and will continue for several years in order to quantify the difference between the expected performance (as described herein) and the actual performance once those controls are fully implemented. Any performance gap identified by the monitoring program can then be addressed through operations adjustments, retrofit of additional controls, or initiating a Use Attainability Analysis (UAA) if it becomes clear that CSO control will not result in full attainment of applicable standards.

In addition, protocols established by NYCDEP and the City of New York for capital expenditures require certain evaluations to be completed prior to the construction of the CSO controls delineated in this Plan. Depending on the technology implemented and on the engineer's cost estimate for the project, these evaluations may include pilot testing, detailed facility planning, preliminary design, and value engineering. Each of these steps provides additional opportunities for refinement and adaption so that the fully implemented program achieves the goals of the original Waterbody/Watershed Facility Plan.

Project Description

Located in western Brooklyn, Gowanus Canal extends approximately 1.5 miles, from its northern terminus at Butler Street in the Boerum Hill section, to a line drawn between the western shoreline at Clinton Street and the eastern shore at 25th Street, beyond which the Canal opens into Gowanus Bay and ultimately to Upper New York Bay. The Canal has four short branches that historically served as "turning basins" to allow vessels to reverse direction. Gowanus Canal's watershed is approximately 1,758 acres, of which 1,612 acres are served by combined sewers draining to either the Red Hook or to the Owls Head Wastewater Pollution Control Plant (WPCP). There are a total of 11 CSOs that can discharge to the Canal.

The present character of Gowanus Canal and its drainage area is considerably different than the character of its pre-urbanized condition (Table ES-1). Originally a tidal creek winding through marshland, the waterbody was dredged, straightened and bulkheaded as the surrounding area was drained, urbanized and industrialized during the development of New York City. By 1870, the waterbody had been transformed to very near its present configuration, and Gowanus Canal was serving as a major industrial waterway through which materials were brought to and from the area industries. The surrounding area had been fully urbanized and industrialized, with sewage and industrial wastes discharging directly to the Canal without treatment, and the natural marshlands and freshwater streams had been replaced with combined sewers and storm drains. The urbanization of the surrounding drainage area resulted in an estimated three-fold increase in the annual runoff volume and a six-fold increase in the peak runoff rate to the waterbody. Stripped of the surrounding buffers of marshland and its natural freshwater flow, the waterbody was deprived of any natural response mechanisms that might have helped absorb the increased hydraulic and pollutant loads. The Canal's limited circulation and exchange with New York Harbor waters allowed pollutants to build up within the Canal, and water quality deteriorated to such an extent that Gowanus Canal was notorious as a polluted waterway.

Table ES-1. Urbanization of Gowanus Canal Watershed

	Pre-Urbanized	***Urbanized***[1]
Drainage area	*1,286 acres*	*1,758 acres*
Adjacent wetlands	*439 acres*[2]	*0 acres*
Population[3]	*~10,000*	*108,800*
Surface imperviousness	*10%*	*62%*
Annual wet-weather discharge[4]	*143 MG*	*473 MG*
Peak runoff rate[4]	*39 MGD*	*247 MGD*
Notes: (1) Existing condition; (2) Approximated from historical maps; (3) Based on U.S. Census estimates for 1840 (pre-urbanized) and 2000 (urbanized; (4) For a typical precipitation year (JFK gage, 1988); includes stormwater and combined-sewage overflows.		

Efforts to address water quality in Gowanus Canal date back to the late 1800s, when the City of Brooklyn contracted for the design of a tunnel between the head of Gowanus Canal and Buttermilk Channel to improve circulation and flush pollutants from the Canal. In 1911, construction of the so-called "Flushing Tunnel" was completed, and the facility operated until the mid-1960s. Meanwhile, New York City was constructing wastewater pollution control plants (WPCPs) to treat sewage and industrial wastes during dry weather and to capture a portion of the combined sewage generated during wet weather. Two WPCPs service the Gowanus Canal drainage area: the Owls Head WPCP, which began operating in 1952, and the Red Hook WPCP, which began operating in 1987.

Currently, about 108,800 people live within Gowanus Canal's 1,758-acre drainage area, over 90 percent of which is served by combined sewers draining to either the Red Hook or the Owls Head WPCPs. Industrial discharges to the Canal have virtually disappeared in the wake of the changing character of the area industries and the City's Industrial Pretreatment Program, whereby the remaining industrial effluents are accepted into the sewer system for treatment at the WPCPs. Other City-wide programs have also benefited Gowanus Canal. For example, the City-Wide Floatables Plan addresses discharges of street litter with catch basin controls and a program to remove floatables in the Harbor with tributary skimmer vessels and the installation of a floatables boom within the Canal. The NYCDEP has also engaged in a number of projects to improve the sewer system and water quality specifically in Gowanus Canal. Under the Gowanus

Canal 201 Facilities Plan (1982), dry-weather overflows to the Canal were eliminated and improvements to operations at the Gowanus Pump Station were made. Under the Inner Harbor CSO Facility Plan (1993), the NYCDEP completed other actions, such as regulator improvements, maximizing wet-weather flow to the WPCPs, dredging a portion of Gowanus Canal and reactivating the Gowanus Canal Flushing Tunnel. The Gowanus Canal elements of the Inner Harbor CSO Facility Plan alone have incurred expenditures of at least $11.1 million to date. Other projects, such as the Gowanus Facilities Upgrade Facility Plan, are currently underway to address remaining issues and to further improve water quality in Gowanus Canal.

The State of New York has designated Gowanus Canal as a Class SD waterbody, with a designated best use of fishing and waters suitable for fish survival. Water-quality standards specific to Class SD waters require that dissolved-oxygen concentrations shall not be less than 3.0 mg/L at any time. Since there is no recreational use classification of Gowanus Canal, there are no numerical recreational use water quality standards applied to the waterbody. Narrative standards address aesthetic conditions such as floatables and odors.

In 1998, NYSDEC designated Gowanus Canal as a high-priority waterbody for TMDL development with its inclusion on the Section 303(d) list of impaired waterbodies. The cause of the listing was dissolved oxygen/oxygen demand due to urban runoff, storm sewers and CSO. Despite the advances described above, Gowanus Canal remained on the 303(d) list in 2006 (NYSDEC, 2007), again due to low dissolved-oxygen concentrations related to wet-weather discharges from combined and storm sewers. Low dissolved-oxygen levels periodically returned to the Canal due to deficiencies in some of the engineered improvements made as part of the Inner Harbor Facility Plan, as described below.

Figure ES-1 demonstrates how, prior to the reactivation of the Flushing Tunnel, measured dissolved oxygen levels in Gowanus Canal could be below 3.0 mg/L during warm-weather periods. Though the Flushing Tunnel was reactivated in 1999 and greatly reduced occurrences of these low dissolved oxygen levels, the flushing system can become inoperable at low tide and has otherwise required periodic shut downs for maintenance and repairs. Furthermore, the flushing capacity of the system is limited by a constriction where the Columbia Street Interceptor passes through the Flushing Tunnel.

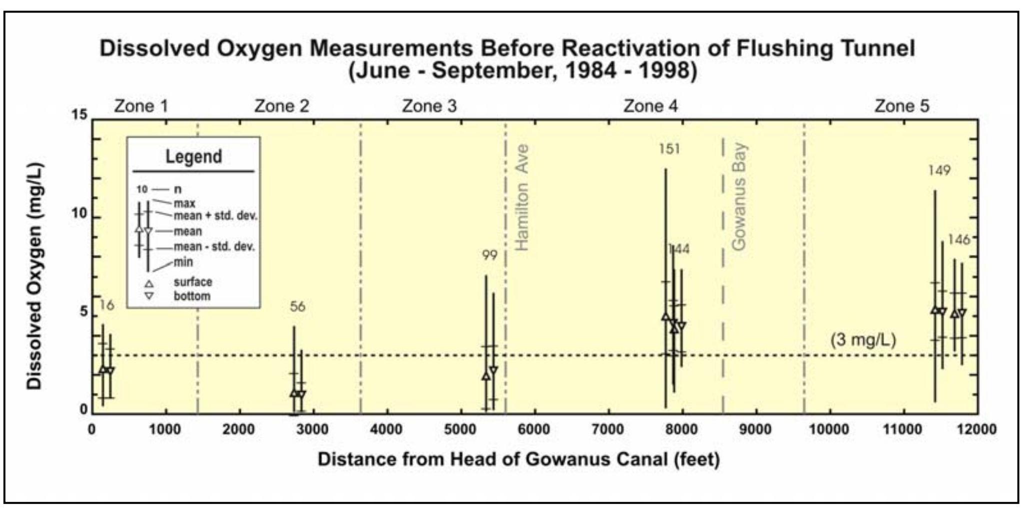


Figure ES-1. Historical Dissolved Oxygen Measurements (Without Flushing Tunnel)

Modeling analyses performed herein to account for an inactive Flushing Tunnel indicate that, in a precipitation year of 100 rainfall events, there would be approximately 75 CSO events lasting roughly 6 to 7 hours each and discharging a total of 377 MG to Gowanus Canal (Table ES-2). Stormwater inputs from storm sewers and overland runoff direct to the Canal contribute an additional 74 MG per year, or roughly 16 percent of the total wet-weather discharge volume to the Canal. As demonstrated on Figure ES-2, without the Flushing Tunnel active, the calculated impact of these inputs on dissolved oxygen in the Canal is significant, with minimum-calculated dissolved oxygen concentrations less than 3.0 mg/L throughout much of the Canal.

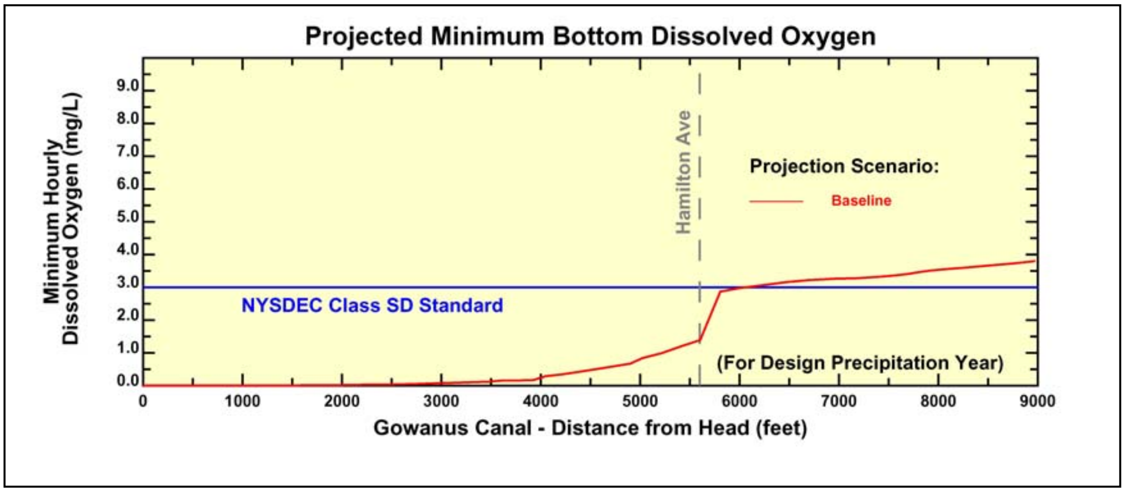


Figure ES-2. Model-Calculated Minimum Dissolved Oxygen (Baseline)

A range of CSO-control alternatives has been examined to reduce CSO-pollution impacts to Gowanus Canal. The evaluated range of alternatives includes "Low Cost" alternatives that address aesthetics issues without reducing CSO volume, CSO-storage facilities to capture up to 100 percent of the CSO volume generated in the drainage area during wet weather, and sewer separation. All alternatives include implementation of City-Wide programs such as the City-Wide Comprehensive CSO Floatables Plan and the 14 BMPs for CSO Control (per the SPDES permits) to maximize use of existing systems and facilities for CSO capture and pollutant reduction. Many of the evaluated alternatives included dredging to eliminate CSO sediments exposed during low tide, as well as some form of floatables control beyond what is specifically accounted for in the City-Wide Comprehensive CSO Floatables Plan. One set of alternatives, herein dubbed the Water Quality Improvement Plan (WQIP), includes a host of CSO controls planned for by NYCDEP prior to initiation of its Waterbody/Watershed Facility Planning Project, such as rehabilitation of the Gowanus Canal Flushing Tunnel, capacity expansion of the Gowanus Wastewater Pumping Station, and installation of CSO floatables control at RH-034. In addition, the WQIP involves a cleaning/inspection program to restore and maintain the functionality of the floatables/solids trap at OH-007, periodic floatables skimming in the Canal, and dredging as noted above. The subsequent CSO-retention alternatives involve augmenting the WQIP with CSO-retention facilities employing either tank or tunnel technology and providing storage capacities ranging

Table ES-2. CSO & Stormwater Discharges

Type	*Number of Events*	*Total Annual Volume (MG)*
CSO	*75*	*377*
Stormwater	*79*	*74*
Total	***-***	***451***

from 4.0 MG to 33.4 MG. Overall, the estimated costs associated with the evaluated alternatives ranged from about $22 million to close to $1.6 billion. The evaluated alternatives are summarized in Table ES-3.

Table ES-3. Summary of Alternatives

Alternative Name	*Effective Retention Volume (MG)*	*Number of CSO Events*	*CSO Volume (MG)*	*Estimated Cost ($million)*
Skim	*0*	*75*	*377*	*$ 0.9*
Skim+Dredge	*0*	*75*	*377*	*$ 22.2*
Skim +Screen+Dredge	*0*	*75*	*379*	*$ 35.0*
WQIP	*0*	*47*	*250*	*$ 257.1*
WQIP + 1 Tank	*4*	*47*	*177*	*$ 457.1*
WQIP + 2 Tanks	*8*	*35*	*118*	*$655.1*
WQIP+Tunnel	*11.1*	*11*	*81*	*$ 807.8*
WQIP+Tunnel	*17.8*	*8*	*36*	*$ 844.3*
WQIP+Tunnel	*23.9*	*4*	*15*	*$ 871.8*
WQIP+Tunnel	*33.4*	*0*	*0*	*$ 921.8*
Sewer Separation	*0*	*0*	*0*	*$ 1,592.3*

Modeling analyses were performed to project the expected water-quality benefits of each of the evaluated alternatives. As shown on Figure ES-3, dissolved-oxygen levels are projected to attain the Class SD criterion of ≥ 3.0 mg/L 100 percent of the time for the WQIP and all subsequent alternatives. Figure ES-3 also shows that the WQIP and subsequent alternatives are expected to attain the IEC Class B-1 criterion of ≥ 4.0 mg/L 91 percent of the time. Notably, no further benefit is projected to result from additional controls beyond the Water Quality Improvement Plan. As a result, the Water Quality Improvement Plan is selected as the Waterbody/Watershed Facility Plan.

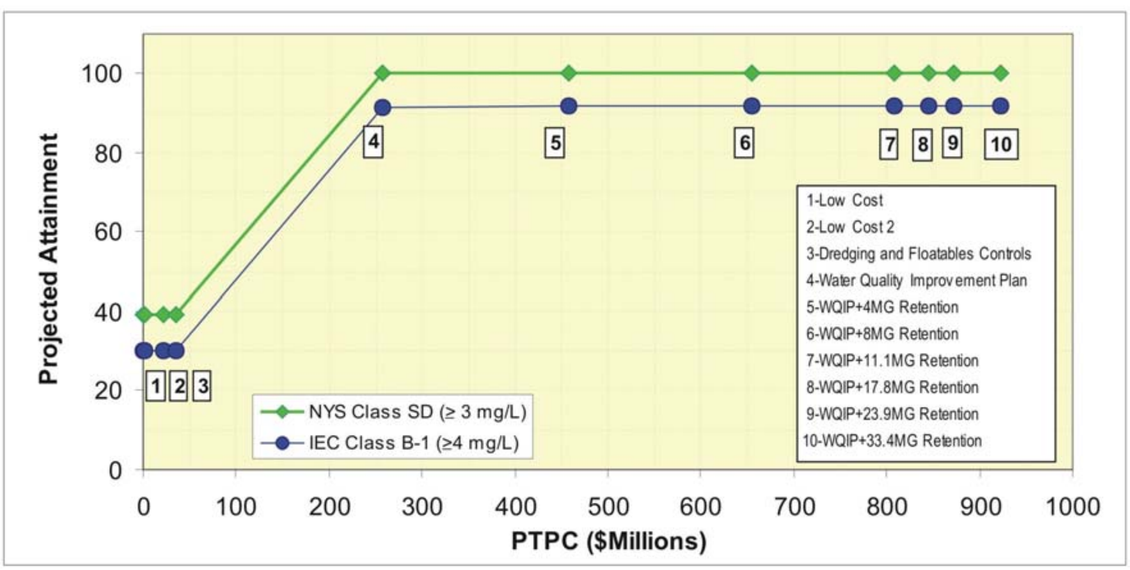


Figure ES-3. Projected Attainment of Dissolved Oxygen Criteria vs. Cost for Evaluated Alternatives

As developed herein, the Gowanus Canal Waterbody/Watershed Facility Plan intends to solve water-quality problems that have faced the Canal for over a century. The central elements of the Plan represent actions that go beyond those already implemented as part of the Inner Harbor CSO Facility Plan (such as maximization of flow at the Red Hook and Owls Head WPCPs) and other City-wide initiatives (such as the CSO Floatables Plan, and implementation of the 14 BMPs for CSO control). The additional elements of the Waterbody/Watershed Facility Plan, which are expected to cost a total of $257.1 million and to be completely implemented in 2013, include the following:

Rehabilitation of the Gowanus Canal Flushing Tunnel

Rehabilitating the Flushing Tunnel will enhance circulation and restore the Canal's assimilative capacity for pollutants by introducing water from Upper New York Bay to the head of Gowanus Canal. The rehabilitation will increase its average capacity roughly 40 percent to 215 million gallons per day (MGD), will eliminate shutdowns at low tide, and will virtually eliminate shutdowns for maintenance through a new pumping system with redundant, interchangeable pumps.

Reconstruction of the Gowanus Pump Station

Reconstruction of the Gowanus Pump Station is projected to reduce the annual volume of CSO discharges to the Canal by 34 percent, and installing CSO screens at the Pump Station will eliminate floatables discharges from all overflows projected to occur in a typical precipitation year at this location. This element will also include replacement of the force main to convey pumped flow directly to the Columbia Street Interceptor. This force main, which runs along the inside of the Flushing Tunnel, will be slightly rerouted near the Columbia Street Interceptor to lessen a constriction within the Flushing Tunnel at that location. Replacement of the force main will relieve capacity in the hydraulically limited Bond-Lorraine Sewer and will reduce discharges from RH-035 and RH-030 by 90 percent.

Floatables Controls at Major CSOs and Periodic Skimming

This element involves implementing floatables controls at two CSO locations that together represent about 78 percent of the CSO volume discharged to the Canal in the Waterbody/Watershed Facility Plan condition, plus periodic skimming as necessary to address floatables issues in the Canal.

As indicated above, the Gowanus Pump Station (RH-034) will receive a CSO floatables screening system that is projected to eliminate all floatables discharges in the design (typical) precipitation year. In severe wet-weather events, overflow rates exceeding 200 MGD will bypass the screens without adversely affecting removal of floatables from CSO flow passing through the screens.

The second major CSO location is OH-007. Instituting programmatic cleaning and inspection of the floatables/solids trap at OH-007 should maintain the functionality of the trap, which will provide control of floatables and solids discharges in that location.

Dredging Head of Gowanus Canal

Dredging the upper 750 feet of Gowanus Canal to a final water depth of 3.0 feet below mean lower low water will eliminate exposed CSO sediment mounds, which will improve aesthetic conditions both by removing the mounds from sight and by eliminating the odors associated with them. This work will include placement of a 2-ft deep sand cap to provide a clean substrate at the final water depth of 3.0 feet below mean lower low water.

Programmatic Implementation of Sustainable Stormwater Management Initiatives

As enumerated in Section 5.11, low-impact development, stormwater BMPs, and other green solutions for stormwater management will continue to be evaluated for programmatic implementation by the City of New York through parallel planning efforts. NYCDEP expects these evaluations to yield promising technologies suitable for implementation in its CSO program, and will do so as the opportunities arise. In addition, City-Wide efforts that include regulatory and administrative review and revision will obligate NYCDEP to comply with recommended changes, including explicit mandates for City agencies to practice sustainability whenever public resources are used. These changes would be included through a future modification to the current Waterbody/Watershed Facility Plan, either when the Waterbody/Watershed Facility Plan is converted to a Drainage Basin Specific Long Term Control Plan, or when the subsequent City-Wide Long Term Control Plan is developed.

Implementation Schedule and Cost

The elements of the Waterbody/Watershed Facility Plan will be implemented by September 2014, with the exception of dredging, which is contingent upon NYSDEC issuance of all necessary final, non-appealable permits, the application for which will be submitted by June 2010. The estimated cost for all elements is $257.1 million (June 2008 dollars.)

Post-Construction Monitoring

Post-construction monitoring will be integral to assessment of the control elements of the Waterbody/Watershed Facility Plan. Monitoring will consist of collecting relevant sampling data from the waterbody, as well as collecting relevant precipitation data and data characterizing the operation of the sewer system. Analysis of these data will provide an indication of how the controls are performing irrespective of natural wet-weather variations. Due to the dynamic nature of both natural precipitation and receiving water conditions, a period of ten years will be necessary to generate the minimal amount of field data necessary to perform meaningful statistical analyses for water-quality standards review and for any formal use-attainability analyses that may be indicated.

Summary of Expected Water-Quality Benefits

As documented herein, implementation of the Waterbody/Watershed Facility Plan is projected to substantially improve water quality relative to Baseline conditions. Water quality with the Waterbody/Watershed Facility Plan is projected to attain the applicable NYSDEC Class SD standards for dissolved oxygen 100 percent of the time over the entire length of the Canal (Figure ES-4). As noted above, additional controls (including 100 percent CSO capture and sewer separation) are not projected to provide additional water-quality benefits.

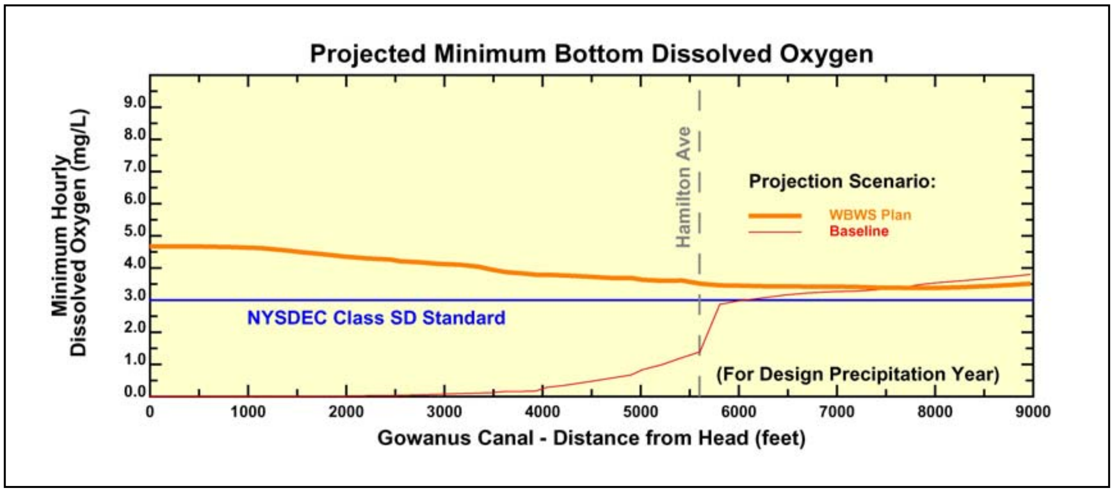


Figure ES-4. Projected Minimum Dissolved Oxygen with Waterbody/Watershed Facility Plan

With respect to the narrative water-quality criteria for aesthetics, the Waterbody/Watershed Facility Plan is expected to substantially reduce floatables and odors. Under the Plan, the Flushing Tunnel will increase flushing rates approximately 40 percent, improving circulation between the Canal and Harbor waters. The Plan will reduce the volume of CSO discharged to Gowanus Canal by 34 percent overall. With respect to floatables issues, the Plan will augment ongoing programmatic controls such as street sweeping, catch basin retention, and other best management practices described in the City-Wide Comprehensive CSO Floatables Plan, by implementing additional floatables controls at the two major CSOs that together represent about 78 percent of the CSO discharges to the Canal under Baseline conditions: RH-034, where a new CSO-screening system will remove floatables from CSO discharges up to a peak rate of 200 MGD; and OH-007, where operation of a floatables trap chamber will remove floatables. Any remaining floatables issues will be addressed with the deployment of a skimmer vessel to conduct open-water floatables removal from the Canal on an as-needed basis. Reductions in settleable solids discharges will result from the 34 percent volumetric reduction in CSO discharges and from the operation of the OH-007 trap chamber. Finally, exposed CSO sediments and the odors associated with them will be eliminated by dredging the upper 750 feet of the Canal and placing a 2-ft deep sand cap to provide a clean substrate in the dredged area and to provide a final water depth of 3.0 ft below mean lower low water.

Consistency with Federal CSO Control Policy

The Gowanus Canal Waterbody/Watershed Facility Plan was developed so that it satisfies the requirements of the federal CSO Control Policy. Through extensive water-quality and sewer-system modeling, data collection, community involvement, and engineering analysis, the NYCDEP has adopted this Plan to incorporate the findings of over a decade of inquiry to achieve the highest reasonably attainable use of Gowanus Canal. This Waterbody/Watershed Facility Plan addresses each of the nine elements of long-term CSO control as defined by federal policy and described herein. Furthermore, the Gowanus Canal Waterbody/Watershed Facility Plan satisfies the metrics of the Demonstration Approach.

The Demonstration Approach metrics are based primarily on whether the selected alternative is projected to meet applicable water-quality standards. As described above, the

Gowanus Canal Waterbody/Watershed Facility Plan is projected to meet the Class SD dissolved oxygen criterion 100 percent of the time during the design (typical) precipitation year, and higher dissolved-oxygen criteria are also projected to be attained most of the time. Higher levels of control—up to and including 100 percent CSO abatement—are not projected to provide significantly improved dissolved oxygen. Narrative criteria for aesthetics are also expected to be met in light of the high level of floatables control and the removal of odor-causing exposed CSO sediment mounds in the upper Canal.

Summary

The Gowanus Canal Waterbody/Watershed Facility Plan satisfies federal CSO policy requirements. Through extensive water-quality and sewer-system modeling, data collection, community involvement, and engineering analysis, the NYCDEP has developed a Plan that incorporates the findings of over a decade of inquiry to achieve the highest reasonably attainable water quality and associated use of Gowanus Canal.

1.0 Introduction

The City of New York owns and operates 14 water pollution control plants (WPCPs) and their associated collection systems through the New York City Department of Environmental Protection (NYCDEP). The system contains approximately 450 combined sewer overflows (CSOs) located throughout the New York Harbor complex. NYCDEP is executing a comprehensive watershed-based approach to long-term CSO control planning to address the impacts of these CSOs on the water quality and use of the waters of New York Harbor. As illustrated in 1-1, multiple waterbody assessments are being conducted to consider causes of non-attainment of water quality standards and to identify opportunities and requirements for maximizing beneficial uses. This Waterbody/Watershed Facility Plan (WB/WS) Report provides the details of the assessment and the actions that will be taken to improve water quality in one of these waterbodies: Gowanus Canal (Item 12 on Figure 1-1).

New York City's environmental stewardship of the New York Harbor began in 1909 with water quality monitoring that continues today "to assess the effectiveness of New York City's various water pollution control programs and their combined impact on water quality" (NYCDEP, 2000). CSO abatement has been ongoing since at least the 1950s, when conceptual plans were first developed to reduce CSO discharges to Spring Creek and other confined tributaries in Jamaica Bay. From 1975 through 1977, the City conducted a harbor-wide water quality study funded by a Federal Grant under Section 208 of the Water Pollution Control Act Amendments of 1972. This study confirmed tributary waters in the New York Harbor were negatively affected by CSOs. In addition, dry-weather discharges—which NYCDEP has since tracked down and eliminated—were also occurring. In 1984, a City-wide CSO abatement program was developed that initially focused on establishing planning areas and defining how facility planning should be accomplished. The City was divided into eight individual project areas that together encompass the entire harbor area: four open-water areas (East River, Jamaica Bay, Inner Harbor and Outer Harbor) and four tributary areas (Flushing Bay, Paerdegat Basin, Newtown Creek, and Jamaica Tributaries). For each project area, water-quality CSO Facility Plans were developed, as required under the State Pollutant Elimination System (SPDES) permits for each WPCP. The SPDES permits, administered by the New York State Department of Environmental Conservation (NYSDEC), apply to CSO outfalls as well as plant discharges, and therefore contain conditions for compliance with applicable federal and New York State requirements for CSOs.

In 1992, NYCDEP entered into an Administrative Consent Order with the NYSDEC. This Consent Order was incorporated into the SPDES permits with a provision stating that it governs NYCDEP's obligations for its CSO program. The 1992 Order was modified in 1996 to add a catch basin cleaning, construction, and repair program. A new Consent Order became effective in 2005 that supersedes the 1992 Consent Order and its 1996 modifications with the intent to bring all CSO-related matters into compliance with the provisions of the federal Clean Water Act and New York State Environmental Conservation Law. The new Order contains requirements to evaluate and implement CSO abatement strategies on an enforceable timetable for 18 waterbodies and, ultimately, for City-wide long-term CSO control. NYCDEP and NYSDEC also entered into a separate Memorandum of Understanding (MOU) to facilitate reviews of water quality standards in accordance with the federal CSO control policy.

New York City
Department of Environmental Protection

Gowanus Canal Waterbody/Watershed Facility Plan

LTCP Project Waterbody/Watershed Assessment Areas

FIGURE 1-1

This Gowanus Canal Waterbody/Watershed Facility Plan Report is explicitly required by Appendix A, Item III.B.1 of the 2005 Consent Order, and is intended to be consistent with the CSO Control Policy issued by the United States Environmental Protection Agency (USEPA). In 1994 the USEPA issued a national CSO Policy requiring municipalities to develop a long term plan for controlling CSOs (i.e., a LTCP). The CSO policy became law in December 2000 with the passage of the Wet Weather Water Quality Act of 2000. The approach to developing the LTCP is specified in USEPA's CSO Control Policy and Guidance Documents, and involves the following nine minimum elements, known collectively as the USEPA's Nine Minimum Controls (NMCs):

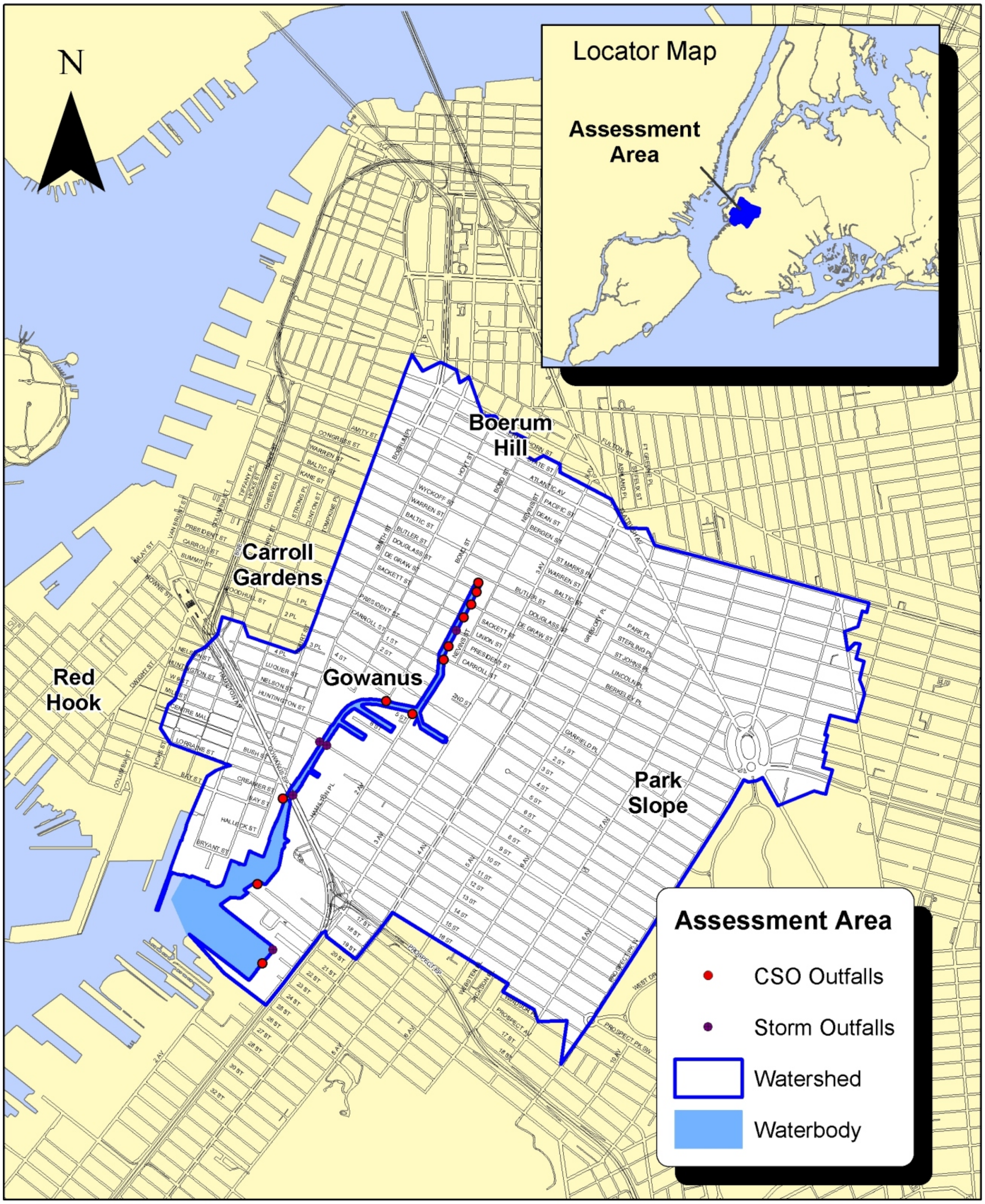
1. System Characterization, Monitoring and Modeling
2. Public Participation
3. Consideration of Sensitive Areas
4. Evaluation of Alternatives
5. Cost/Performance Consideration
6. Operational Plan
7. Maximizing Treatment at the Treatment Plant
8. Implementation Schedule
9. Post Construction Compliance Monitoring Program

Subsequent sections of this WB/WS Facility Plan report will discuss each of these elements in more depth, along with the simultaneous coordination with state water quality standards (WQS) review and revision as appropriate.

1.1 WATERBODY/WATERSHED ASSESSMENT AREA

A comprehensive watershed-based approach is being employed that investigates conditions in Gowanus Canal, within its benthic sediment, along its shorelines, and in its watershed. This approach includes identifying pollutant sources originating in the watershed that impact water quality and/or designated uses. In a natural or non-urban setting, the watershed would be delineated as the topographic watershed tributary to the waterbody, accounting for man-made diversions or other factors. In the case of Gowanus Canal, the watershed tributary to the waterbody is mostly the sewershed of combined and separated sewer systems that service the watershed and discharge to Gowanus Canal during wet weather. Since the sewershed does not reflect the actual topographic watershed, the assessment area of the Gowanus Canal Waterbody/Watershed Facility Plan encompasses Gowanus Canal, its sewershed, and adjacent parks and undeveloped properties that drain to Gowanus Canal via overland runoff.

Figure 1-2 presents a map of the Gowanus Canal waterbody and watershed areas. The waterbody portion of the Gowanus Canal waterbody/watershed assessment area begins at the northern, head-end terminus of the Canal near Butler Street, and extends to a line drawn between the western shoreline at Clinton Street and the eastern shore at 25th Street. The waterbody area includes four short branches off of the main canal that historically served as "turning basins" to allow vessels to reverse direction. These turning basins are named according to their locations at 4th Street, 6th Street, 7th Street, and 11th Street. The entire waterbody assessment area is classified as a saline tributary to Upper New York Bay according to Title 6 of the New York Code of Rules



New York City
Department of Environmental Protection

Gowanus Canal Waterbody/Watershed Assessment Area

FIGURE 1-2

and Regulations (NYCRR), Chapter X, Part 890. Although listed as a tributary, Gowanus Canal receives freshwater inflows only from intermittent CSO and stormwater discharges.

The watershed portion of the Gowanus Canal assessment area is approximately 1,758 acres and includes the Red Hook, Carroll Gardens, Boerum Hill, Gowanus, and Park Slope neighborhoods of western Brooklyn within Community Districts 6 and 7. This area is serviced by combined sewer systems of the Red Hook and Owls Head WPCPs. The total combined sewer system services an entirely urbanized area of 1,612 acres. Though there are a total of 15 permitted CSO locations on Gowanus Canal, there are only 12 locations where CSOs actually discharge to the Canal. Field inspections determined that two permitted CSO outfalls have been physically closed and two other permitted CSO outfalls receive runoff from stormwater-only drainage areas. One additional non-permitted CSO was recently discovered during field investigations and is being appropriately addressed by the NYCDEP. Small portions of separately sewered areas serviced by the Red Hook and Owls Head WPCPs are also in the assessment area, as well as areas adjacent to the waterbody that have private drainage systems. More detailed sewer system discussions are provided in later sections of this report.

Gowanus Canal is designated by the State of New York as a Class SD waterbody. The best usage of Class SD waters is fishing. This classification may be given to those waters that, because of natural or man-made conditions, cannot meet the requirements for primary or secondary contact recreation and fish propagation. Water quality standards specific to Class SD waters require that dissolved oxygen concentrations shall not be less than 3.0 mg/L at any time. Since there is no recreational use classification of Gowanus Canal, there are no numerical recreational-use water-quality standards applied to the waterbody. Gowanus Canal is listed on New York State's Section 303(d) List of Impaired Waters Requiring a Total Maximum Daily Load (TMDL), as dated May 17, 2007 (NYSDEC, 2007). The listed cause of the impairment is "dissolved oxygen/oxygen demand," and the listed sources of oxygen demand are urban runoff, storm sewers and CSO.

Downstream of Gowanus Canal in Gowanus Bay and Upper New York Bay, the waters are designated as Class I. The best uses of Class I waters are secondary contact recreation and fishing. The State of New York defines secondary contact recreation as recreational activities where contact with the water is minimal and where ingestion of the water is not probable.

Secondary contact recreation includes, but is not limited to, fishing and boating. In addition, Class I waters shall be suitable for fish propagation and survival. Numerical water quality standards for Class I waters are specified for dissolved oxygen, total coliform and fecal coliform. The water quality standards require that dissolved oxygen concentrations shall not be less than 4.0 mg/L at any time. Total coliform must have a monthly geometric mean of less than 10,000 cells calculated as Most Probable Number per 100 milliliters (MPN/100 mL) from a minimum of five examinations. Fecal coliform must have a monthly geometric mean of less than 2,000 MPN/100 mL from a minimum of five examinations.

1.2 REGULATORY CONSIDERATIONS

The waters of the City of New York are primarily subject to New York State regulation, but must also comply with the policies of the USEPA, as well as water quality standards established by the Interstate Environmental Commission (IEC). The following sections detail the regulatory issues relevant to long-term CSO planning.

1.2.1 Clean Water Act

Although Federal laws protecting water quality were passed as early as 1948, the most comprehensive approach to clean water protection was enacted in 1972, with the adoption of the Federal Water Pollution Control Act Amendments, commonly known as the Clean Water Act (CWA), including the amendments adopted in 1977. The CWA established the regulatory framework to control surface water pollution, and gave the USEPA the authority to implement pollution control programs. Among the key elements of the CWA was the establishment of the National Pollutant Discharge Elimination System (NPDES) permit program, which regulates point sources that discharge pollutants into waters of the United States. Combined sewer overflows and municipal separate storm sewer systems (MS4) are also subject to regulatory control under the NPDES program. In New York State, the NPDES permit program is administered by the State through NYSDEC, and is thus a SPDES program. New York has had an approved SPDES program since 1975.

The CWA requires that discharge permit limits are based on receiving WQS established by the State. These standards should "wherever attainable, provide water quality for the protection and propagation of fish, shellfish and wildlife and for recreation in and on the water and take into consideration their use and value of public water supplies, propagation of fish, shellfish, and wildlife, recreation in and on the water, and agricultural, industrial, and other purposes including navigation" (40 CFR 131.2). The standards must also have an antidegradation policy for maintaining water quality at acceptable levels, and a strategy for meeting these standards must be developed for those waters not meeting WQS. The most common type of strategy is the development of a total maximum daily load (TMDL) to determine what level of pollutant load would be consistent with meeting WQS. TMDLs also allocate acceptable loads among sources of the relevant pollutants.

Section 305(b) of the CWA requires states to periodically report the water quality of waterbodies under their respective jurisdictions, and Section 303(d) requires states to identify impaired waters where specific designated uses are not fully supported. The NYSDEC Division of Water addresses these requirements by following its Consolidated Assessment and Listing Methodology (CALM). The CALM includes monitoring and assessment components that determine water quality standards attainment and designated use support for all waters of New York State. Waterbodies are monitored and evaluated on a five-year cycle. Information developed during monitoring and assessment is inventoried in the Waterbody Inventory/Priority Waterbody List (WI/PWL). The WI/PWL incorporates monitoring data, information from state and other agencies, and public participation. The Waterbody Inventory refers to the listing of all waters, identified as specific individual waterbodies, within the state that are assessed. The Priority Waterbodies List is the subset of waters in the Waterbody Inventory that have documented water quality impacts, impairments or threats. The Priority Waterbodies List provides the candidate list of waters to be considered for inclusion on the Section 303(d) List.

In 1998, NYSDEC listed Gowanus Canal as a high priority waterbody for TMDL development with its inclusion on the Section 303(d) List. The cause of the listing was oxygen depletion due to CSO discharges that depressed dissolved oxygen levels with enough severity to preclude fish propagation. Gowanus Canal was again listed on the 2004 Section 303(d) List as a high priority waterbody, but urban runoff and stormwater were added to the sources deemed responsible for depressed dissolved oxygen concentrations. This listing was unchanged as of May 17, 2007, when New York State published the 2006 Section 303(d) List (NYSDEC, 2007). As the 303(d) List associates the cause of depressed dissolved oxygen with urban runoff and stormwater, this LTCP will serve as the TMDL when approved by NYSDEC, as it will address the sources of the impairment.

Another important component of the CWA is the protection of uses. USEPA regulations state that a designated use for a waterbody may be refined under limited circumstances through a Use Attainability Analysis (UAA), which is defined a "*a structured scientific assessment of the chemical, biological, and economic condition in a waterway*" (USEPA, 2000)s. In the UAA, the state would demonstrate that one or more of a limited set of situations exists to make such a modification. First, it could be shown that the current designated use cannot be achieved through implementation of applicable technology-based limits on point sources or cost-effective and reasonable management practices for nonpoint sources. Or, a determination could be made that the cause of non-attainment is due to natural background conditions or irreversible human-caused conditions. Another alternative would be to establish that attaining the designated use would cause substantial environmental damage or substantial and widespread social and economic costs. If the findings of a UAA suggest authorizing the revision to a use or modification of a water quality standard is appropriate, the analysis and the accompanying proposal for such a modification must go through the public review, participation, and the USEPA approval processes.

1.2.2 Federal CSO Policy

The first national CSO Control Strategy was published by USEPA in the Federal Register on September 8, 1989 (54 FR 37370). The goals of that strategy were to minimize the water quality, aquatic biota, and human health impacts from CSOs by ensuring that CSO discharges comply with the technology-based and water-quality-based requirements of the CWA. On April 19, 1994, USEPA officially issued the CSO Control Policy (59 FR 18688), which established a consistent national approach for controlling discharges from all CSOs to the waters of the United States. The CSO Control Policy provides guidance to permittees and NPDES permitting authorities such as NYSDEC on the development and implementation of a Long-Term CSO Control Plan to attain water quality standards in accordance with the CWA. On December 15, 2000, amendments to Section 402 of the CWA (known as the Wet Weather Water Quality Act of 2000) were enacted, incorporating the CSO Control Policy by reference.

USEPA has stated that its CSO Control Policy represents a comprehensive national strategy to ensure that municipalities, permitting authorities, WQS authorities and the public engage in a comprehensive and coordinated planning effort to achieve cost effective CSO controls that ultimately meet appropriate health and environmental objectives and requirements (USEPA, 1995a). Four key principles of the CSO Control Policy ensure that CSO controls are cost effective and meet the objectives of the CWA:

1. Clear levels of control are provided that would be presumed to meet appropriate health and environmental objectives;

2. Sufficient flexibility is allowed to municipalities to consider the site-specific nature of CSOs and to determine the most cost effective means of reducing pollutants and meeting CWA objectives and requirements;

3. A phased approach to implementation of CSO controls is acceptable; and

4. WQS and their implementation procedures may be reviewed and revised, as appropriate, when developing CSO control plans to reflect the site-specific wet weather impacts of CSOs.

In addition, the CSO Control Policy clearly defines expectations for permittees, state WQS authorities, and NPDES permitting and enforcement authorities. Permittees were expected to have implemented USEPA's nine minimum controls by 1997, after which long-term control plans should be developed. The NMCs are embodied in the 14 best management practices (BMPs) required by NYSDEC as discussed in Section 5.3 and include:

1. Proper operation and maintenance of combined sewer systems and combined sewer overflows;

2. Maximum use of the collection system for storage;

3. Review and modification of pretreatment requirements to determine whether non-domestic sources are contributing to CSO impacts;

4. Maximizing flow to the Publicly Owned Treatment Works (POTW);

5. Elimination of CSOs during dry weather;

6. Control of solid and floatable material in CSOs;

7. Pollution prevention programs to reduce contaminants in CSOs;

8. Public notification; and

9. Monitoring to characterize CSO impacts and the efficacy of CSO controls.

WQS authorities should review and revise, as appropriate, State WQS during the CSO long term planning process. NPDES permitting authorities should consider the financial capability of permittees when reviewing CSO control plans.

In July 2001, USEPA published "*Coordinating CSO Long Term Planning with Water Quality Standards Reviews*", additional guidance to address questions and describe the process of integrating development of CSO long-term control plans with water quality standards reviews (USEPA, 2001). The guidance acknowledges that the successful implementation of an LTCP requires coordination and cooperation among CSO communities, constituency groups, states and USEPA using a watershed approach. As part of the LTCP development, USEPA recommends that WQS authorities review the LTCP to evaluate the attainability of applicable WQS. The data collected, analyses conducted and planning performed by all parties may be sufficient to justify a

WQS revision if a higher level of designated uses is attainable or if existing designated uses are not reasonably attainable. If the latter is true, USEPA allows the state WQS authorities to consider several options.

- Application of site-specific criteria;

- Apply criteria at point of contact rather than end of pipe (mixing zone, waterbody segmentation);

- Apply less stringent criteria when it is unlikely that recreational uses will occur or when water is unlikely to be ingested;

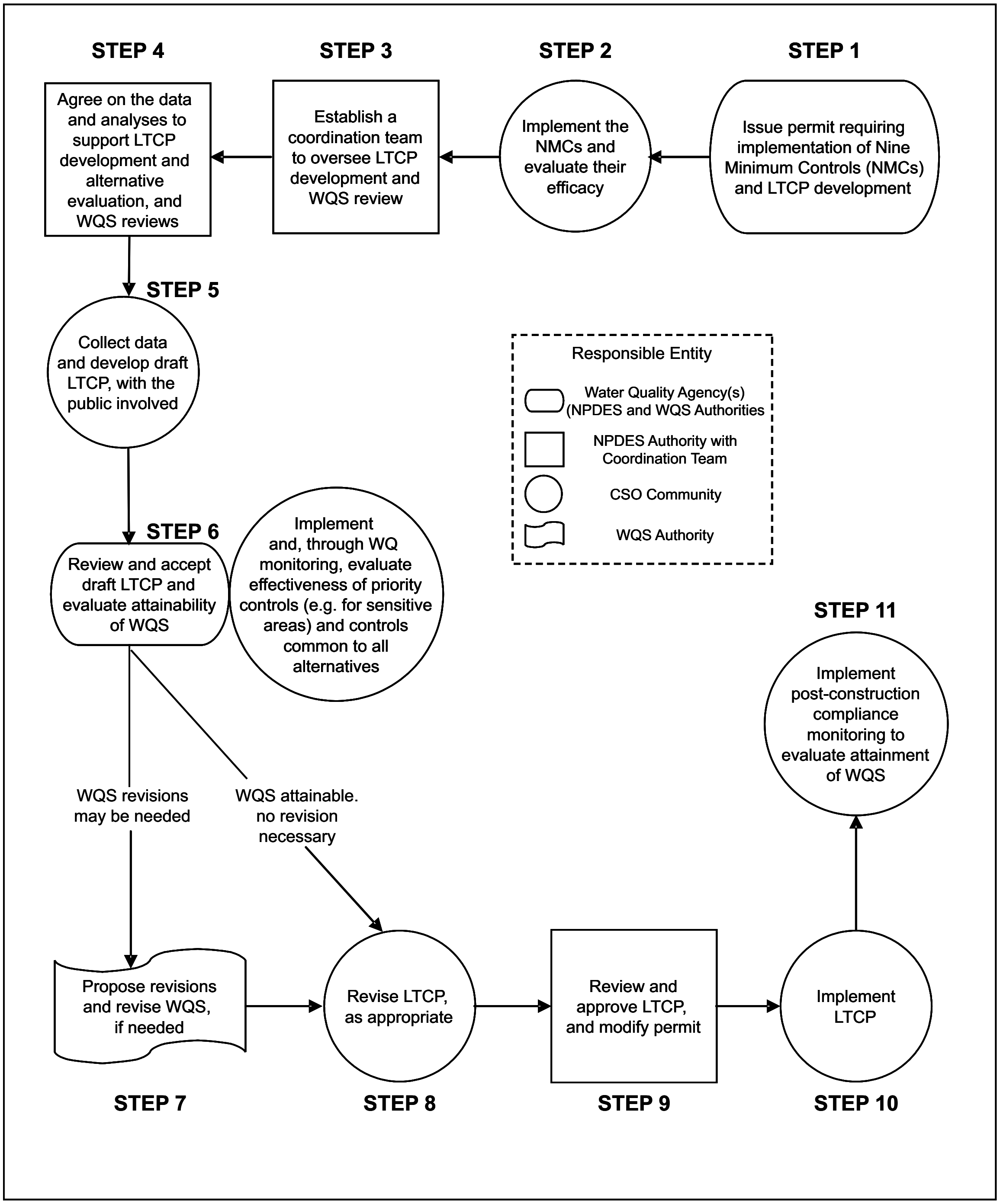
- Consider subcategories of uses, such as precluding swimming during or immediately following a CSO event or developing a CSO subcategory of recreational uses; and

- Consider a tiered aquatic life system with subcategories for urban systems.

If the waterbody supports a use with more stringent water quality requirements than the designated use, USEPA requires the state to revise the designated use to reflect the higher use being supported. Conversely, USEPA requires that a UAA be performed whenever the state proposes to reduce the level of protection for the waterbody. States are not required to conduct UAAs when adopting more stringent criteria for a waterbody. Once WQS are revised, the CSO Control Policy requires post-implementation compliance monitoring to evaluate the attainment of designated uses and WQS and to determine if further water quality revisions and/or additional long-term control planning is necessary. USEPA provides a schematic chart (Figure 1-3) in its guidance for describing the coordination of LTCP development and WQS review and revision.

As discussed herein, the NYC CSO control program for Gowanus Canal was initiated some time ago, and Steps 1 through 5 of the flow chart were completed or undertaken prior to the adoption of the CSO Policy. As described later in this document, this has led to the development of facility plans that have been constructed or are currently under construction (Step 10). With the requirement to develop a Waterbody/Watershed Facility Plan and ultimately an LTCP for Gowanus Canal, the NYCDEP has re-initiated some of the activities in Step 4 and re-examined a number of CSO-control alternatives beyond the previously approved facility plans to evaluate whether additional water-quality uses can be attained through cost-effective controls (Step 6). This report proposes a Waterbody/Watershed Facility Plan that, with minor modification following NYCDEC approval (Step 8) will be presented along with any modified permit requirements for approval as a final LTCP (Step 9). This report also proposes a post-construction monitoring program (Step 11). Moving forward, NYSDEC will need to examine the WQS in accordance with Step 7 and further modify the SPDES permits (attached in Appendix E), if appropriate, in accordance with Step 9.

It is important to note that New York City's CSO abatement efforts were displayed as model case studies by USEPA during a series of seminars held across the United States in 1994 to discuss the CSO Control Policy with permittees, WQS authorities, and NPDES permitting authorities (USEPA, 1994). New York City's field investigations, watershed and receiving water modeling, and facility planning conducted during the Paerdegat Basin Water Quality Facility Planning Project were described as a case study during the seminars. Additional City



New York City
Department of Environmental Protection

Gowanus Canal Waterbody/Watershed Facility Plan

Long-Term CSO Control Planning Procedures

FIGURE 1-3

efforts in combined sewer system characterization, mathematical modeling, water quality monitoring, floatables source and impact assessments, and use attainment were also displayed as model approaches to these elements of long-term CSO planning.

1.2.3 New York State Policies and Regulations

In accordance with the provisions of the Clean Water Act, the State of New York has established WQS for all navigable waters within its jurisdiction. The State has developed a system of waterbody classifications based on designated uses that includes five marine classifications, as shown in Table 1-1.

NYSDEC considers the SA and SB classifications to fulfill the Clean Water Act goals of fully supporting aquatic life and recreation. Class SC supports aquatic life and recreation but the recreational use of the waterbody is limited due to other factors. Class I supports the Clean Water Act goal of aquatic life protection and supports secondary contact recreation. SD waters shall be suitable for fish survival only because natural or manmade conditions limit the attainment of higher standards.

Table 1-1. New York State Numerical Surface Water Quality Standards (Saline)

Class	Usage	Dissolved Oxygen (mg/L)	Total Coliform (MPN/100mL)	Fecal Coliform (MPN/100mL)
SA	Shellfishing for market purposes, primary and secondary contact recreation, fishing. Suitable for fish propagation and survival.	≥ 4.8(1) ≥3.0(2)	≤ 70(3)	N/A
SB	Primary and secondary contact recreation, fishing. Suitable for fish propagation and survival.	≥ 5.0	≤ 2,400(4) ≤ 5,000(5)	≤ 200(6)
SC	Limited primary and secondary contact recreation, fishing. Suitable for fish propagation and survival.	≥ 5.0	≤ 2,400(4) ≤ 5,000(5)	≤ 200(6)
I	Secondary contact recreation, fishing. Suitable for fish propagation and survival.	≥ 4.0	≤ 10,000(6)	≤ 2,000(6)
SD	Fishing. Suitable for fish survival. Waters with natural or man-made conditions limiting attainment of higher standards.	≥ 3.0	N/A	N/A

Notes:

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

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

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

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

(2) Acute standard (never less than 3.0 mg/L).
(3) Median most probable number (MPN) value in any series of representative samples.
(4) Monthly median value of five or more samples.
(5) Monthly 80th percentile of five or more samples.
(6) Monthly geometric mean of five or more samples.

Dissolved Oxygen

The NYSDEC uses a numerical dissolved oxygen standard to establish whether a waterbody supports aquatic-life uses. The numerical dissolved oxygen standard for Gowanus Canal (Class SD) requires that dissolved oxygen concentrations be greater than 3.0 mg/L at all times throughout the waterbody.

Bacteria

The NYSDEC uses numerical standards for total coliform, fecal coliform, and enterococci to establish whether a waterbody supports recreational uses. No numerical bacteria standards apply to Gowanus Canal, a Class SD waterbody.

Narrative Standards

In addition to numerical standards, New York State also has narrative criteria to protect aesthetics in all waters within its jurisdiction, regardless of classification. These standards also serve as limits on discharges to receiving waters within the State. Unlike the numerical standards, which provide an acceptable concentration, narrative criteria generally prohibit quantities that would impair the designated use or have a substantial deleterious effect on aesthetics. An important exception is the parameter "garbage, cinders, ashes, oils, sludge and other refuse," for which the narrative standard is "none in any amounts." The term "other refuse" has been interpreted to include floatable materials such as street litter that finds its way into receiving waters via uncontrolled CSO and storm sewer discharges. It should be noted that, in August 2004, USEPA Region II recommended that the NYSDEC "Revise the narrative criteria for aesthetics to clarify that these criteria are meant to protect the best use(s) of the water, and not literally require "none" in any amount, or provide a written clarification to this end." Table 1-2 summarizes the New York State narrative WQS.

Table 1-2. New York State Narrative Water Quality Standards

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

Table 1-2. New York State Narrative Water Quality Standards

Parameters	Classes	Standard
Garbage, cinders, ashes, oils, sludge and other refuse	SA, SB, SC, I, SD A, B, C, D	None in any amounts.
Phosphorus and nitrogen	SA, SB, SC, I, SD A, B, C, D	None in any amounts that will result in growth of algae, weeds and slimes that will impair the waters for their best usages.

Pollutants of Concern for Section 303(d) Impaired Waters

In accordance with Section 303(d) of the Federal Clean Water Act, NYSDEC periodically identifies "impaired waters" where specific designated uses are not fully supported, and identifies the specific pollutant(s) of concern for these waterbodies. Since its first such review in 1998, and in its most recent review for 2006 (NYSDEC, 2007), New York State has listed Gowanus Canal as an impaired waterbody due to "dissolved oxygen/oxygen demand" caused by "urban/storm/CSO" inputs.

1.2.4 Interstate Environmental Commission

The Interstate Environmental Commission (IEC) is a joint agency of the States of New York, New Jersey, and Connecticut. The IEC was established in 1936 under a Congressionally approved Compact between New York and New Jersey; the State of Connecticut joined in 1941. The Tri-State Compact designates all tidal waters of the greater New York City metropolitan area as the Interstate Environmental District and established the IEC (formerly known as the Interstate Sanitation Commission) to protect waterbody uses within the District through the development and enforcement of waterbody classifications and effluent standards.

The IEC's area of jurisdiction runs west from Port Jefferson and New Haven on Long Island Sound, south from the Bear Mountain Bridge on the Hudson River down to Sandy Hook Bay, and east from the mouth of the Raritan River and Sandy Hook Bay to the Atlantic Ocean at Fire Island Inlet on the southern shore of Long Island. The interior area includes Newark Bay, Kill Van Kull, the Arthur Kill, Upper and Lower New York Bays, and the waters abutting all five boroughs of New York City.

In general, IEC water quality regulations require that all waters of the Interstate Environmental District are free from floating and settleable solids, oil, grease, sludge deposits, and unnatural color or turbidity to the extent necessary to avoid unpleasant aesthetics, detrimental impacts to the natural biota, or use impacts. The regulations also prohibit the presence of toxic or deleterious substances that would be detrimental to fish, offensive to humans, or unhealthful in biota used for human consumption. The IEC also restricts CSO discharges to within 24 hours of a precipitation event, but IEC effluent quality regulations do not apply to CSOs if the combined sewer system is being operated with "reasonable care, maintenance, and efficiency."

Table 1-3 presents the three-tiered IEC waterbody classifications and the associated uses, dissolved oxygen standards, and affected waterbodies. Although IEC regulations are intended to be consistent with the WQS of the signatory States, the three-tiered IEC system and the five New

York State marine classifications in New York Harbor do not correspond exactly in terms of spatial boundaries, numerical limits, or narrative requirements.

Table 1-3. Interstate Environmental Commission Numerical Water Quality Standards

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

The IEC classifies Gowanus Canal as a B-1 waterbody. Uses for this classification include fishing and secondary contact recreation, and a minimum dissolved oxygen concentration of 4.0 mg/L applies to protect the growth and maintenance—though not necessarily the propagation—of fish and other marine life.

1.2.5 Administrative Consent Order

New York City's 14 SPDES permits contain conditions designed to comply with federal and State CSO requirements. NYCDEP was unable to comply with deadlines imposed in their 1988 permits for completion of four CSO abatement projects initiated in the early 1980s. As a result, NYCDEP entered into an Administrative Consent Order with NYSDEC on June 26, 1992, which was incorporated into the SPDES permits with a provision stating that the Consent Order governs NYCDEP's obligations for its CSO program. It also required NYCDEP to implement CSO-abatement projects in nine facility-planning areas divided into two tracks: those areas where dissolved oxygen and coliform standards were being contravened (Track One), and those areas for which floatables control was necessary (Track Two). The 1992 Order was modified on September 19, 1996 to add a catch-basin cleaning, construction, and repair program.

NYCDEP and NYSDEC negotiated a new Consent Order, signed January 15, 2005, that supersedes the 1992 Order and its 1996 Modifications with the intent to bring all NYCDEP CSO-related matters into compliance with the provisions of the Clean Water Act and Environmental Conservation Law. The new Order, noticed by NYSDEC in September 2004, contains requirements to evaluate and implement CSO-abatement strategies on an enforceable timetable for 18 waterbodies and, ultimately, for City-wide long-term CSO control in accordance with USEPA CSO Control Policy. This Order was recently updated and signed on January 7, 2008. NYCDEP and NYSDEC also entered into a separate MOU to facilitate water quality standards reviews in accordance with the CSO Control Policy.

1.3 CITY POLICIES AND OTHER LOCAL CONSIDERATIONS

New York City has approximately 578 miles of waterfront, encompassing 17 percent of the total shoreline of the State. This resource is managed through multiple tiers of zoning, regulation, public policy, and investment incentives to accommodate the diverse interests of the waterfront communities and to encourage environmental stewardship. The local regulatory considerations are primarily applicable to proposed projects and, as such, do not preclude the existence of non-conforming waterfront uses. However, evaluation of existing conditions within the context of these land use controls and public policy can anticipate the nature of long-term growth in the watershed.

1.3.1 New York City Waterfront Revitalization Program

The New York City Waterfront Revitalization Program (WRP) is the City's principal coastal zone management tool and is implemented by the New York City Department of City Planning. The WRP establishes the City's policies for development and use of the waterfront and provides a framework for evaluating the consistency of all discretionary actions in the coastal zone with City coastal management policies. Projects subject to consistency review include any project that is located within the coastal zone and requires a local, state, or federal discretionary action, such as the Uniform Land Use Review Procedure (ULURP) or a City Environmental Quality Review (CEQR). An action is determined to be consistent with the WRP if it would not substantially hinder and, where practicable, would advance one or more of the ten WRP policies. The New York City WRP is authorized under the New York State Waterfront Revitalization and Coastal Resource Act of 1981, which, in turn, stems from the Federal Coastal Zone Management Act of 1972. The original WRP, which was adopted in 1982 as a local plan in accordance with Section 197-a of the City Charter, incorporated the 44 State policies, added 12 local policies, and delineated a coastal zone to which the policies would apply. The WRP was revised in 1999 and the new WRP policies were issued in September 2002. The revised WRP condensed the 12 original policies into 10 policies: (1) residential and commercial redevelopment; (2) water-dependent and industrial uses; (3) commercial and recreational boating; (4) coastal ecological systems; (5) water quality; (6) flooding and erosion; (7) solid waste and hazardous substances; (8) public access; (9) scenic resources; and (10) historical and cultural resources.

1.3.2 New York City Comprehensive Waterfront Plan

The City's long-range goals are contained in the Comprehensive Waterfront Plan (CWP). The CWP identifies four principal waterfront functional areas (natural, public, working, and redeveloping) and promotes use, protection, and redevelopment in appropriate waterfront areas. The companion Borough Waterfront Plans (1993-1994) assess local conditions and propose strategies to guide land use change, planning and coordination, and public investment for each of the waterfront functional areas. The CWP has been incorporated into local law through land use changes, zoning text amendments, public investment strategies, and regulatory revisions, providing geographic specificity to the WRP and acknowledging that certain policies are more relevant than others on particular portions of the waterfront.

1.3.3 Department of City Planning Actions

The New York City Department of City Planning (NYCDCP) was contacted to identify any projects either under consideration or in the planning stages that could substantially alter the land use in the vicinity of the waterbody. NYCDCP reviews any proposal that would result in a fundamental alteration in land use, such as zoning map and text amendments, special permits under the Zoning Resolution, changes in the City Map, the disposition of city-owned property, and the siting of public facilities. In addition, NYCDCP maintains a library of City-wide plans, assessments of infrastructure, community needs evaluations, and land use impact studies. These records were reviewed and evaluated for their potential impacts to waterbody use and runoff characteristics, and the NYCDCP community district liaison for the Community District was contacted to determine whether any proposals in process that required NYCDCP review might impact the Waterbody/Watershed Facility (WB/WS) Plan.

1.3.4 New York City Economic Development Corporation

The New York City Economic Development Corporation (NYCEDC) was contacted to identify and projects either under consideration or in the planning stages that could substantially alter the land use in the vicinity of the waterbody. The NYCEDC is charged with dispensing City-owned property to businesses as a means of stimulating economic growth, employment, and tax revenue in the City of New York while simultaneously encouraging specific types of land use in targeted neighborhoods. As such, NYCEDC has the potential to alter land use on a large scale.

In addition, NYCEDC serves as a policy instrument for the Mayor's Office, and recently issued a white paper on industrial zoning (Office of the Mayor, 2005) intended to create and protect industrial land uses throughout the City. The policy directs the replacement of the current In-Place Industrial Parks (IPIP) with Industrial Business Zones (IBZs) that more accurately reflect the City's industrial areas. Policies of this nature can have implications on future uses of a waterbody as well as impacts to collection systems, so a thorough review of NYCEDC policy and future projects was performed to determine the extent to which they may impact the WB/WS Plan.

1.3.5 Local Law

Local law is a form of municipal legislation that has the same status as an act of the State Legislature. The power to enact local laws is granted by the New York State Constitution, with the scope and procedures for implementation established in the Municipal Home Rule Law. In New York City, local laws pertaining to the use of City waterways and initiatives associated with aquatic health have been adopted beyond the requirements of New York State. Recent adoptions include Local Law 71 of 2005, which required the development of the Jamaica Bay Watershed Protection Plan (JBWPP), and Local Law 5 of 2008, which requires City-owned building or City-funded reconstruction to include certain sustainable practices, as well as requiring the City to draft a sustainable stormwater management plan by Oct. 1, 2008. These initiatives are discussed in Section 5 in detail.

1.3.6 Bathing Beaches

Bathing beaches in New York City are regulated, monitored, and permitted by the City and State under Article 167 of the New York City Health Code and Section 6-2.19 of the New York City Sanitary Code. Siting requirements imposed by State and City codes must be considered to evaluate the potential use of a waterbody for primary contact recreation. These requirements include minimum distances from certain types of regulated discharges (such as CSO outfalls), maximum bottom slopes, acceptable bottom materials, minimum water quality levels, and physical conditions that ensure the highest level of safety for bathers.

1.4 REPORT ORGANIZATION

This report has been organized to clearly describe the proposed Waterbody/Watershed Facility Plan and the environmental factors and engineering considerations that were evaluated in its development. The report begins with an introduction that presents general planning information and the regulatory considerations in order to describe the setting and genesis of the Waterbody/Watershed Facility Plan. Sections 2, 3, and 4 describe the existing watershed, collection system, and waterbody characteristics. Section 5 describes waterbody improvement projects undertaken by NYCDEP and others as appropriate within the waterbody and the greater New York Harbor. Section 6 describes the public participation and agency interaction that went into the development of this Waterbody/Watershed Facility Plan, as well as an overview of NYCDEP's public outreach program. Sections 7 and 8 describe the development of the facility plan for the waterbody. Section 9 discusses the review and revision of water quality standards. The report concludes with references in Section 10 and a glossary of terms and abbreviations in Section 11.

For cross referencing, Table 1-4 lists each of the nine elements of long-term CSO control planning along with relevant sections of this report. Attached for reference in appendices are the Wet-Weather Operating Plans for the Red Hook and Owls Head WPCPs, biological exhibits, public-opinion surveys, figures for alternative analyses, SPDES permits for the Red Hook and Owls Head WPCPs, preliminary operational plans for elements of the Waterbody/Watershed Facility Plan, and minutes of the Stakeholder Team Meeting held on July 25, 2006.

Table 1-4. Locations of the Nine Elements of Long-Term Control Planning

Element		Report Section(s)
1	Characterization of the Combined Sewer System	2.0, 3.0
2	Public Participation	6.0
3	Consideration of Sensitive Areas	4.7
4	Evaluation of Alternatives	7.0
5	Cost/Performance Considerations	7.0
6	Operational Plan	8.0
7	Maximizing Treatment at the Existing WPCP	3.0, 7.0, 8.0
8	Implementation Schedule	8.0
9	Post-Construction Compliance Monitoring	8.0

2.0 Watershed Characteristics

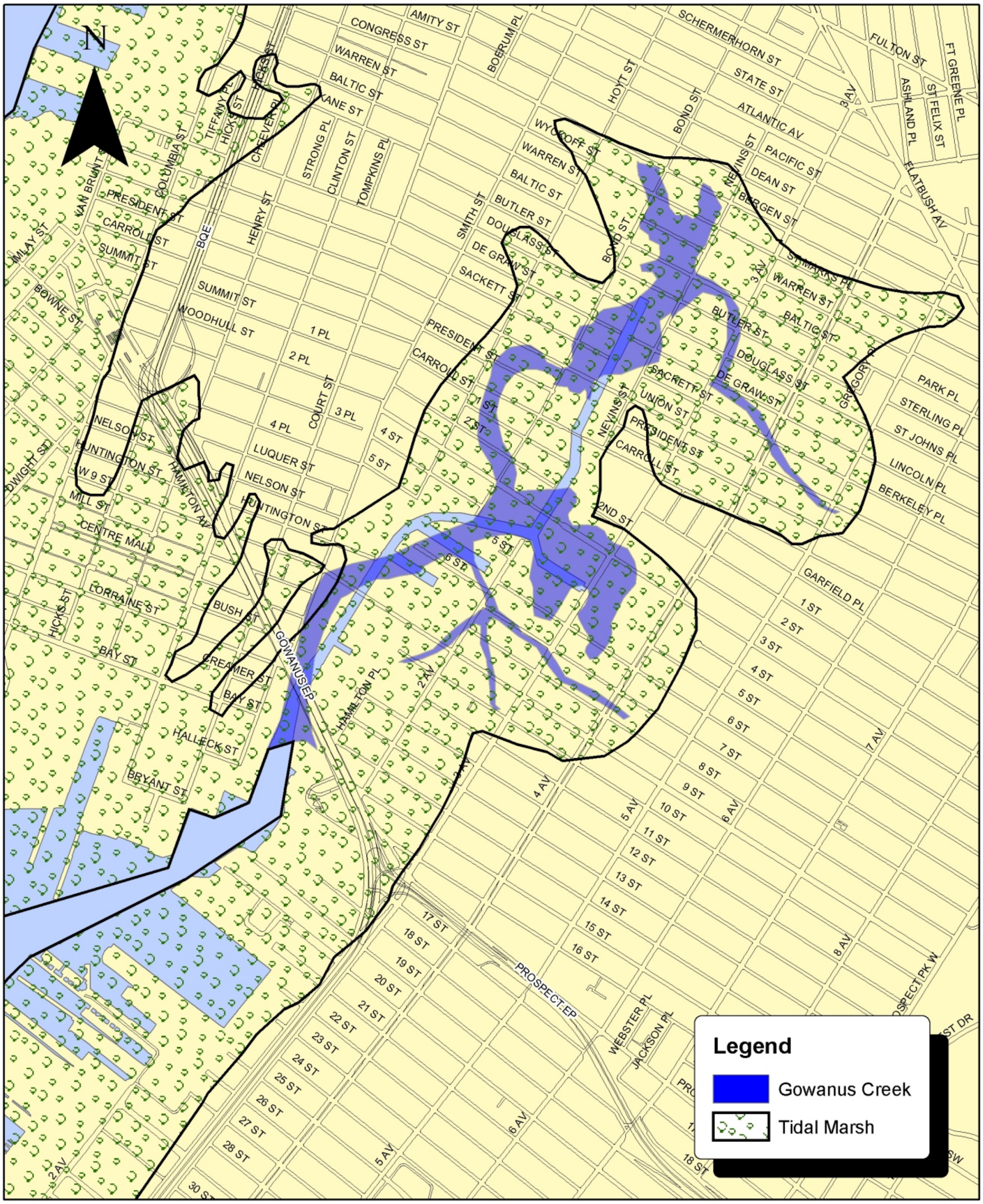
The present-day Gowanus Canal watershed (Figure 1-2) is highly urbanized and bears little resemblance to the natural tidal wetland that existed when the first European settlers came to the area. The growth and expansion of New York City led to the urbanization of that natural area and the creation of the combined sewer systems that can discharge to the Canal.

This section describes the history and urbanization of the watershed and other physical changes impacting the waterbody, and provides information related to existing and proposed land uses and zoning in the watershed and in the riparian areas surrounding the Canal. This section also addresses possible landside pollutant loading sources from industrial activities that have the potential to impact water quality in Gowanus Canal.

2.1 HISTORICAL CONTEXT OF WATERSHED URBANIZATION

In 1639, in one of the earliest recorded real estate transactions in New York City history, Dutch leaders of New Netherlands purchased the area around present-day Gowanus Bay to establish a tobacco plantation. Farmers settled in the area they named “Gowanes Creek” after Gouwane, a leader of a local Lenape tribe, and began modifying the wetlands to support farming, fishing, and commercial activities. Gowanus Creek was altered through dam construction, dredging and filling that created impoundments, added channels, and filled wetlands.

Figure 2-1 presents an interpretation of several period maps depicting Gowanus Creek in the mid 1700s, superimposed over a present-day map of the same area. Historical records indicate that in 1765, the waterbody was still a tidal creek, surrounded by large salt marshes and featuring two ponds: the "Upper" or "Freeke's Mill" Pond, located near the present-day head of the Canal, and the "Lower" or "Denton's Mill" Pond, located near the present-day 4th Street Basin. During the early 1800s, residential developments within the Village of Brooklyn began to surge in what is known today as Brooklyn Heights (NYCDEP, 1983). Areas south and east of Brooklyn Heights lagged behind in development, but the arrival of ferry transportation connecting Brooklyn to New York City promoted growth in South Brooklyn by the mid 1830s. In 1839, a city commission officially mapped a rectangular street-grid system, and by the mid 1800s the City of Brooklyn began incorporating Gowanus Creek and surrounding areas (City Green, 1997). By 1840, dams, landfills, straightening and bulkheading had significantly altered the physical and ecological characteristics of Gowanus Creek. The area was largely industrial, consisting of flour mills, cement works, tanneries, and paint, ink and soap factories that discharged pollutants into the waterbody. Plans for dredging the Creek and creating a canal were proposed during that time for the purposes of supporting local businesses as well as “draining of all that section of the City [Brooklyn] which empties its waters into Gowanus Creek and Bay” (Richards, 1848). The plans included constructing navigational channels and basins, and filling wetlands. The drainage area at that time was calculated to be about 1,700 acres, including proposed filling locations. In 1849, the first mile of Gowanus Creek was dredged and its transformation into Gowanus Canal was essentially completed by 1869.



Source: Gowanus Canal 201 Facilities Plan- Volume 2

New York City
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Gowanus Canal Waterbody/Watershed Facility Plan

Gowanus Creek Prior to Construction of Gowanus Canal

FIGURE 2-1

The extent of the physical transformation of Gowanus Creek into Gowanus Canal is illustrated by reviewing Figures 2-1 and 2-2. The top panel of Figure 2-2 is an excerpt from a historical map dated 1891, featuring Gowanus Canal and its watershed. The map indicates that the transformation of a rural upland to a commercial, industrial and residential watershed was mostly complete by that time. The current configuration of Gowanus Canal is shown on the bottom panel of Figure 2-2, which is an excerpt from aerial photography taken in 2001-2002 for approximately the same geographic area. These figures clearly show the transformation of Gowanus Creek into Gowanus Canal and the replacement of wetlands and open space with urban development.

Today, about 108,800 people live in the 1,758-acre Gowanus Canal watershed, most of which (1,654 acres) is served by combined and storm sewers draining to two different wastewater pollution control plants (as discussed in Section 3). Due to physical changes made to the topography, as well as the construction of the sewer system, the actual drainage area of Gowanus Canal differs somewhat from the watershed that would be expected from an analysis of the surface topography, as shown on Figure 2-3. Urbanization also increased the imperviousness of the watershed so that runoff is now conveyed to the sewer system and into Gowanus Canal much more quickly and without the attenuation that wetlands had provided before being completely eliminated.

2.2 LAND USE CHARACTERIZATION

The Gowanus Canal watershed drains 1,758 acres of western Brooklyn, as described in Section 1 and presented on Figure 1-2. To characterize this area, it is important to look not only at the general land uses within the entire watershed, but also to focus on the land uses and characteristics of the "riparian areas" in the immediate vicinity (i.e., blocks wholly or partially within a quarter mile) of the Canal itself. The following sections describe – as appropriate for the watershed and/or riparian areas – the current land uses, zoning, neighborhood and community characteristics, proposed land uses, and consistency with the New York City Waterfront Revitalization Program.

2.2.1 Current Land Use

In general, the riparian areas immediately surrounding the Canal are dominated by warehousing, commercial uses and heavy industrial uses, while the rest of the watershed is mostly residential. Table 2-1 summarizes the land-use characteristics of both the Gowanus Canal watershed and the riparian areas. As a whole, the Gowanus Canal watershed is 53 percent residential, 2 percent park, and 45 percent mixed uses, including public facilities and institutions, commercial, manufacturing, and transportation. Riparian areas (including all blocks which are wholly or partially within a quarter mile of the Canal) are characterized as 18 percent residential, 6 percent park, and 76 percent mixed uses.

Gowanus Canal, 1891

Gowanus Canal, 2001/2002

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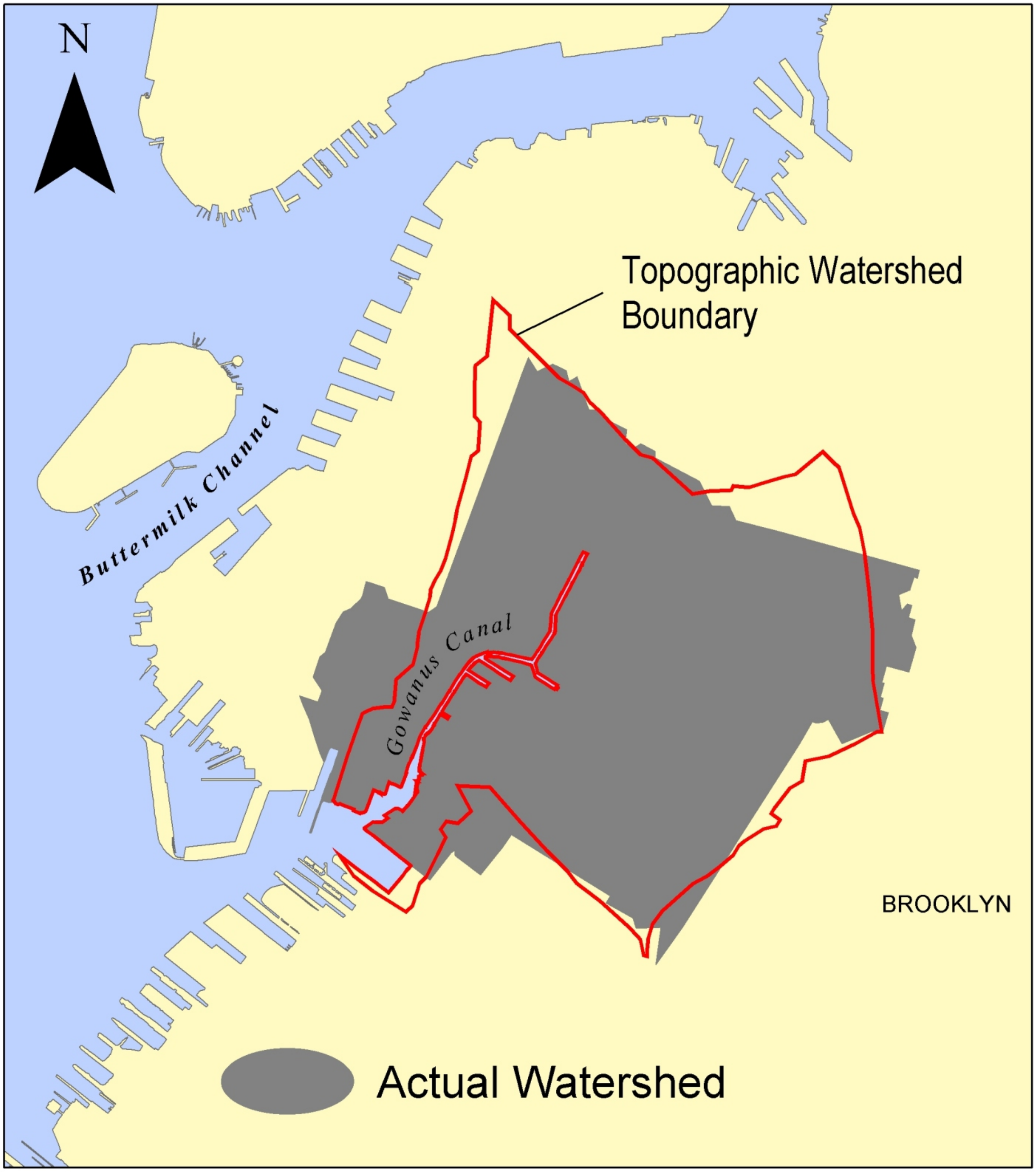
Gowanus Canal Waterbody/Watershed Facility Plan

Gowanus Canal Urbanization

FIGURE 2-2



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Gowanus Canal Topographic and Actual Watersheds

Table 2-1. Gowanus Canal Land Use Summary by Category

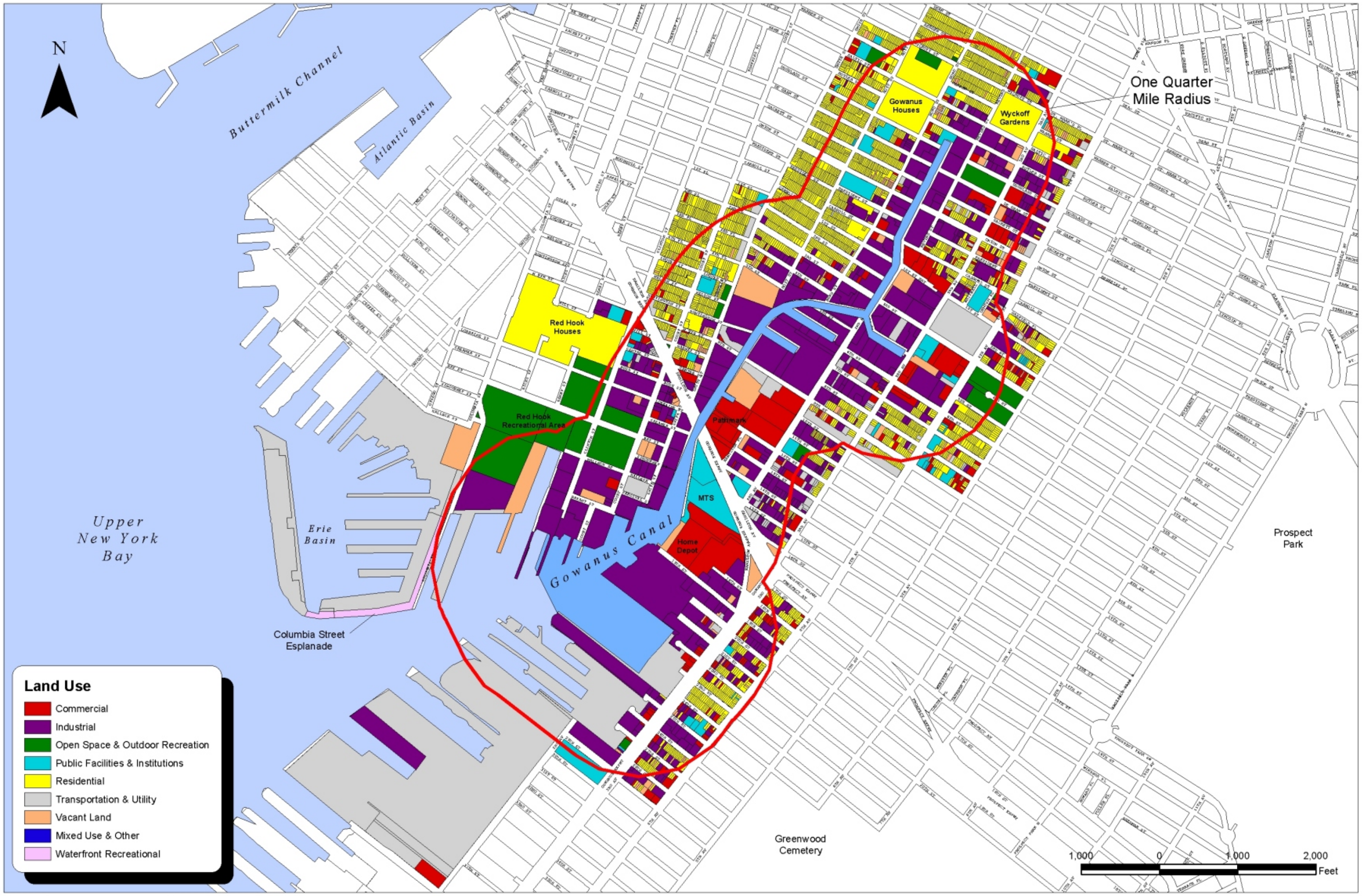
Land Use Category	Watershed Area	Riparian Area (Within 1/4 Mile Radius)(1)
Residential	53 %	18 %
Park and Recreation	2 %	6 %
Mixed Use(2)	45 %	76 %

(1) Riparian areas include all blocks wholly or partially within a quarter mile of the Canal. See Figure 2-4.
(2) Public facilities and institutional, commercial, manufacturing, transportation and vacant.

Figure 2-4 presents a map of the land uses within the riparian areas surrounding Gowanus Canal. These riparian areas are generally dominated by industrial uses along the Canal's upper reaches, with scattered commercial, institutional and vacant land uses scattered along the waterfront in the vicinity of and south of the Gowanus Expressway. Transportation uses are concentrated near the mouth of the Canal, at the westernmost extent of the waterbody/watershed assessment area. The Red Hook Recreational Area, located north and east of Erie Basin, represents the largest section of open space within the assessment area.

Approximately one third of the riparian land area (shown on Figure 2-4) surrounding Gowanus Canal is classified as having transportation or utility uses. These transportation uses are primarily located near the mouth of the Canal. One major transportation use is the South Brooklyn Marine Terminal, located along the southern shoreline beyond the Canal. Another is the Erie Basin Barge Port, which has barge slips and distribution centers located along the interior of Erie Basin. Erie Basin also features a New York City Police Department vehicle-impound lot at the western end of the seawall arm, a large one-story warehouse building and associated parking area, and additional storage and commercial uses. In addition, the newly refurbished Columbia Street Esplanade, which includes a pedestrian walkway, bikeway and fishing pier, is located along the south side of the seawall. The former New York Shipyard is located to the north of Erie Basin, approximately one-quarter mile west of the lower reaches of the Canal.

Industrial uses dominate the Gowanus Canal waterfront, and generally extend from the waterfront to the first upland block from the Canal. Industrial uses exist on approximately 25 percent of the land within the assessment area. Common industrial uses throughout the reach include various manufacturing operations, distribution/trucking centers, warehouses and bulk fuel/petroleum storage facilities. A cement plant is located at the intersection of Bond and 3rd Street. Further south, along the western bank of the Canal, fuel tanks, a scrap metal yard and a parking lot are located between 9th Street and the Gowanus Expressway. Further south and west of the Gowanus Expressway, Hess Oil operates a fuel-storage facility in the vicinity of Bryant and Court Streets: this facility extends from Clinton Street east to Smith Street and the Canal. North of the Hess facility, several automotive and truck repair facilities exist along the Gowanus Canal waterfront.



New York City
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Gowanus Canal Waterbody/Watershed Facility Plan

Gowanus Canal Generalized Land Use Map (1/4 Mile Radius)

FIGURE 2-4

Situated at the intersection of Smith and 5th Streets is a six-acre parcel of city-owned property that was designated a "Public Place" by the New York City Board of Estimate in 1974. This parcel, which was previously occupied by a coal gasification plant, was declared an Inactive Hazardous Waste Site by the NYSDEC due to the presence of solvents, coal tar residues, and pthalate wastes left from former industrial tenants (reference: Community Board 6 website). This parcel has remained vacant pending decisions regarding remediation.

In general, residential uses are located upland of – but still within close proximity to – the Gowanus Canal waterfront. The Red Hook Houses, a New York City Housing Authority (NYCHA) development, is located at the westernmost extent of the assessment area, approximately three blocks north of the Gowanus Canal waterfront. Northeast of the Red Hook Houses, residential uses predominate, with scattered institutional uses and small scale commercial uses that serve the residential populations of the area. Public and community facilities in the vicinity include the New York City Fire Department Engine Company 279, Ladder 131 facility (at the corner of Smith and Lorraine Streets), Saint Mary's Roman Catholic Church and Convent (along Nelson Street), and the Brooklyn Psychiatric Center (at the intersection of Union and Hoyt Streets). Farther north, near the head of the Canal, are the Gowanus Houses, a large NYCHA housing development that is located on Douglass Street, between Hoyt and Bond Streets.

North of 1st Street, the ends of streets in the vicinity of Gowanus Canal have undergone various improvements. These include community gardens and Green Streets, intended to convert paved, vacant areas, medians, and unused traffic islands into green spaces filled with trees, shrubs and other types of ground cover. These improvements have created small areas of open space within the assessment area. In addition, street-end improvements are currently in place along DeGraw Street, east of the Canal.

Beginning at the north end of Gowanus Canal and proceeding southward, the eastern side of the Canal is dominated by industrial uses, with other land uses interspersed. The Wyckoff Houses, a NYCHA housing development, is located in the vicinity of Baltic and Nevins Streets, north and east of the Canal. The Thomas Greene Playground is located between Nevins and 3rd Avenue, east of the Canal. Consolidated Edison of New York maintains a vehicle parking and maintenance facility between 3rd and 4th Avenues at 3rd Street, adjacent to and south of P.S. 372 - The Children's School at 219 1st Street. Further south, J.J. Byrne Park is located in the vicinity of the 4th Street Basin. The proposed Brooklyn Commons Cinema and retail shopping space, currently under construction during the writing of this report, is located between 2nd Avenue and Gowanus Canal, north of a Pathmark shopping center and immediately adjacent to Hamilton Avenue and the Gowanus Expressway. East of the Pathmark shopping center is the New York City Department of Sanitation (DSNY) Brooklyn District 6 Garage, which is located at the intersection of 2nd Avenue and 14th Street.

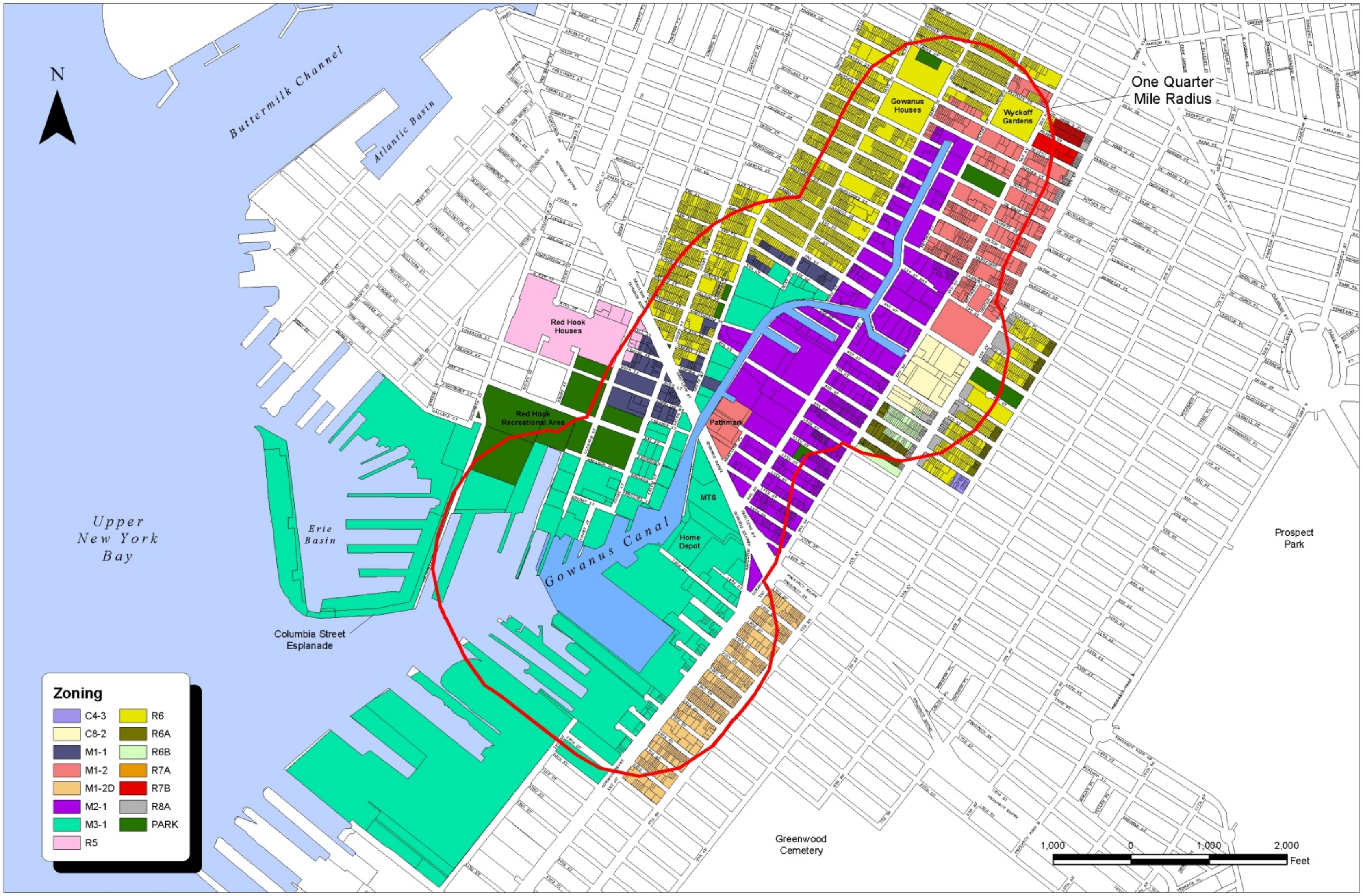
Several large industrial and institutional operations are located south of the Gowanus Expressway and Hamilton Avenue along the Gowanus Canal waterfront. The New York City Department of Transportation (NYCDOT) operates an asphalt plant on the south side of the Canal immediately west of Hamilton Avenue. Adjacent to the NYCDOT facility is the DSNY Hamilton Avenue Marine Transfer Station, also on the south side of the Canal. South of the DSNY facility along Hamilton Avenue are two large commercial uses, specifically Home Depot, a home-improvement retailer, and Jetro, a retail supermarket catering to the food service industry. To the east of 3rd Avenue, land uses are mixed residential and industrial. Waterfront uses to the south are dominated by large-scale industrial and transportation uses, including the NYCEDC South Brooklyn Marine Terminal, which extends from 29th to 39th Street, and currently includes a 90-acre auto terminal as various wharf structures and piers including the Continental Terminals. The Bush Terminal Docks are located further south of the assessment area, along Upper New York Bay.

2.2.2 Zoning

Zoning in the areas immediately surrounding the waterbody is important, not only to characterize the waterbody and the potential uses associated with it, but also as a consideration when developing engineering solutions as part of a LTCP. This section focuses on the zoning classifications in the riparian area comprised of blocks wholly or partially within a quarter mile of Gowanus Canal, as shown on Figure 2-5.

As shown on Figure 2-5, the riparian area immediately adjacent to the Gowanus Canal waterfront is dominated by industrial zoning classifications. South of the Gowanus Expressway/Hamilton Avenue, the waterfront area (the block extending inland from the Canal) is zoned M3-1, which corresponds to the heaviest industrial and manufacturing uses. This area features marine terminals, power-generating facilities, transfer stations, and an asphalt plant. North of the Gowanus Expressway, the waterfront area along the western side is mostly heavy industrial to 4th Street, while the waterfront area north of 4th Street and along the eastern side of the Canal is virtually all zoning classification M2-1, another industrial designation allowing for moderate manufacturing uses. On the eastern side of the Canal, just to the north of the Gowanus Expressway, there is an area zoned M1-2, a lighter industrial classification, in which there is a Pathmark supermarket. However, the M3-1 and M2-1 zoning classifications preclude many residential and community facilities and restricts commercial uses.

Beyond the first upland block surrounding the Canal, zoning typically transitions from industrial to residential. South of the Gowanus Expressway/Hamilton Avenue and east of the Canal, the area to the east of 3rd Avenue is zoned M1-2D, a light industrial classification that allows for limited residential development. On the west side of the Canal, the heavy industrial zones adjacent to the Canal give way to park designations, which include the Red Hook Recreational Area. Extending north from this park area to about 3rd Street are several small areas of M1-1 zoning, another light industrial classification that allows for certain community uses. To the west is a residential area that extends north around the head of the Canal, just beyond the waterfront block. This residential area is dominated by the R6 zoning classification, which allows for medium-density housing—typically buildings between 3 and 12 stories. North of 3rd Street, this residential area is adjacent to the M2-1 industrial-zoned waterfront block that surrounds the Canal. Near the head of the Canal, but just east of the waterfront block, there is an area zoned M1-2, a light industrial classification that generally serves as a buffer between heavier industrial uses and residential uses. South of this area, on the east side of the Canal between 7th and 3rd Streets, is an area zoned C8-2, another classification that serves as a transition between manufacturing and residential uses. In general, housing units are not permitted in M1-2 and C8-2 zones. To the south and east of these zones are residential areas



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Gowanus Canal Waterbody/Watershed Facility Plan

Gowanus Canal Generalized Zoning Map (1/4 Mile Radius)

FIGURE 2-5

designated as R6, R6A, and R6B zoning, which define medium-density housing districts of slightly different lot-coverage and set-back requirements. The 4th Avenue corridor in the assessment area features R8A zoning, which is a high-density residential classification typically corresponding to bulky, 11-story apartment buildings.

2.2.3 Proposed Development and Land Uses

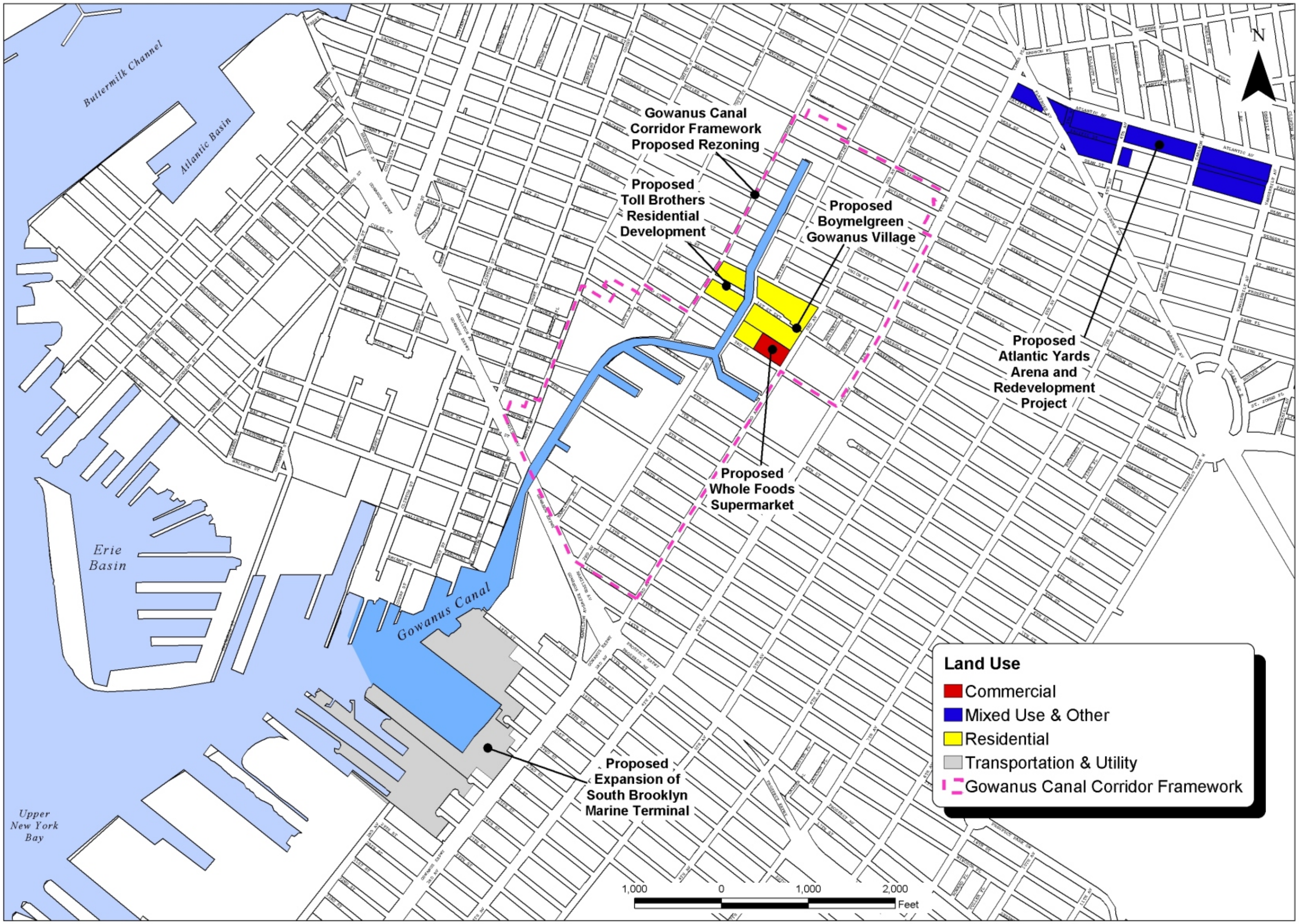
An assessment of currently proposed land uses or significant new facilities was conducted for the Gowanus Canal watershed area. Several significant proposed or recently completed developments were identified within the assessment area (Figure 2-6).

As part of widespread revitalization and expansion efforts within the Port of New York, the NYCEDC has commenced improvements within the existing South Brooklyn Marine Terminal (SBMT), located at the southernmost extent of the assessment area along the Upper New York Bay waterfront. The project involves the development of a 90-acre auto terminal, as well as the development of enhanced break-bulk facilities, wharf structures and dredging of existing berths to 35 feet to accommodate larger vessels. Construction is expected to begin in November 2008 and should be completed by May 2010. In addition, improvements to site fencing, lighting and security at the site and rail access would also be developed to serve a new rail terminal at the SBMT. This work is currently underway.

The Atlantic Yards project will involve the development of a sports and entertainment arena, landscaped open space, a boutique hotel, ground-floor retail space for local businesses, office space, and over 6,400 units of affordable, middle-income and market-rate housing. The proposed project will be located at the intersection of Atlantic and Flatbush Avenues, bounded by Pacific and Dean Streets and Vanderbilt Avenue, and primarily situated over the existing Metropolitan Transit Authority (MTA)/Long Island Railroad (LIRR) Vanderbilt rail yards. Atlantic Yards will span 22 acres and transform the current railyards and predominantly underutilized and industrial area into 17 buildings. The $4 billion development will encompass 336,000 square feet of office space, up to 6.4 million square feet of residential space, an 850,000 square foot sports and entertainment arena, 247,000 square feet of retail space, a 165,000 square foot hotel (180 rooms) and over eight acres of publicly accessible open space. Initial construction began in 2007 and the project will be developed in phases over an estimated 10-year period.

North of 3rd Street, on the eastern side of the Canal, a Whole Foods supermarket has been proposed for development. This approximately 1.5-acre site is located at the northwestern corner of 3rd Street at 3rd Avenue, as shown on Figure 2-6. Construction was initiated in 2006 and is ongoing at the site for an approximately 68,000 square foot store with a 430-car parking lot.

Residential developments by Toll Brothers, Boymelgreen Developers and others have also been proposed for areas immediately adjacent to the Canal. Toll Brothers has proposed a potential residential development along the western shore of the Canal between Bond Street, Carroll Street, 2nd Street and the Canal. In addition, other residential developments have been proposed or are in the active planning stages adjacent to the Toll Brothers site and at the Boymelgreen "Gowanus Village" site located on the eastern shore of the Canal along 3rd Avenue between Carroll and 2nd Street.



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Gowanus Canal Waterbody/Watershed Facility Plan

Gowanus Canal Proposed Development

FIGURE 2-6

In January 2007, the New York City Department of City Planning initiated a process to evaluate zoning of the areas adjacent and in close proximity to the Canal from Hamilton Avenue north to Baltic Avenue. This project, dubbed the Gowanus Canal Corridor Framework, will ultimately identify areas where future housing or mixed uses may be appropriate, as well as areas to be maintained for continued industrial and commercial use. It will also propose key urban design principles for areas where such land use changes could occur.

2.2.4 Neighborhood and Community Character

The Gowanus Canal watershed includes all or parts of the neighborhoods of Red Hook, Carroll Gardens, Boerum Hill, Gowanus, and Park Slope. The general locations of these neighborhoods within the Gowanus Canal watershed are shown on Figure 1-2. The riparian area, comprised of blocks wholly or partially within a quarter mile of the Canal (see Figures 2-4 and 2-5), includes portions of each of these neighborhoods except Park Slope, which is to the east of the riparian area. This section describes the character of the portions of each neighborhood that are within the riparian areas.

The character of the neighborhoods and communities in the immediate vicinity of Gowanus Canal is dominated by industry, although residential and transportation-related uses are also prominent throughout the riparian area. Residential areas are concentrated to the north and west of the Canal, generally beginning at the second block from the waterfront. Transportation uses are more prevalent along the southernmost limits of Gowanus Canal, primarily within Erie Basin and the piers along the eastern shoreline, near Gowanus Bay and Upper New York Bay.

The neighborhood of Red Hook is located south of the Gowanus Expressway, along the westernmost extent of Gowanus Canal. Approximately 75 percent of the population of Red Hook resides within the Red Hook Houses. South of this development is the Red Hook Recreational Area, which is the largest section of open space within the riparian area and contains an outdoor swimming pool, baseball, football, soccer and cricket fields, as well as open lawn space for various outdoor uses.

The neighborhoods of Carroll Gardens and Boerum Hill lie west and north of Gowanus Canal, respectively. Properties immediately adjacent to the Gowanus Canal waterfront are predominantly industrial in nature, but otherwise residential uses generally dominate these neighborhoods, comprised of brownstones, one and two-family homes and multi-apartment walk-ups, as well as small-scale commercial operations which service the residential populations of these areas. The neighborhood surrounding Smith and Court Streets has undergone extensive redevelopment and gentrification in the previous decade, primarily in the form of housing. The recent trend in the area has been towards the conversion of once three- and four-family houses into single-family homes. In addition, several previous industrial spaces such as a former furniture warehouse have been converted to rental units. As a result, this area has seen an increase in median rent and home prices in the past several years.

Two large residential developments are located within the neighborhood of Boerum Hill, approximately 500 feet from the head of Gowanus Canal. Wyckoff Gardens contains approximately 530 apartments in two, 20-story buildings located north and east of the head of the Canal. The Gowanus Houses, north and west of the Canal, contains a number of apartments, as well as associated playground areas. In addition, the Brooklyn Psychiatric Center occupies nearly an entire block at the corner of Hoyt and Union Streets.

Much of the central and eastern portions of the Gowanus Canal riparian area falls within the neighborhood of Gowanus. This neighborhood is dominated by industrial uses, with scattered residential dwellings intermixed. The waterfront in this area is entirely industrial in nature, with no established parklands in the vicinity of Gowanus Canal except the Thomas Greene Playground, which is located between Nevins Street and 3rd Avenue, between Douglass and DeGraw Streets. The Gowanus Arts Exchange, located at 295 Douglass Street within the Gowanus community, is a non-profit community arts organization, which hosts a variety of programs, classes and other activities for the neighborhood. Commercial uses, retail stores and a car dealership are located immediately north of the Gowanus Expressway at the Canal waterfront. South of the Gowanus Expressway, the area is characterized by an active and working waterfront area with multiple marine-based uses. These include several large-scale industrial and transportation uses that line the shore.

2.2.5 Consistency With the Waterfront Revitalization Program (WRP)

The NYCDCP Waterfront Revitalization Program targets an area referred to as the coastal zone boundary, which was originally mapped and adopted in 1982. The WRP has designated the lower reaches of Gowanus Canal as the Sunset Park Significant Maritime and Industrial Area (SMIA), as shown on Figure 2-7. This is reflective of the concentration of industrial and manufacturing uses throughout the reach. The SMIA currently extends south from 9th Street, along the Canal, and includes Erie Basin to the west and the waterfront piers along Upper New York Bay to the south. It also extends farther south and west beyond the assessment area.

Policy Two of the "New Waterfront Revitalization Program" (2002) encourages the support of "water-dependent and industrial uses in New York City coastal areas that are well-suited to their continued operation." As a result, the NYCDCP encourages the continued uses of Gowanus Canal for industrial purposes, and recommends strengthening, through appropriate infrastructure investment, the active industrial/maritime areas throughout the area, including Gowanus Canal. In addition, through the Gowanus Bay and Canal Ecosystem Restoration Feasibility Study, the U.S. Army Corps of Engineers (USACE) is assessing existing environmental limitations and identifying potential restoration and protection projects that may be proposed for the waterbody. A review of current and proposed land uses for the Gowanus Canal project area shows that these uses and recommendations would be consistent with the WRP, in addition to the "Plan for the Brooklyn Waterfront" (1994), the "New York City Comprehensive Waterfront Plan" (1992) and the SMIA designation by the NYCDCP.

2.3 REGULATED SHORELINE ACTIVITIES

An investigation of selected existing federal and state databases was performed in an effort to gather information on potential land-side sites that have the potential to affect water quality in Gowanus Canal. The extent of the study area was generally limited to the area in immediate proximity to Gowanus Canal. For the purposes of this assessment, potential sources included the existence of underground storage tanks (UST), major oil storage facilities (MOSF), known contaminant spills, existence of state or federal superfund sites, the presence of SPDES

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Gowanus Canal Waterbody/Watershed Facility Plan

Gowanus Canal Significant Maritime & Industrial Area

FIGURE 2-7

permitted discharges to the waterbody and other sources that may have the potential to affect the water quality.

USEPA Superfund Information System, which contains several databases with information on existing superfund sites, was accessed. These databases included: the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), Resource Conservation and Recovery Act Information (RCRAinfo), Brownfields Management System, Site Spill Identifier List (SPIL) and the National Priorities List (NPL). In addition to these federal databases, several databases managed by the NYSDEC were also reviewed. The NYSDEC Spill Incident Database and the Environmental Site Remediation Database, which allows searches of the NYSDEC Brownfield cleanup, state superfund (inactive hazardous waste disposal sites), environmental restoration and voluntary cleanup programs were reviewed. In addition, an Environmental Data Records (EDR) DataMap Area Study report was performed for areas immediately adjacent to the Canal and up to the nearest adjacent mapped street. This EDR report was primarily reviewed to provide information with regard to UST, leaking storage tanks (LTANKS) MOSF, as well as additional information from the state and federal databases listed above.

Based upon a review of the USEPA databases, no known superfund sites are located in the immediate vicinity of the Gowanus Canal. The EDR database, however, indicated the presence of three Comprehensive Environmental Response, Compensation - No Further Remedial Action Planned (CERC-NFRAP) sites adjacent to the Canal. These sites include the Department of Sanitation Hamilton Avenue Incinerator, located at 555 Hamilton Avenue, Vidan Auto Salvage, located at 327-321 Bond Street and Brooklyn Union Gas/Citizens Gate, located at 6th Street and 2nd Avenue. RCRA databases indicate that there are six large quantity generators and 40 small quantity generators located in proximity to the Gowanus Canal. Under RCRA large quantity generators produce over 1000 kilograms of hazardous waste or over 1 kilogram of acutely hazardous waste per month. Small quantity generators produce between 100 kilograms and 1,000 kilograms of waste per month. RCRA sites in proximity to the Canal are listed in Table 2-2.

A review of the USEPA Brownfield database revealed that there are three brownfield sites in the immediate vicinity of the Canal. One site is the Bayside Fuel Oil Depot - Bond Street Terminal, located at 510 Sackett Street. This property is MOSF with a 1.5 million gallon fuel oil storage capacity. This site is also listed as having a Voluntary Cleanup Program (VCP) agreement for the cleanup of fuel oil. The VCP is a voluntary remedial program that uses private monies to remediate contaminated sites to levels that allow for the productive use of these sites. Additional brownfield sites are the former Metropolitan Gas Works, located at 12th Street and Second Avenue and Citizens manufactured gas plant (MGP) at Carroll Gardens, located at the corner of 5th and Smith Streets. The database indicates that these sites are substantially contaminated with MGP residuals, including coal tar and petroleum products. No other brownfields were identified in the vicinity of the Canal.

Table 2-2. RCRA Sites Located in the Vicinity of the Gowanus Canal as of 2005

Site Name	Address
RCRA Large Quantity Generators	
Amerada Hess Brooklyn Terminal	722 Court Street
Argus Div Witco Chemical Corporation	688 Court Street
Consolidated Edison	222 First Street
MTA NYCT- Campbell Storage Facility	532 Smith Street
Spentonbush Red Star Co	671 Court Street
Tanks to U	233 Nevins Street
RCRA Small Quantity Generators	
NYCDEP Gowanus Pumping Station	201 Douglass Street
O-Z Gedney	262 Bond Street
Petroleum Tama Cleaners	236 Butler Street
Bayside Fuel Oil Depot Corporation	510 Sackett Street
Chatham Cleaners Inc.	280 Nevins Street
NYCDOT Bin 2240270	Union Street Bridge Overpass
Thomas Paulson & Son Inc.	450 Union Street
NYSDOT Union Street Bridge	Union Street Bridge- Gowanus
Vidan Auto Salvage	327-321 Bond Street
Two Dans Enterprises	385 Carroll Street
Wesley Lacquer Corp.	95 Fourth Avenue
Finest Auto & Recovery	310 3rd Avenue
New York Telephone Co.	175 Third Avenue
Dicent Service Station	169 3rd Avenue
NYSDOT 3rd Street Bridge & Gowanus Canal	3rd Street Bridge Over Gowanus
Kentile Floors Inc.	58 2nd Avenue
Spartan Dismantling Corp.	110 5th Street
NYC Environmental Service	39 2nd Avenue
NYC Department of Sanitation	15 2nd Avenue BKN-2
Pippin Enterprises LTD	220 3rd Avenue
MTA NYCT – Smith & 9th Street	Smith & 9th Street
Polizzi Sal	519 Smith Street
V5326	213 6th Street
S & S Water Corp.	107-89 6th Street
Olympic Environmental Services	107 6th Street
Filmar Tank Cleaning Co.	107 6th Street
Citizens Gate Station	77 6th Street
Mentron Inc.	65 9th Street
Universal Fixture Corp.	59 9th Street
Bayside Fuel Oil Depot Corp.	537 Smith Street
Maaco Auto Painting & Bodywork	358 Fourth Avenue
Aetnacraft Industries Inc.	69 Second Avenue
Consolidated Edison TM 842	Hamilton Ave & Smith Street
US Postal Service	136 Second Avenue
NYC Department of Sanitation	Hamilton Shop, 465 Hamilton Avenue
NYCDOT Asphalt Plant	448 Hamilton Avenue
NYCDOT Hamilton Avenue Asphalt Plant	488 Hamilton Avenue
Bruno Truck Sales	435 Hamilton Avenue
NYCDOT Bin 2233080	14th Street over Belt Parkway
3rd Avenue Auto Parts	694 3rd Avenue

Review of the NYSDEC SPIL databases indicate that there were 131 spills that have occurred within a one-block radius of the Gowanus Canal within the past 15 years. Of these 131 spills, 10 remain open as of August 2005 and are listed in Table 2-3. The majority of these spills only affected soil, however, contamination to surface and/or groundwaters was also noted. The largest of the 10 open spills occurred at the Bayside Fuel Company (NYSDEC Spill No. 9713116), located at 537 Bond Street. This spill, which occurred in 1998, resulted in the release of 200 gallons of No. 4 fuel oil that affected the soil. No other open spills were reported in immediate proximity to the Canal.

The NYSDEC Petroleum Bulk Storage Database identified several USTs in the immediate vicinity of the Canal. According to the database, there are a total of 20 UST sites in proximity to the Canal. These sites contain USTs that are in-service, temporarily out of service or closed. The storage capacity of the USTs ranges from 550 to 7,500 gallons and these store unleaded gasoline; diesel; No. 1, 2, 4, 5 and/or 6 fuel oil; or other materials. The UST sites are identified in Table 2-4. No additional USTs were identified in the immediate vicinity of Gowanus Canal.

The LTANKS database, provided by EDR, identified 27 leaking storage tanks sites in proximity to the Gowanus Canal. The LTANKS list identifies LUSTS or leaking above ground storage tanks. The 27 tanks were reported to leak gasoline, unknown petroleum, diesel, No. 2 fuel oil or other materials. These leaks were caused by tank test failures, tank failures or tank overfills. Of the 27 reported leaks identified, seven remained open as of August 2005. Table 2-5 summarizes the leaks that are still being investigated by the NYSDEC. Based on the review of available information, no other open spills were reported in the area.

The MOSF database indicates that three MOSFs are located in proximity to the Canal. These MOSFs include two Bayside Fuel Oil Depot Corporation facilities located at 510 Sackett Street and 537 Smith Street and the Amerada Hess Brooklyn Terminal, located at 722 Court Street. The Bayside facility located on Sackett Street has two underground storage tanks with a total capacity of 1,501,000 gallons that are used to store No. 1, 2, and/or 4 fuel oil. The Bayside facility located on Smith Street has six tanks with a total storage capacity of 1,989,390 gallons. Tanks at this site store No. 1, 2, 4, 5 and/or 6 fuel oil. The Amerada facility has 10 underground storage tanks with a total capacity of 29,191,558 gallons. This facility stores No. 1, 2, 4, 5 and/or 6 fuel oil. No other MOSFs were identified in the immediate vicinity of the Canal.

A review of the New York State Registry of Inactive Hazardous Waste Disposal Sites indicates that there is one Inactive Hazardous Waste Disposal Site located in proximity to the Canal. This site is the former Citizens MGP located at Carroll Gardens, located at the corner of 5th and Smith Streets. This location was a former dumpsite for Brooklyn Union Gas Company, which operated a coal gasification plant. This site is currently vacant and is reported as having at least fourteen 55-gallon drums embedded in concrete. No other sites were located in the immediate vicinity of Gowanus Canal.

A review of the databases and available information discussed above indicates that none of these potential sources of contamination are associated with existing or previous combined sewer overflows.

Table 2-3. NYSDEC Open Spills through 2005

Location	Date	Spill Number	Quantity	Material	Resource Affected	Spill Cause
11 2nd Avenue	04/17/00	0000664	< 1 gallon	Unknown Petroleum	Soil	Unknown
Bayside Fuel Oil Company 285 Bond Street	11/25/98	9810785	20 gallons	Diesel	Soil	Equipment failure
Bayside Fuel Oil Company 537 Smith Street	02/24/98	9713116	200 gallons	#4 Fuel Oil	Soil	Other
Brooklyn West 06 DOS-DDC 127 2nd Avenue	12/06/93	9310764	< 1 gallon	Diesel	Soil	Unknown
Brooklyn West 06 DOS-DDC 127 2nd Avenue	09/27/00	0007546	< 1 gallon	#2 Fuel Oil	Groundwater	Other
Excavation at 2nd Avenue and 6th Street	09/20/99	9907402	< 1 gallon	Unknown Petroleum	Soil	Unknown
Manhole #65435 3rd Avenue and 1st Street	06/02/05	0502530	3 gallons	Unknown Petroleum	Soil	Unknown
Private Property 400 Carroll Street	04/26/04	0400876	6 gallons	#6 Fuel Oil	Groundwater	Other
Spentonbush/ Redstar 671 Court Street	12/17/98	9811726	1 gallon	Diesel	Surface water	Unknown
Vacant Building 450 Union Street	06/08/01	0102612	< 1 gallon	#2 Fuel Oil	Soil	Unknown

Table 2-4. Underground Storage Tanks (UST) In Proximity to Gowanus Canal as of 2005

Site	Address	Tank Capacity	Product Stored	Number of Tanks	Status
NYCDEP – Gowanus Pumping Station	201 Douglass Street	550 Gallons 1500 Gallons	Unleaded Gasoline Diesel	1 2	Closed, In Place In Service
Sackett Street Garage	498-502 Sackett Street	4000 Gallons	Unleaded Gasoline	3	In Service
T E Conklin Brass & Copper Co. Inc.	270 Nevins Street	550 Gallons	Diesel	1	Closed, In Place
Admiral Metals	270 Nevins Street	5000 Gallons		1	Closed, Removed
Clarin Truck Leasing Corp.	312 3rd Avenue	550 Gallons	Diesel	6	In Service
Bell Atlantic	175 Third Street	 2000 Gallons	Unleaded Gasoline Unleaded Gasoline	1 2	Closed, Removed In Service
160 3rd Street	160 Third Street	2200 Gallons	Diesel	1	Closed, In Place
Achim Importing Co.	58 2nd Avenue	6000 Gallons	# 1, 2 or 4 Fuel Oil	1	Closed, In Place
Mciz Corp.	15 2nd Avenue	550 Gallons 2000 Gallons 4000 Gallons 2000 Gallons 2000 Gallons	Other Diesel Diesel Diesel Unleaded Gasoline	1 1 1 1 1	Closed, In Place Closed, In Place Closed, In Place Closed, In Place Closed, In Place
Red Hook Concrete Loading Corp.	Smith Street and 9th Street	1100 Gallons 1000 Gallons	Diesel Diesel	1 1	In Service Temp. Out of Service
Northville	519 Smith Street	550 Gallons	Unleaded Gasoline	5	Closed
Walter Umla Labor Division of Dykes	180 6th Street	4000 Gallons 550 Gallons	# 1, 2 or 4 Fuel Oil Unleaded Gasoline	1 1	Closed In Service
U-Haul Co. of Metro NY	259 6th Street	4000 Gallons 4000 Gallons 4000 Gallons	Diesel Other Unleaded Gasoline	1 1 1	Closed, Removed Closed, Removed Closed, Removed
North Petroleum Corp. #13397	363 Fourth Avenue	4000 Gallons 550 Gallons	Unleaded Gasoline Not Reported	3 2	Closed Closed
Hamilton Avenue Yard	448 Hamilton Avenue	1100 Gallons 1100 Gallons 1100 Gallons	Unleaded Gasoline Unleaded Gasoline Diesel	1 2 1	Closed, Removed Closed, In Place Closed, In Place
Bruno Truck Sales Corp.	435 Hamilton Avenue	1000 Gallons 1000 Gallons 4000 Gallons 4000 Gallons	Other Lube Oil Unleaded Gasoline Diesel	2 1 1 1	Temp. Out of Service Temp. Out of Service Temp. Out of Service Temp. Out of Service
Argus Division/ Witco Corp.	688 Court Street	3000 Gallons 1500 Gallons 7600 Gallons 7500 Gallons	# 5 or 6 Fuel Oil #1, 2 or 4 Fuel Oil # 5 or 6 Fuel Oil Empty	1 1 1 1	Closed Closed Closed, In Place Closed, Removed
Sunset Industrial Park	50 21st Street	3000 Gallons	# 1, 2 or 4 Fuel Oil	1	Closed, In Place
Zophar Mills Inc.	112-130 26th Street	550 Gallons 1080 Gallons 1080 Gallons 1080 Gallons	Other Other #1, 2 or 4 Fuel Oil #1, 2 or 4 Fuel Oil	1 1 2 1	In Service In Service In Service Closed
Supreme Auto Manufacturing Corp.	770 3rd Avenue	1500 Gallons	#1, 2 or 4 Fuel Oil	1	Closed

Table 2-5. Open LUST Sites in Proximity to Gowanus Canal as of 2005

Location	Date	NYSDEC Spill Number	Quantity Released	Material Spilled	Cause
U-Haul Corporation 259 6th Street	12/12/94	9412186	< 1 gallon	Gasoline	tank overfill
Brooklyn West 06 DOS-DDC 127 2nd Avenue	01/03/95	9413174	< 1 gallon	Unknown Petroleum	tank test failure
Hamilton Avenue Yard (Asphalt Plant) 448 Hamilton Avenue	06/10/03	0302574	< 1 gallon	Gasoline	tank test failure
NYC Dept of Sanitation 15 2nd Avenue BK-N-2	03/25/97	9614826	< 1 gallon	Other	tank failure
Mciz Corporation 1-25 2nd Avenue	06/24/96	9603998	< 1 gallon	Diesel	tank test failure
537 Smith Street	11/27/90	9009301	< 1 gallon	#2 Fuel Oil	tank test failure
Bayside Terminals 537 Smith Street	11/26/90	9009292	< 1 gallon	Diesel	tank test failure

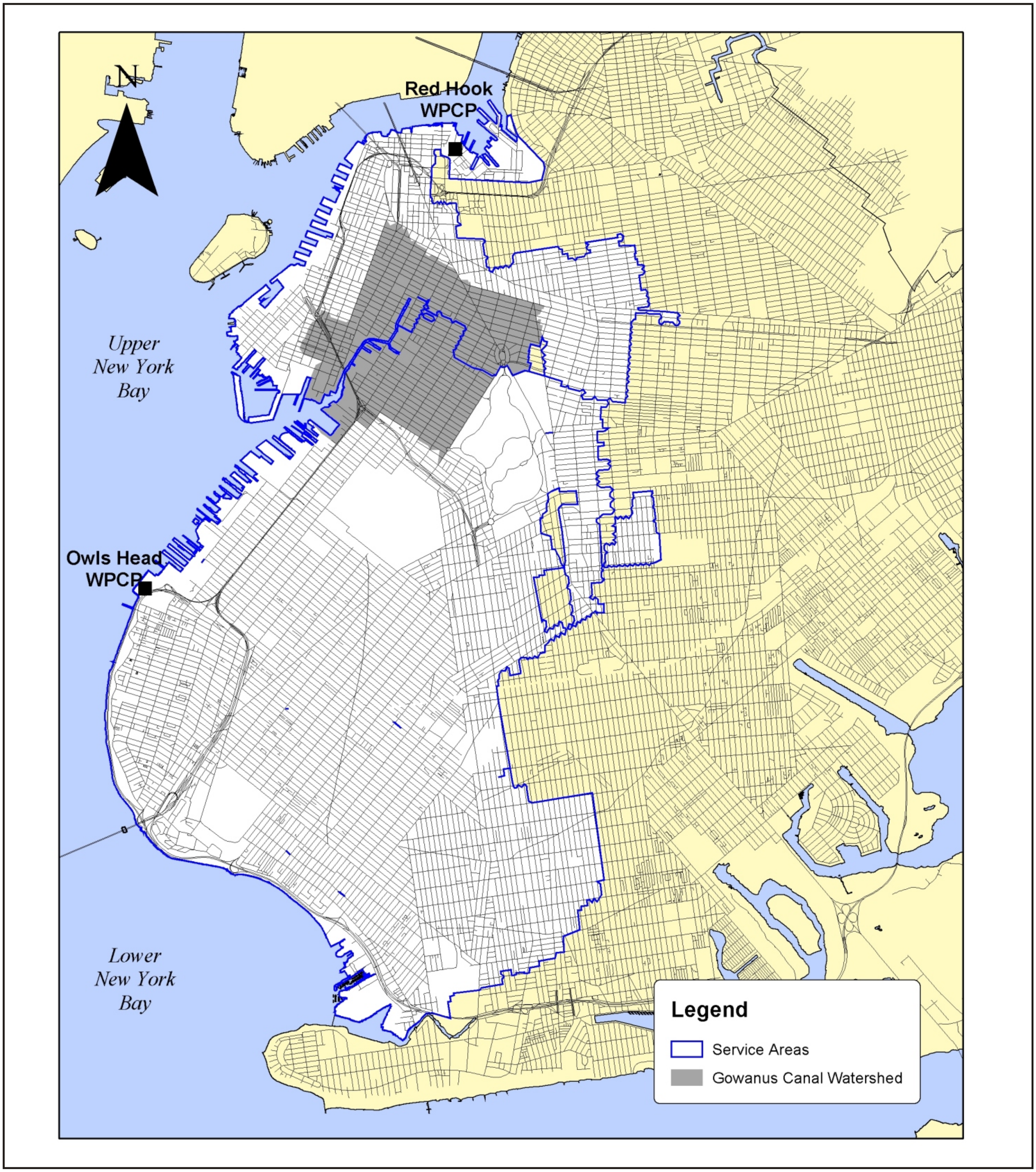
3.0 Existing Sewer System Facilities

The Gowanus Canal watershed consists primarily of sewersheds tributary to two different WPCPs: the Red Hook and Owls Head WPCPs. Figure 3-1 presents the Gowanus Canal watershed in relation to the Red Hook and Owls Head WPCP drainage areas. During significant rainfall events, Gowanus Canal receives discharges of combined sewage via reliefs from the combined sewer system, as well as relatively small discharges of stormwater runoff via storm sewers and direct overland runoff. This section presents a description of the existing sewer system facilities, the collection system, and characteristics of discharges to Gowanus Canal.

3.1 RED HOOK WPCP

The Red Hook WPCP is permitted by NYSDEC under SPDES permit number NY-0027073. The facility is located at 63 Flushing Avenue, Brooklyn, NY, 11205, on a 19-acre site adjacent to the East River and bounded by Flushing Avenue and Navy Street. The Red Hook WPCP serves approximately 3,054 acres of northwest Brooklyn, including the communities of Red Hook, Gowanus, Carroll Gardens, Cobble Hill, Vinegar Hill, Fulton Ferry, Brooklyn Heights, Downtown, Navy Yard, Clinton Hill, Fort Greene, Boerum Hill, Prospect Heights, and Crown Heights. Approximately 137 miles of sanitary, combined, and interceptor sewers feed the Red Hook WPCP.

The Red Hook WPCP began operating in 1987 with a step-aeration design capacity of 60 million gallons per day (MGD), and has been providing full secondary treatment since 1989. Treatment processes include primary screening, raw sewage pumping, grit removal and primary settling, air-activated sludge capable of operating in the step aeration mode, final settling, and chlorine disinfection. Figure 3-2 presents the layout of these treatment processes in a site plan of the WPCP; as shown, these existing processes fully utilize the available space at the site. Figure 3-3 presents a schematic diagram of these same processes. As NYSDEC requires in the plant SPDES permit and in accordance with the Wet Weather Operating Plan (WWOP, see Section 3.1.2), the Red Hook WPCP has a design dry-weather flow (DDWF) capacity of 60 MGD, and is designed to receive a maximum wet-weather flow of 120 MGD (2 times DDWF), with 90 MGD (1.5 times DDWF) receiving secondary treatment. Flows over 90 MGD receive primary treatment and disinfection. The daily average dry-weather flow during 2007 was 30 MGD. During severe wet-weather events in 2007, the WPCP treated 124 to 137 MGD. Table 3-1 summarizes the Red Hook WPCP permit limits.



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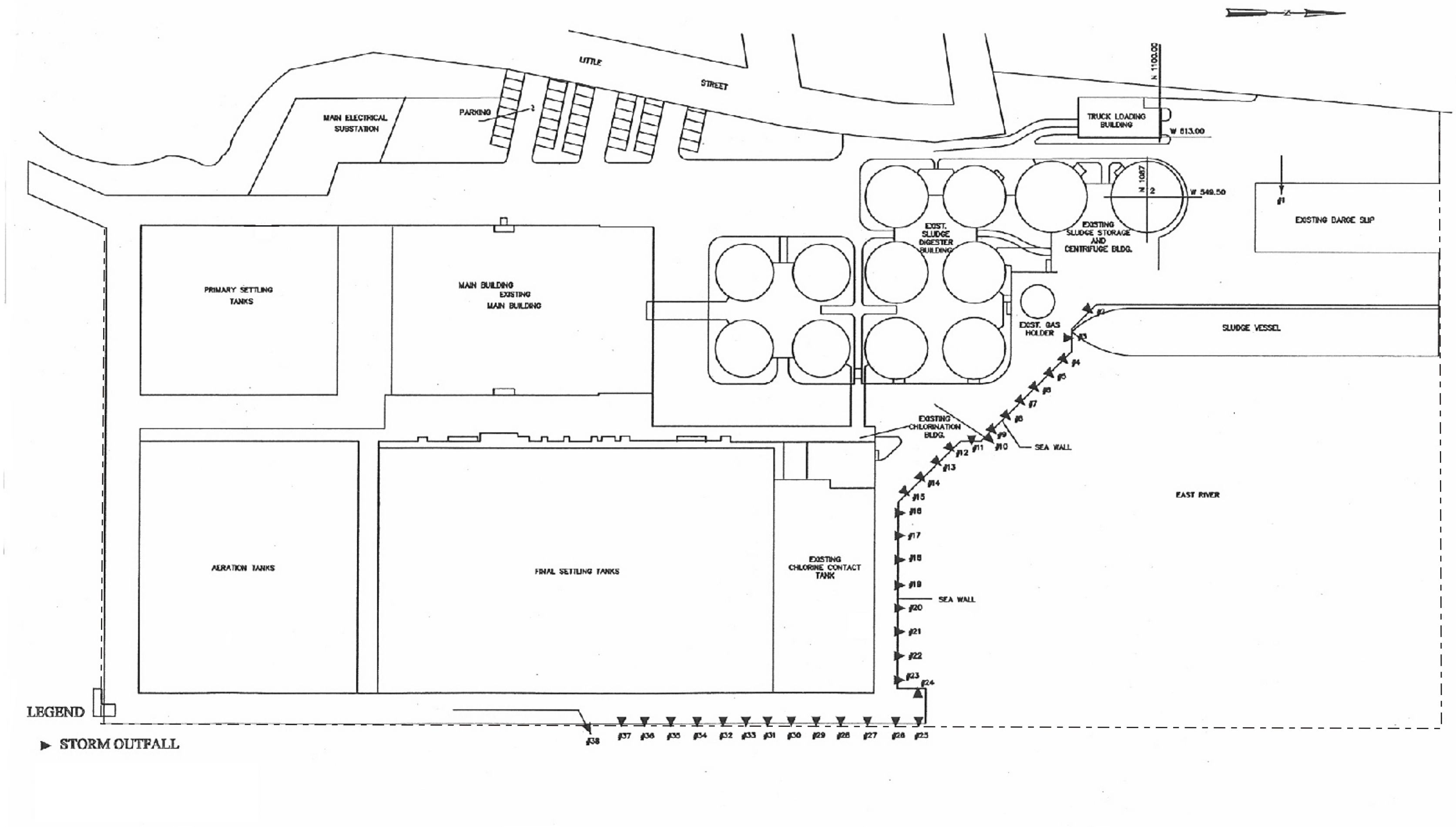
Gowanus Canal Watershed and WPCP Service Areas

FIGURE 3-1



Red Hook WPCP Process Layout and Site Plan

FIGURE 3-2

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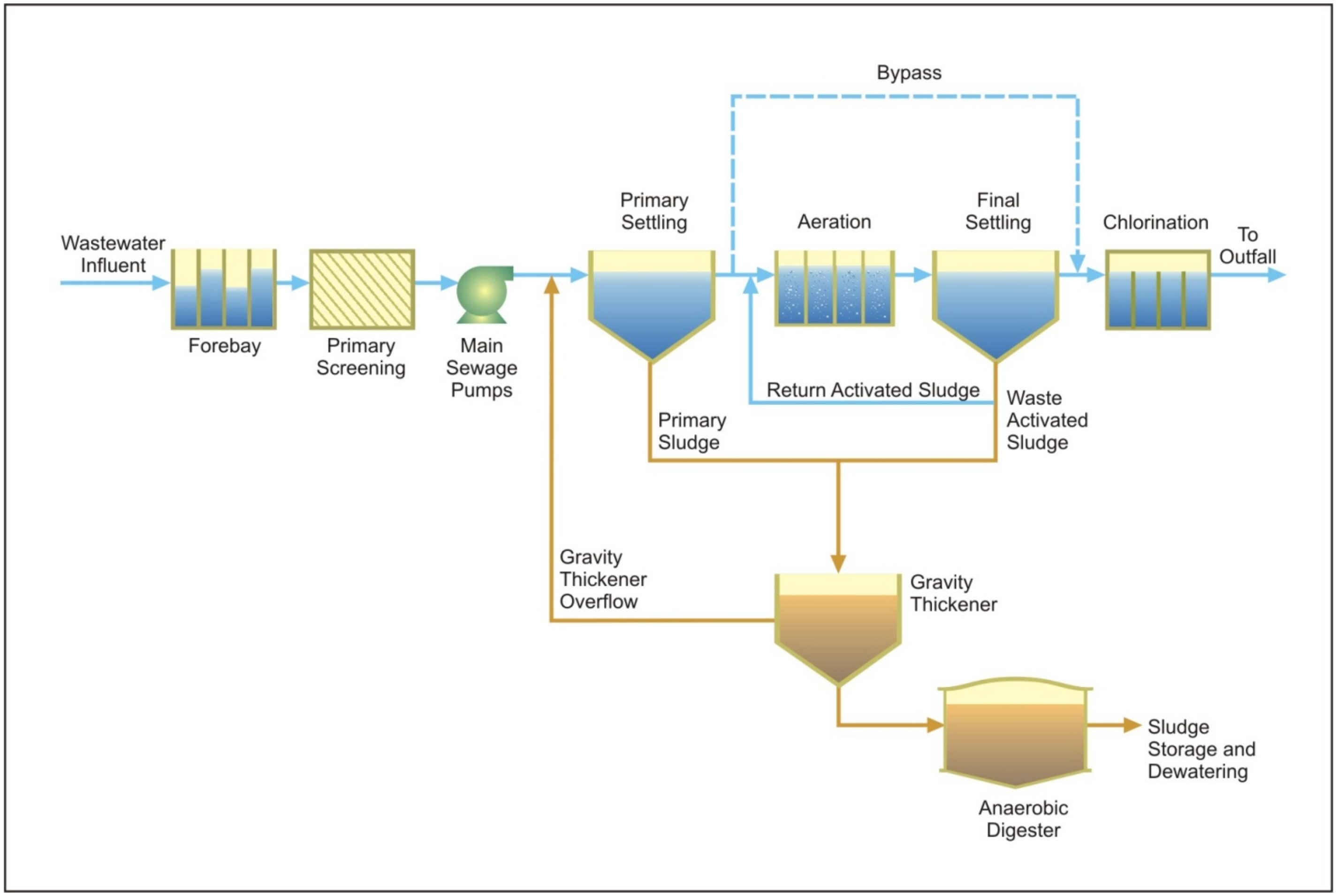

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Gowanus Canal Waterbody/Watershed Facility Plan

Red Hook WPCP Process Flow Diagram

FIGURE 3-3

Table 3-1. Select Red Hook WPCP SPDES Effluent Permit Limits

Parameter	Basis	Value	Units
Flow	DDWF Maximum secondary treatment Maximum primary treatment	60 90(1) 120	MGD
$CBOD_5$	Monthly average 7-day average	25 40	mg/L
TSS	Monthly average 7-day average	30 45	mg/L
Total Nitrogen	12-month rolling average	108,375(2)	lb/day

(1) 1.5 DDWF (1.3 at HP to protect BNR process as recommended by the WWOP)
(2) Nitrogen limit for the Combined East River Management zone, calculated as the sum of the discharges from the four Upper East River WPCPs (Bowery Bay, Hunts Point, Wards Island, Tallman Island) and one quarter of the discharges from the 2 Lower East River WPCPs (Newtown Creek, Red Hook). This limit is effective through November 2009, then decreases stepwise until the limit of 44,325 lb/day takes effect in 2017.

NYCDEP has examined the feasibility of processing twice DDWF (120 MGD) through the complete WPCP. NYCDEP has found that it is not feasible to route all 120 MGD through the existing secondary treatment portion of the facility due to treatment process constraints, and that it is not feasible to construct new secondary facilities as the WPCP completely occupies the available land at the site (Figure 3-2).

3.1.1 Process Information

Figure 3-3 presents a schematic of the treatment process employed at the Red Hook WPCP. A 102-inch interceptor delivers flow to the Red Hook WPCP. The influent throttling chamber is located at the terminus of the interceptor and is connected to the screening forebay by a 108-inch by 72-inch influent conduit. At the entrance to the conduit, there is a set of stop-log grooves that can isolate the flow to the treatment plant. Downstream of the stop-log grooves is a 108-inch by 72-inch hydraulically operated flow throttling gate used to regulate or shut off flow from the influent chamber. Although high velocities develop as flow is routed under the throttling gate, these velocities dissipate within the influent conduit—prior to entry to the screenings forebay—due to a 90-degree bend and the extensive length of the influent conduit.

At the screenings building, there is a set of stop log grooves in the influent conduit and a 108-inch by 72-inch main influent sluice gate that can isolate the flow into the screenings forebay. Four screening channels connect the screenings forebay to the wet well. Each screening channel has an influent sluice gate and an effluent sluice gate that can isolate the channel when the screen is not needed or in the event that screen or channel repair work is necessary. The screens are 6-feet wide with 1-inch clear spacing and are cleaned with a vertical traveling rake. Each screen is designed to handle 53.3 MGD; however, this capacity can be negatively impacted by heavy loadings of debris. During wet-weather events, plant personnel can flood the screening channels to maximize flow and reach 120 MGD. A set of manually operated velocity-control gates is located in each screen channel, downstream of the screen, to maintain low velocity through the screen.

There are five vertical, centrifugal, mixed-flow, bottom suction, flooded suction main sewage pumps, each rated 30 MGD at a total dynamic head of 50 feet. Each pump draws flow from the wet well via a 36-inch suction line. Discharge from each pump is via a 30-inch line that includes a cone check valve and gate valve. The 30-inch lines connect to a 66-inch discharge line that conveys the flow to the primary settling tank distribution structure. There is a venturi meter on the 66-inch line for flow measurement.

The primary settling tank distribution structure receives raw sewage from the main sewage pumps via the 66-inch discharge line. The distribution structure divides the flow equally to the four primary settling tanks. The four primary settling tanks have a total volume of 3.2 million gallons (MG) and a surface overflow rate of 1,974 gallons per day per square foot (gpd/sf) at average design flow. Each rectangular primary settling tank includes three longitudinal chain and flight collectors and cross collectors.

Primary tank effluent is conveyed to the aeration tanks in a primary effluent channel. During wet-weather events, the plant uses a secondary bypass channel to convey primary effluent to the chlorine contact tanks when the flow into the secondary treatment process exceeds 90 MGD. The bypass gate automatically opens at a plant flow of 90 MGD.

Four 4-pass aeration tanks provide biological treatment with a total volume of 8.8 MG. Four 9,500 standard cubic feet per minute (scfm) blowers provide air to the aeration tanks through ceramic domes. Aeration tank effluent is conveyed to the eight rectangular final settling tanks in an aeration tank effluent channel. The total volume of the final settling tanks is 10.5 MG with a surface overflow rate of 600 gpd/sf at average design flow.

The disinfection system includes two double-pass chlorine contact tanks, three 10,000 gallon sodium hypochlorite storage tanks, four metering pumps, and an automated control system. The two tanks have a total volume of 1.72 MG and a detention time of 20.6 minutes. The chlorine contact tanks are sized such that one tank operating at 120 MGD will provide sufficient contact time (more than 15 minutes) for disinfection. Chlorinated effluent is discharged to the East River via a 96-inch outfall.

Sludge thickening is accomplished by four 60-foot diameter gravity thickeners. Each thickening tank unit has a 10.3-foot side water depth (SWD) and a total surface area of 11,320 square feet. The gravity thickener overflow is returned to the aeration tanks, and the thickened sludge is sent to the digesters. Sludge digestion is accomplished in six 60-foot diameter digestion tanks arranged with a total volume of 4 MG so that three tanks are run as primary digesters, two tanks can be run as either primary or secondary digesters, and one tank is run as a secondary digester.

Two sludge-storage tanks are provided for the storage of digested sludge. Digested sludge is dewatered on site in preparation for final disposal and the centrate is returned to the aeration tanks.

3.1.2 Wet-Weather Operating Plan

NYCDEP is required by its SPDES permit to maximize the treatment of combined sewage at the Red Hook WPCP. The permit requires treatment of flows up to 90 MGD through complete secondary treatment. Further, to maximize combined sewage treatment, the SPDES permit requires flows of up to 120 MGD to be processed through all elements of the WPCP except the aeration basins and the final settling clarifiers. New York State requires the development of a WWOP as one of 14 BMPs for collection systems that include combined sewers. The goal of the WWOP is to maximize flow to the WPCP, one of the nine elements of long-term CSO control planning. NYCDEP has developed a WWOP for each of its 14 WPCPs, and Table 3-2 summarizes the requirements for the Red Hook WPCP, and notes that flows beyond the maximum capacity of the aeration basins and final clarifiers (i.e. over 90 MGD) would cause damage to the WPCP by creating washout of biological solids and clarifier flooding. The WWOP therefore suggests that the facility operate at or near its maximum capacity as designed and configured, and as permitted by NYSDEC. The WWOP for Red Hook, attached as Appendix A, was submitted to NYSDEC in April 2005 as required by the SPDES permit.

3.1.3 Other Operational Constraints

NYSDEC and NYCDEP entered into a Nitrogen Control Consent Order that updated the New York City SPDES permits to reduce nitrogen discharges to Long Island Sound and Jamaica Bay in order to reduce the occurrence of eutrophic conditions and improve attainment of dissolved oxygen numerical criteria. Although the permitted effluent nitrogen load established by the Nitrogen Control Consent Order includes the discharge the Red Hook WPCP, there are currently no plans to implement Biological Nitrogen Removal (BNR) at either facility because the City is meeting its overall nitrogen goals. However, because of ongoing efforts by the Harbor Estuary Program (HEP) for water quality improvements, it is possible that BNR may be required at some point in the future. According to the 1998 NYCDEP Nitrogen Control Feasibility Plan, infrastructure at the Red Hook WPCP does exist in the aeration tanks and froth-control system that would make it possible to operate at basic step-feed BNR, but the plant is not being run in that mode and there are no plans to begin BNR operation.

3.2 OWLS HEAD WPCP

The Owls Head WPCP is permitted by the NYSDEC under SPDES permit number NY-0026166. The facility is located at 6700 Shore Road, Brooklyn, NY, 11220 in the Bay Ridge section of Brooklyn, on a 14-acre site adjacent to the Upper New York Bay and next to Owls Head Park. The Owls Head WPCP serves approximately 13,644 acres in western Brooklyn, including the communities of Bath Beach, Bensonhurst, Bay Ridge, Dyker Heights, Fort Hamilton, Borough Park, Ocean Parkways, Flatbush, Sunset Park, Windsor Terrace, Kensington, Prospect Park South, Gravesend, Prospect Lefferts Gardens, and Park Slope. Approximately 471 miles of sanitary, combined, and interceptor sewers feed the Owls Head WPCP.

Table 3-2. Wet Weather Operating Plan for Red Hook WPCP

Unit Operation	General Protocols	Rationale
Influent Gates and Screens	Leave gate in normal dry weather operating position until plant flow approaches 120 MGD, wet well level exceeds an acceptable level, screen channel level exceeds acceptable level, bar screens become overloaded, or grit removal exceeds capacity. If necessary activate additional screens in order to accommodate increased flow.	To regulate flow to the plant and prevent excessive flows from destabilizing plant performance.
Main Sewage Pumps	Bring extra pumps on line based on wet well water levels. Operate pumps optimally to maintain wet well levels.	To maintain a safe water level in the wet well.
Primary Settling Tanks	Make sure four primary sludge pumps are pumping and back-flush when necessary while watching water surface elevations at the weirs for flooding and flow imbalances. Reduce flow if grit accumulation exceeds the plant's ability to handle it or loss of equipment warrants reduction to keep flow balanced to the primary tanks.	Maximize suspended solids and CBOD5 removal, prevent premature weir flooding, prevent short circuiting, prevent excessive sludge and grit accumulation in individual clarifiers, and maximize scum removal. Sludge blankets need to be kept to minimum levels
Bypass Channel	Open the bypass gate to Parshall flume when the plant influent flow exceeds 90 MGD or if the primary clarifier weirs flood with less than 3 primary settling tanks in service. Open bypass gate downstream of Parshall flume when required.	To relieve flow to the aeration system and avoid excessive loss of biological solids and to relieve primary clarifier flooding
Aeration Tanks	Keep all necessary aeration tanks in step-feed operation and adjust the airflow to maintain a dissolved oxygen greater than 2 mg/L.	To provide effective secondary treatment to storm flows up to 90 MGD.
Final Settling Tanks	Observe the clarity of the effluent and watch for solids loss. If necessary, increase the RAS rate to maintain low blanket levels.	High flows will substantially increase solids loadings to the clarifiers, which may result in high clarifier sludge blankets or high effluent TSS. This can lead to loss of biological solids that may destabilize treatment efficiency in dry weather conditions.
Chlorination	Check, adjust (increase), and maintain the hypochlorite feed rates to provide chlorine residual at determined target of less than 2 mg/l.	Hypochlorite demand will increase as flow rises and secondary bypasses occur.
Sludge Handling	Proceed as normal.	Uninfluenced by wet weather.

The Owls Head WPCP began operating in 1952 and has been providing full secondary treatment since 1995. Treatment processes include primary screening, raw sewage pumping, grit removal and primary settling, air activated sludge capable of operating in the step aeration mode, final settling, and chlorine disinfection. Figure 3-4 presents the layout of these treatment processes in a site plan of the WPCP; as shown, these existing processes fully utilize the available space at the site. Figure 3-5 presents a schematic diagram of these same processes. As NYSDEC requires in the plant SPDES permit and in accordance with the Wet-Weather Operating Plan (WWOP, see Section 3.2.2), the Owls Head WPCP has a DDWF capacity of 120 MGD, and is designed to receive a maximum wet-weather flow of 240 MGD (twice DDWF), with 180 MGD (1.5 times DDWF) receiving secondary treatment. Flows over 180 MGD receive primary treatment and disinfection. The daily average dry-weather flow during 2007 was 86 MGD. During severe wet-weather events in 2007, the WPCP treated 238 to 250 MGD. Table 3-3 summarizes the Owls Head WPCP permit limits.

Table 3-3. Select Owls Head WPCP SPDES Effluent Permit Limits

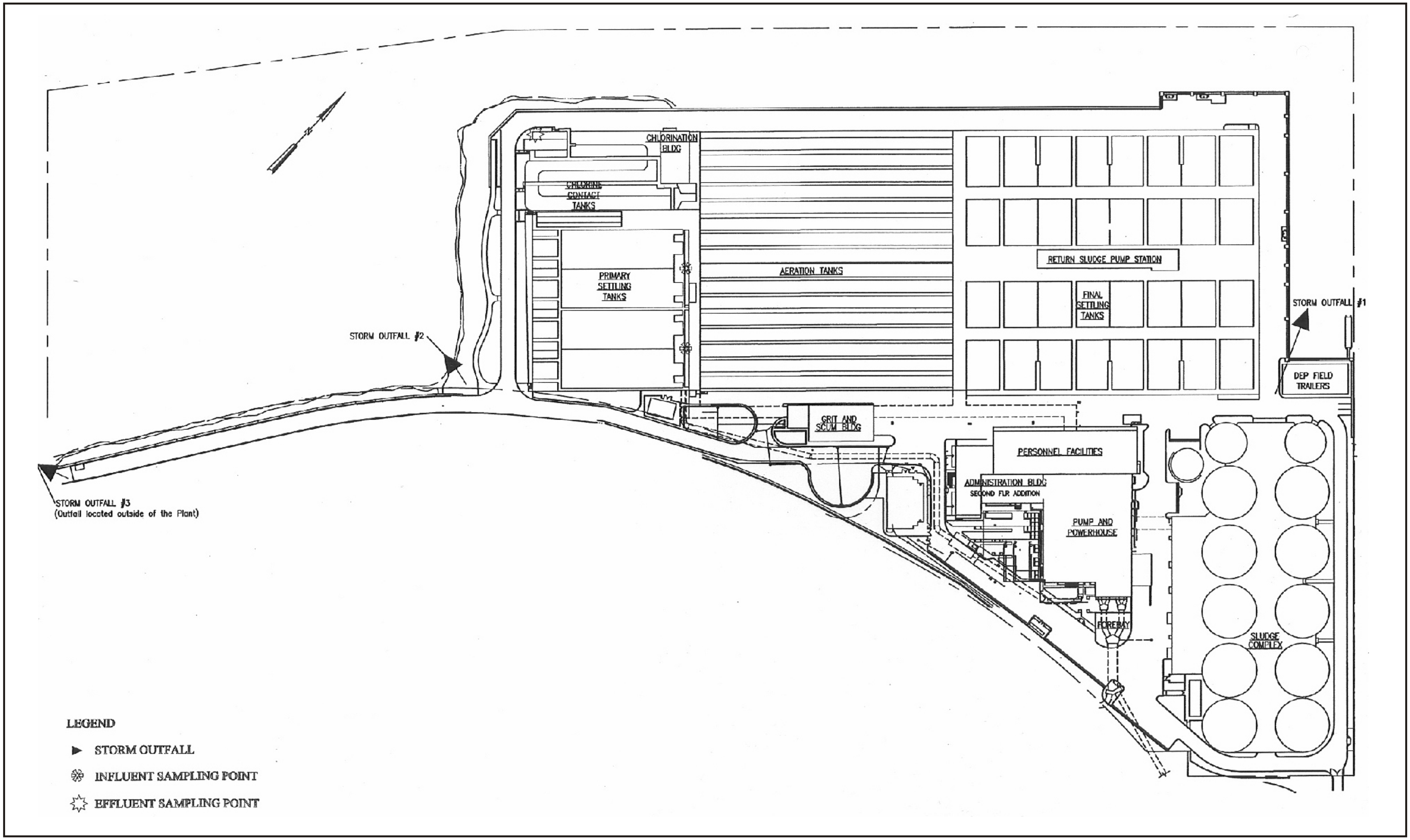
Parameter	Basis	Value	Units
Flow	DDWF(1) Maximum secondary treatment Maximum primary treatment	120 180(1) 240	MGD
$CBOD_5$	Monthly average 7-day average	25 40	mg/L
TSS	Monthly average 7-day average	30 45	mg/L
Total Nitrogen	12-month rolling average(2)	N/A(2)	lb/day

(1) 1.5 DDWF
(2) Limits not applicable to North River, Oakwood Beach, Owls Head, and Port Richmond WPCPs.

NYCDEP has examined the feasibility of processing twice DDWF (240 MGD) through the complete WPCP. NYCDEP has found that it is not feasible to route all 240 MGD through the existing secondary treatment portion of the facility due to treatment process constraints, and that it is not feasible to construct new secondary facilities as the WPCP completely occupies the available land at the site (Figure 3-4).

3.2.1 Process Information

Figure 3-5 shows a schematic of the treatment process employed at Owls Head WPCP. Sewage from the Owls Head drainage area is transported through the north interceptor sewer (150-inch by 96-inch) and the south interceptor sewer (108-inch by 108-inch) which join together at a junction chamber. The plant has a functional Supervisory Control And Data Acquisition (SCADA) system that monitors and/or controls most major processes, including throttling gates, main sewage pumps (speed control only) and the secondary bypass gates. The junction chamber divides the flow from the influent sewer into two forebay branches, each of which contains a forebay sluice gate and a stop-plank assembly at the lowest ends. The forebay sluice gates are used to throttle the flow in the forebay branches. The gates close automatically in the event of a power failure. Downstream of the forebay sluice gates, each of the two forebay piping branches connects to a junction chamber, each of which contains a stop-plank assembly utilized for isolation purposes. Four pipe branches connect to four 80-inch by 180-inch screening channels, each equipped with one hydraulically operated influent sluice gate, a coarse and fine screen set up in series, and a hydraulically operated effluent sluice gate. After passing through the screening channels and the effluent sluice gates, sewage flow enters the wet well, the lowest point in the system.



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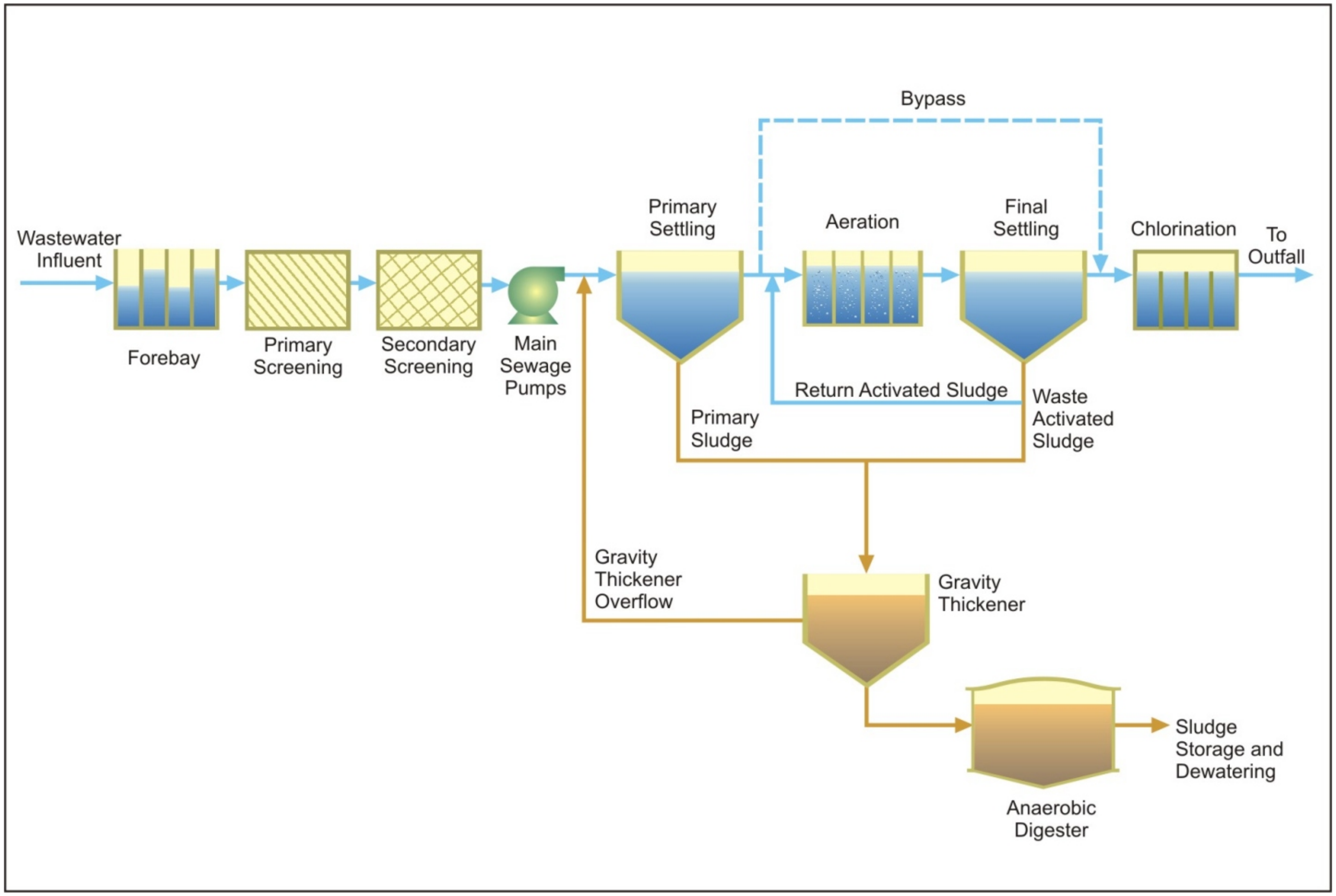
Owls Head WPCP Process Layout and Site Plan

FIGURE 3-4



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Owls Head WPCP Process Flow Diagram

Gowanus Canal Waterbody/Watershed Facility Plan

FIGURE 3-5

The screens are reciprocating-rake type, front cleaned, front return, mechanically cleaned bar (climber) screens that were designed for continuous operation. Primary and secondary screens are provided. The primary (coarse) screens have a 5/4-inch clear spacing and the secondary (fine) screens have a 3/4-inch clear spacing. The bar screen rakes elevate the captured screenings to a discharge chute approximately four feet above the opening floor. Screenings are dislodged by a screen wiper and dropped into a cubic yard container and are later transferred to a six-cubic-yard container and eventually picked up and transported to a designated New York City landfill according to a predetermined schedule.

Five 60-MGD vertical centrifugal or mixed flow-type pumps, driven directly by electric motors are available to pump the maximum design flow of 240 MGD with one pump held as a reserve. Each of the five main sewage pumps has a 700-HP electric motor of the wound-rotor induction type, suitable for speed control by varying rotor resistance. The synchronous speed of these motors is 390 rpm at 50 Hz. New main sewage pumps are currently being designed as 85-MGD capacity, with 800-HP and variable-frequency drives. Replacement of the pumps is anticipated to start in 2006. The sewage is discharged from the five main sewage pumps through their respective 42-inch diameter discharge lines to a 90-inch diameter force main that transports the sewage to the four primary settling tanks. The four primary settling tanks have a total volume of 4.8 MG and a surface overflow rate of 2,238 gpd/sf at average design flow. The primary settling tanks are equipped with steel chain and redwood flight sludge-collector mechanisms. Primary tank effluent flows to the aeration tanks through a channel equipped with wet-weather, overflow-bypass weirs.

The plant has a secondary bypass channel to convey primary effluent to the chlorine-contact tanks when the flow into the secondary treatment process exceeds 180 MGD. The capacity of the bypass channels is believed to be around 60 MGD.

Four 4-pass, step-feed aeration tanks are provided for step aeration with activated sludge. The total aeration tank volume is 18.7 MG and four 20,000 scfm blowers provide air through ceramic disc, full-floor coverage, fine-bubble diffusers. Aeration tank effluent flows by gravity to 16 final settling tanks. The collected solids are either wasted to the gravity thickeners or returned to the aeration tanks. The total volume of the final settling tanks is 13.5 MG, with a surface overflow rate of 800 gpd/sf at average design flow.

The plant effluent is disinfected with sodium hypochlorite solution. Sodium hypochlorite is fed with a rotary-feeder/eductor system, with metering pumps provided for prechlorination and backup. Two plug-flow contact tanks with a total volume of 2.5 MG are provided to detain the effluent for 15 minutes at peak flow prior to discharge to Upper New York Bay. An outfall sewer, with two branches and 64 diffusers, disperses the effluent approximately 220 feet into the Bay.

The primary solids are pumped to cyclone degritters to separate the grit from the primary sludge. Scum from the primary tanks is pumped to a scum-concentration tank. Grit and concentrated scum are trucked to a sanitary landfill. Degritted primary sludge is pumped to the sludge-processing complex, where it is mixed with the waste-activated sludge. Combined sludge is screened with mechanically cleaned bar screens prior to gravity thickening in four 80-foot diameter thickeners. Thickened sludge is pumped to four 80-foot diameter, high rate anaerobic digesters with a total volume of 7.2 MG. The digesters are mixed with a pumped liquid mixing system and are heated with external heat exchangers. The digesters are designed to operate in either the mesophilic or thermophilic modes. Digested sludge then flows to two 80-foot diameter gas extractors and eventually is pumped to two 60-foot diameter sludge storage tanks with a total volume of 1 MG. Digested sludge is transported by sludge vessel to the 26th Ward WPCP for dewatering and beneficial reuse. To remove odors, exhaust air from the thickener gallery, screening chamber, sludge-storage tanks, and grit and scum buildings is treated with nine 12-foot diameter, dual bed, activated-carbon adsorption units.

3.2.2 Wet-Weather Operating Plan

NYCDEP is required by its SPDES permit to maximize the treatment of combined sewage at the Owls Head WPCP. The permit requires treatment of flows of up to 180 MGD through complete secondary treatment. Further, to maximize combined sewage treatment, the SPDES permit requires that flows of up to 240 MGD to be processed through all elements of the WPCP except the aeration basins and the final settling clarifiers.

New York State requires the development of a WWOP as one of the 14 BMPs for collection systems that include combined sewers. The goal of the WWOP is to maximize flow to the WPCP, one of the nine elements of long-term CSO control planning. NYCDEP has developed a WWOP for each of its 14 WPCPs, and Table 3-4 summarizes the requirements for the Owls Head WPCP, and notes that flows beyond the maximum capacity of the aeration basins and final clarifiers (i.e., over 180 MGD) would cause damage to the WPCP by creating washout of biological solids and clarifier flooding. The WWOP therefore suggests that the facility operate at or near its maximum capacity as designed and configured, and as permitted by NYCDEC. The WWOP for Owls Head, attached in Appendix A, was submitted to NYSDEC in December 2007 as required by the SPDES permit.

3.2.3 Other Operational Constraints

NYSDEC and NYCDEP entered into a Nitrogen Control Consent Order that updated the New York City SPDES permits to reduce nitrogen discharges to the Long Island Sound and Jamaica Bay in order to reduce the occurrence of eutrophic conditions and improve attainment of dissolved oxygen numerical criteria. There are no effluent nitrogen limitations at the Owls Head WPCP associated with the Nitrogen Control Consent Order. Therefore, there are no plans to implement BNR at the Owls Head WPCP. However, because of ongoing efforts by the HEP for water quality improvements, it is possible that BNR may be required at some point in the future.

3.3. GOWANUS CANAL WATERSHED COLLECTION SYSTEM

The Gowanus Canal watershed covers an area totaling about 1,758 acres in western Brooklyn (Figure 3-1) and represents approximately 4 percent of Brooklyn's total area of about 46,000 acres. The Gowanus Canal watershed is highly urbanized, with approximately 94 percent of the area served by sewers. As shown in Table 3-5, combined sewers service the vast majority of the watershed, with only 2 percent served by storm sewers and 6 percent draining directly to the Canal as non-point source runoff.

Table 3-4. Wet Weather Operating Plan for Owls Head WPCP

Unit Operation	General Protocols	Rationale
Influent Gates and Screens	Leave gate in full open position until pump capacity is hit, screen channel level exceeds acceptable level with maximum pumping, bar screens become overloaded, or grit removal exceeds capacity. Set a third primary screen into operation and set screen rakes to continuous operation in order to accommodate increased flow.	To regulate flow to the plant and prevent excessive flows from destabilizing plant performance.
Main Sewage Pumps	As wet well level rises put off-line pumps in service and increase speed of variable speed pumps up to maximum capacity always leaving one pump out of service as standby.	Maximize flow to treatment plant and minimize need for flow storage in collection system and associated overflow from collection system into receiving waterbody.
Primary Settling Tanks	Make sure four primary sludge pumps are on-line and watch water surface elevations at the weirs for flooding and flow imbalances. Reduce flow if sludge cannot be withdrawn quick enough from the primaries, grit accumulation exceeds the plants ability to handle it, or a primary tank must be taken out of service.	Provide settling for the increased flows.
Bypass Channel	The bypass gate automatically opens or closes to maintain secondary flow at 180 MGD or greater.	To relieve flow to the aeration system and avoid excessive loss of biological solids and to relieve primary clarifier flooding.
Aeration Tanks	Keep at least four aeration tanks in operation and adjust the airflow to maintain proper dissolved oxygen levels.	To provide effective secondary treatment to storm flows up to 180 MGD.
Final Settling Tanks	Balance flows to the tanks and observe the clarity of the effluent to watch for solids loss.	High flows will substantially increase solids loadings to the clarifiers, which may result in high clarifier sludge blankets or high effluent TSS. This can lead to loss of biological solids that may destabilize treatment efficiency in dry weather conditions.
Chlorination	Check, adjust (increase), and maintain the hypochlorite feed rates to provide proper chlorine residual for adequate fecal kill.	Hypochlorite demand will increase as flow rises and secondary bypasses occur.
Sludge Handling	Proceed as normal.	Uninfluenced by wet weather.

Table 3-5. Gowanus Canal Watershed - Summary of Sewerage Categories

Sewerage Category	Drainage Area (Acres)	Percentage of Watershed
Point Sources		
Combined Sewers	1,612	92%
Storm Sewers	42	2%
Non-Point Sources		
Unsewered	104	6%
Total Watershed	1,758	100%

Overall, the collection system associated with the Gowanus Canal sewershed consists of 4 pump stations, 11 active CSO discharges, and 4 storm sewer discharges. The following sections describe the combined and storm sewer systems.

3.3.1 Combined Sewer System

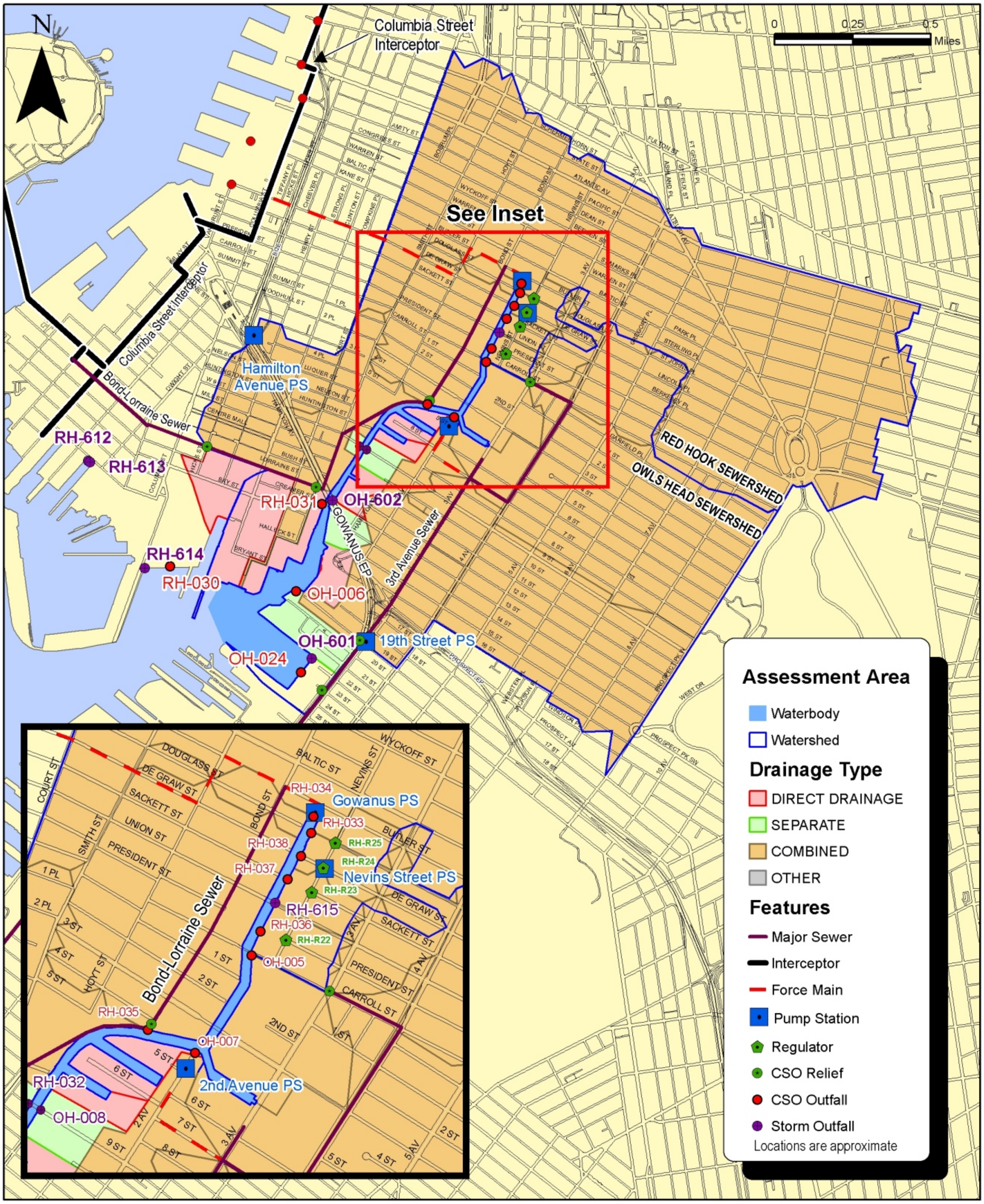
Combined sewers serve about 1,612 acres—92 percent—of the 1,758-acre Gowanus Canal watershed. Figure 3-6 presents the major components of this combined sewer system, including pump stations, force mains, major trunk sewers, regulators, CSO outfalls, and associated area delineations. As shown, the sewershed is comprised of two distinct subareas, one draining to the Red Hook WPCP and the other to the Owls Head WPCP. Combined-sewer discharges in each subarea are addressed in the SPDES permits for the corresponding WPCP (Red Hook: NY-0027083; Owls Head: NY-0026166). The following describes the combined sewer system in each of these subareas.

Red Hook Sub-Area

The portion of the Gowanus Canal sewershed draining to the Red Hook WPCP surrounds the upper reaches of the Canal and includes the area west of the Canal. This drainage area is approximately 933 acres, includes two pump stations, and seven active CSOs.

The Nevins Street and Gowanus Pump Stations operate within the Red Hook portion of the Gowanus Canal sewershed. The Nevins Street Pump Station, built in 1977 and last upgraded in 1980, is located on Nevins Street between Sackett Street and Degraw Street. Serving a drainage area of about 32 acres, this pump station has a capacity of 2.2 MGD. The pump station consists of two 2.2 MGD pumps and is designed so that the second pump is available as a standby to be used if the first pump needs maintenance work. During dry weather, the service area contributes an average sanitary flow of about 0.54 MGD. During wet weather, the pump station receives regulated combined sewer flow from four regulators (R-22, R-23, R-24, and R-25). The pump station conveys up to 2.2 MGD of the combined sewage via a force main to a trunk sewer feeding the Gowanus Pump Station. Excess flow is discharged to Gowanus Canal via outfall RH-038.

The Gowanus Pump Station, located on Douglass Street at the head of Gowanus Canal, was built in 1908 and was last upgraded in 2002. This pump station has a capacity of 20.2 MGD and serves a drainage area of about 657 acres. The pump station consists of five pumps, with a minimum of two pumps running at any given time. During dry weather, the service area contributes a sanitary flow of about 9.5 MGD. During wet weather, the pump station receives unregulated combined sewage flow from most of its drainage area as well as regulated combined sewage flow the Nevins Street Pump Station. Though the Gowanus Pump Station is designed to convey flow to the Columbia Street Interceptor via a force main in the Flushing Tunnel, the NYCDEP has experienced problems with that force main and is now temporarily rerouting pumped flow to the Bond-Lorraine Sewer (described below) via the Butler Street Interceptor. Using this configuration, the Gowanus Pump Station can convey up to about 28.5 MGD (due to a lower head loss versus the design configuration), with excess flows discharged to the head of Gowanus Canal via outfall RH-034. However, the capacity of the Bond-Lorraine Sewer is



New York City
Department of Environmental Protection

Gowanus Canal Waterbody/Watershed Facility Plan

Gowanus Canal Sewershed- Sewer System Components

FIGURE 3-6

limited, and this configuration does not provide a net reduction of CSO volume versus the design configuration.

The Bond-Lorraine Sewer is a principal element of the Red Hook portion of the Gowanus sewershed. This 72-inch brick sewer runs from the Gowanus Pump Station southward along the western side of the Canal to Lorraine Street, where it turns west and ultimately connects to the Columbia Street interceptor. In addition to the force-main flow it receives from the Gowanus Pump Station, the Bond Lorraine Sewer also receives flow from combined-sewered areas west of the Canal. The Bond-Lorraine Sewer has two relief points that can discharge to Gowanus Canal via outfalls RH-031 and RH-035. In 2001 and 2004, the NYCDEP conducted sewer cleaning and television inspections of the Bond-Lorraine Sewer (Gannett Fleming, 2004). These inspections revealed sediment accumulations and other pipe restrictions that may limit the sewer's conveyance capacity.

There are a total of seven active CSO outfalls in the Red Hook portion of the Gowanus Canal sewershed. Table 3-6 presents a listing of these CSO outfalls' permit numbers, locations, dimensions, and associated regulators and drainage areas. Field inspections have determined that outfall RH-039 is closed and no longer discharges to the Canal. Field inspections also determined that outfall RH-032 (not shown in Table 3-6), though permitted as a CSO, is not connected to a combined sewer and is actually a stormwater discharge (see Section 3.3.2). In summary, of the nine CSOs permitted to discharge from the Red Hook service area to Gowanus Canal under the Red Hook WPCP SPDES permit (NY-0027083), only seven CSOs are active.

Owls Head Sub-Area

The portion of the Gowanus Canal sewershed draining to the Owls Head WPCP is generally located to the south and east of Gowanus Canal. This drainage area is approximately 679 acres and includes two pump stations, and four active CSOs.

The 2nd Avenue and 19th Street pump Stations operate within the Owls Head portion of the Gowanus Canal sewershed. The 2nd Avenue Pump Station, located at the northern terminus of the 2nd Avenue near the 4th Street turning basin, was built in 1990 and serves a drainage area of 558 acres. The pump station has a 1 MGD capacity that it achieves using one pump; a second pump is available as a spare. During dry weather, its service area contributes an average of 0.6 MGD of sanitary flow. During wet weather, a potential area of up to approximately 558 acres is tributary to the pump station, which conveys up to 1 MGD to the 3rd Avenue Sewer. Excess flow discharges to Gowanus Canal via outfalls OH-007 and OH-005.

The 19th Street Pump station, located near the intersection of 19th Street and 3rd Avenue, was built in 1951. With a rated capacity of 5 MGD, this pump station services separately sewered areas that generate an average of 2.5 MGD of sanitary flow. The pump station has one pump and a spare that is available for maintenance procedures. The 19th Street Pump Station conveys flow to the 3rd Avenue Interceptor Sewer.

Table 3-6. CSO Discharges to Gowanus Canal from Red Hook WPCP Service Area

Outfall Permit Number [1,2]	**Outfall Location**	**Outfall Size**	**CSO Discharge From**	**Regulator / Relief Location**	**Combined Sewer Area (Acres)** [4]
RH-031	Creamer St	72" diameter	Bond-Lorraine Sewer Relief	Lorraine St. & Smith St.	70
RH-033	Douglass St.	38"W x 44"H	Regulator R-25	Nevins St. & Douglass St.	5
RH-034	Butler St.	4 barrels, each 163" diameter	Gowanus Pump Station	Douglass St.	657
RH-035	Bond St.	48" diameter	Bond-Lorraine Sewer Relief	Bond St. & 4th St.	88
RH-036	President St.	18" diameter	Regulator R-22	Nevins St. & President St.	10
RH-037	Sackett St.	18" diameter	Regulator R-23	Nevins St. & Sackett St.	7
RH-038	Degraw St.	144"W x 62"H	Regulator R-24	Nevins St. & Degraw St.	10
RH-039 [3]	Douglass St.	38"W x 44"H	Bond-Lorraine Sewer Relief	NA (closed)	NA
Total Combined Sewer Areas (Acres)					**933**

(1) SPDES permit numbers replace “RH” with “NY-0027073.”
(2) CSO-permitted outfall RH-032 (not shown) is a stormwater outfall, according to field inspections.
(3) CSO-permitted outfall RH-039 is closed, according to field inspection.
(4) Combined-sewer areas shown for Bond-Lorraine Sewer reliefs represent the incremental drainage area between reliefs.

There are a total of four reportedly active CSO outfalls in the Owls Head portion of the Gowanus Canal sewershed. Table 3-7 presents a listing of these CSO outfalls' permit numbers, locations, dimensions, and associated regulators and drainage areas. Field inspections have determined that an additional permitted CSO outfall, OH-009, is closed and no longer discharges to the Canal. Similarly, the field inspections also determined that another outfall permitted for CSO discharge, OH-008 (not shown in Table 3-7), is actually a stormwater discharge (see Section 3.3.2). The field inspections also revealed an additional relief on the 3rd Avenue Interceptor Sewer at 23rd Street, with an outfall to the lower end of Gowanus Canal at 23rd Street. This location was not associated with a SPDES number prior to April 2006, when NYCDEP and NYSDEC designated this CSO location as "OH-024." In summary, though there are five CSOs permitted to discharge to Gowanus Canal from the Owls Head service area under the Owls Head WPCP SPDES permit (NY-0026166), only three of these—plus a fourth at a previously unknown location—now discharge CSO to Gowanus Canal.

3.3.2 Stormwater Sewer System and Non-Point Source Runoff

Storm sewers serve about 42 acres, or 2 percent, of the 1,758-acre Gowanus Canal watershed. Figure 3-6 presents the stormwater discharge points using the numbering system employed by the NYCDEP Shoreline Survey. As shown, portions of the Gowanus Canal drainage area draining to both the Red Hook WPCP and the Owls Head WPCP contain some stormwater drainage areas. Stormwater outfalls in these areas are presented below.

Red Hook Sub-Area

The Red Hook portion of the Gowanus Canal drainage area contains one active stormwater outfall draining about 2 acres. This outfall was previously designated RH-032 as a permitted CSO, but field inspections determined that it is not connected to a combined sewer and that it is actually a stormwater discharge. As of April 2006, this outfall has been redesignated as "RH-601" to reflect that it conveys stormwater only. Field inspections of stormwater outfall RH-615 determined that this outfall does not receive flows from any area and does not discharge during wet weather or otherwise. Table 3-8 presents the locations, dimensions, and drainage areas associated with these stormwater outfalls.

Owls Head Sub-Area

The Owls Head portion of the Gowanus Canal drainage area contains three active stormwater outfalls draining a total of about 40 acres (see green-shaded areas on Figure 3-6). Table 3-9 lists these outfalls and presents the location, dimensions, and drainage area associated with each. Outfall OH-008 is permitted as a CSO, but field inspections determined that it is actually a stormwater discharge. There are two other documented stormwater discharges from this area.

Table 3-7. CSO Discharges to Gowanus Canal from Owls Head WPCP Service Area

Outfall Permit Number [1,2]	Outfall Location	Outfall Size	CSO Discharge From	Regulator / Relief Location	Combined Sewer Area (Acres) [5]
OH-005	5 ft south of Carroll St. Bridge	42" diameter	3rd Ave Sewer Relief	3rd Ave. & Carroll St.	34
OH-006	19th St. (north side)	36" diameter	3rd Ave Sewer Relief	3rd Ave. & 19th St.	306
OH-007	east of 2nd Ave.	78" diameter	2nd Ave Pump Station	3rd Ave. & 7th St.	339
OH-009 [3]	5th St.	78" diameter	3rd Ave Sewer Relief	NA (closed) [2]	0
OH-024 [4]	23rd St.	42"W x 24"H (Oval)	3rd Ave Sewer Relief	3rd Ave. & 23rd St.	NA
Total Combined Sewer Area (Acres)					**679**

(1) SPDES permit numbers replace "OH" with "NY-0026166."
(2) CSO-permitted outfall OH-008 (not shown) is a stormwater outfall, according to field inspection.
(3) CSO-permitted outfall OH-009 is closed, according to field inspection.
(4) This outfall was recently discovered and was designated "OH-024" in April 2006.
(5) Combined-sewer areas shown for 3rd Avenue Sewer reliefs represent the incremental drainage area between reliefs.

Table 3-8. Stormwater Discharges to Gowanus Canal from Red Hook WPCP Service Area

Stormwater Outfall	Outfall Location	Outfall Size	Stormwater Sewer Area (Acres)
RH-032 (RH-601)[1]	W. 9th St.	12" diameter	2
RH-615	10ft north of Union St. Bridge	8" diameter	0[2]
Total Stormwater Drainage Area			**2**

(1) RH-032 was a SPDES-permitted CSO location, but field inspections determined that this is a stormwater outfall. As of April 2006, this outfall is designated "RH-601."
(2) RH-615 is listed as a stormwater outfall, but field inspections determined that it has no tributary area.

Table 3-9. Stormwater Discharges to Gowanus Canal from Owls Head WPCP Service Area

Stormwater Outfall	Outfall Location	Outfall Size	Stormwater Sewer Area (Acres)
OH-008 (OH-607)[(1)] OH-008[(1)]	E. 9th St.	12" diameter	8
OH-601	22nd St.	36"W x 48"H (Egg)	22
OH-602	30ft south of Gowanus Expressway	18" diameter	10
Total Stormwater Drainage Area			**40**
[(1)] OH-008 is permitted as a CSO outfall but field inspections determined that it is a stormwater outfall. As of April 2006, this outfall is designated "OH-607"			

Overland Runoff

Unsewered areas immediately adjacent to Gowanus Canal contribute direct overland runoff during rain events. This overland runoff represents a non-point source discharge to the waterbody from land areas totaling approximately 104 acres. These areas are shown shaded in pink on Figure 3-6

3.4 SEWER SYSTEM MODELING

Mathematical watershed models are used to simulate the hydrology (rainfall runoff) and hydraulics (sewer system flows and water levels) of a watershed, and are particularly useful in characterizing sewer system response to rainfall conditions and in evaluating engineering alternatives on a performance basis. In the hydrology portion of the model, climatic conditions (such as hourly rainfall intensity) and physical watershed characteristics (such as slope, imperviousness, and infiltration) are used to calculate rainfall-runoff hydrographs from individual subcatchments. These runoff hydrographs are then applied at corresponding locations in the sewer system as inputs to the hydraulic portion of the model, where the resulting hydraulic grade lines and flows are calculated based on the characteristics and physical features of the sewer system, such as pipe sizes, pipe slopes, and flow-control mechanisms like weirs. Model output includes sewer-system discharges which, when coupled with pollutant concentration information, provide input necessary for receiving-water models to determine water-quality conditions. The following generally describes the tools employed to model the Gowanus Canal watershed. A more detailed write up describing the calibration of the model-calibration and model-projection process is provided under separate cover in the LTCP WB/WS Landside Modeling Report.

3.4.1 InfoWorks CS™ Modeling Framework

The hydraulic modeling framework used in this effort is a commercially available, proprietary software package called InfoWorks CS™, developed by Wallingford Software of the United Kingdom. InfoWorks CS™ is a hydrologic/hydraulic modeling package capable of performing time-varying simulations in complex urban settings for either short-term events or long-term periods, with output of calculated hydraulic grade lines and flows within the sewer system network and at discharge points. InfoWorks CS™ solves the complete St. Venant hydraulic equations representing conservation of mass and momentum for sewer-system flow and accounts for backwater effects, flow reversals, surcharging, looped connections, pressure flow, and tidally affected outfalls. Similar in many respects to the USEPA's older Storm Water Management Model (SWMM), InfoWorks CS™ offers a state-of-the-art graphical user interface with greater flexibility and enhanced post-processing tools for analysis of model calculations. In addition, InfoWorks CS™ utilizes a four-point implicit numerical solution technique that is generally more stable than the explicit solution procedure used in SWMM.

Model input for InfoWorks CS™ includes watershed characteristics for individual subcatchments, including area, surface imperviousness and slope, as well as sewer-system characteristics, such as information describing the network (connectivity, pipe sizes, pipe slopes, pipe roughness, etc.) and flow-control structures (pump stations, regulators, outfalls, WPCP headworks, etc.). Hourly rainfall patterns and tidal conditions are also important model inputs. InfoWorks CS™ allows interface with graphical information system (GIS) data to facilitate model construction and analysis.

Model output includes flow and/or hydraulic gradeline at virtually any point in the modeled system, at virtually any time during the modeled period. InfoWorks CS™ provides full interactive views of data using geographical plan views, longitudinal sections, spreadsheet-style grids and time-varying graphs. A three-dimensional junction view provides an effective visual presentation of manholes. Additional post-processing of model output allows the user to view the results in various ways as necessary to evaluate system response.

3.4.2 Application of Models to Gowanus Canal

New York City is comprised of 14 independent sewersheds, each having a distinct sewer system model. Because the Gowanus Canal watershed overlaps two different WPCP service areas, two different models were employed for the Gowanus Canal study area: one model for the Red Hook WPCP service area, and a second model for the Owls Head WPCP service area. Each of these models had been previously constructed using information and data compiled from the NYCDEP's as-built drawings, WPCP data, previous and ongoing planning projects, regulator improvement programs, and inflow/infiltration analyses. This information includes invert and ground elevations for manholes, pipe dimensions, pump-station characteristics, and regulator configurations and dimensions.

Model simulations include WPCP headworks, interceptors, branch interceptors, major trunk sewers, all sewers greater than 60 inches in diameter plus other smaller, significant sewers, and control structures such as pump stations, diversion chambers, tipping locations, reliefs, regulators and tide gates. As presented in LTCP WB/WS Landside Modeling Report, these models were previously calibrated and validated using flow and hydraulic-elevation data collected during the Inner and Outer Harbor CSO Facility Planning Projects, as well as more recent data collected in the past several years for facility planning. Field verifications were conducted by the NYCDEP during its Use and Standards Attainment (USA) Project and ongoing facility planning projects to confirm and re-measure system components where data or information gaps existed. All CSO and stormwater outfalls permitted by the State of New York are represented in the models, with stormwater discharges from separately sewered areas simulated using separate models as necessary.

Conceptual alternative scenarios representing no-action and other alternatives were simulated for the design meteorological condition (1988 JFK rainfall) as described below. Tidally influenced discharges were calculated on a time-variable basis. Pollutant concentrations selected from field data and best professional judgment were assigned to the sanitary and stormwater components of the combined sewer discharges to calculate variable pollutant discharges. Similar assignments were made for stormwater discharges. Discharges and pollutant loadings were then post-processed and used as inputs to the receiving-water model of Gowanus Canal, described in Section 4.

3.4.3 Baseline Design Condition for Sewer System Modeling

Sewer-system or "landside" modeling can be an important tool in evaluating the impact of proposed physical changes to the sewer system and/or of proposed changes to the operation of the system. In order to provide a basis for these comparisons, a "Baseline condition" was developed. This Baseline condition generally represents the current state of the watershed and sewer system, with certain exceptions specifically used for planning purposes. For the Gowanus Canal landside model, the Baseline conditions are summarized as follows:

1) Sanitary (dry-weather) sewage flow rates at each WPCP reflect year 2045 projections: 40 MGD at Red Hook and 115 MGD at Owls Head.

2) Wet-weather treatment capacities at each WPCP reflects 2003 conditions: 113 MGD at Red Hook and 235 MGD at Owls Head.

3) The Gowanus Pump Station operates at a capacity of 28.5 MGD and routes flow to the Bond-Lorraine Sewer.

4) Sedimentation levels in sewers are associated with reasonable maintenance.

Establishing the future sanitary sewage flow at the WPCPs is a critical step in the Waterbody/Watershed Planning analysis because the City's CSO-control program relies in part on the capacity of the sewage conveyance and treatment systems to reduce CSO overflows. Increases in sanitary sewage flows associated with increased populations will reduce the capacity available for wet-weather flow, thereby increasing the CSO volumes that need to be accounted for in the planning process. The year 2045 has been selected as the planning horizon for the analyses contained herein. Some 40 years in the future, 2045 was selected as a point in time when CSO facilities currently under construction (Paerdegat Basin and Alley Creek CSO retention facilities) or recently completed (Flushing Creek CSO retention facility) will likely be in need of a major upgrade. For example, NYCDEP recently completed a major renovation to the Spring Creek CSO retention facility after over 35 years of operation. NYCDEP generally finds that it is most cost effective to construct facilities sized in accordance with expected future populations to avoid constructing the facilities larger than necessary to perform the functions expected of them during their natural like cycle. These facilities can then be reconstructed during future renovations depending on the needs at that point in time.

At the direction of the Mayor's Office, the Department of City Planning assessed population growth from 2000 to 2010 and 2030 in a set of projections made for 188 neighborhoods within the City (NYCDCP, 2006). These assessments included general potential future development activity as well as specific development projects, such as the Atlantic Yards project (Section 2.2.3). NYCDEP escalated these populations forward to 2045 by assuming that the rate of growth between 2045 and 2030 would be 50 percent of the rate of growth between 2000 and 2030. NYCDEP used GIS analyses to distribute these population projections among the subcatchments draining to each CSO regulator, and then applied the WPCP-specific, per-capita sanitary sewage flow rate from calendar year 2000 to develop a conservatively high estimate of the expected sanitary sewage flow rates for each subcatchment. Overall, this increase in the dry-weather flow rates to 40 MGD (from 30 MGD in 2006) at the Red Hook WPCP, and to 115 MGD (from 95 MGD IN 2006) at the Owls Head WPCP, properly accounts for the potential reduction in available wet-weather treatment capacity associated with projections of a larger population.

For the same reasons stated above, the wet-weather capacity of the sewage conveyance and treatment systems is another critical factor in the planning process. In this regard, existing conditions were defined as the capacity of the conveyance and treatment systems prior to the development of wet-weather operating plans and infrastructure improvements required by the CSO Consent Order; in short, the capacity of the conveyance and treatment systems in calendar year 2003. The wet-weather capacities shown represent the average of the maximum capacities observed for the top 10 storms during 2003 (HydroQual, 2004b).

In the Gowanus Canal drainage area, an important component of the sewer system is the Gowanus Pump Station. As described in Section 3.3.1, although the station is designed to pump up to 20.2 MGD to the Columbia Street Interceptor, the current operational configuration allows the station to pump up to 28.5 MGD via the short Butler Street force main to the Bond-Lorraine Sewer.

Over time, sedimentation buildup can negatively impact the conveyance capacity of the sewer system. Although the sewer system is generally designed to be self-cleaning, sedimentation buildup can be a problem in locations where the sewage has high solids content and/or where sewer slopes are relatively flat. One such area in the Gowanus Canal sewershed is the Bond-Lorraine Sewer, which the City has cleaned on multiple occasions. To account for the reduction in the theoretical conveyance capacity of this 72-inch-diameter sewer due to sedimentation that occurs despite reasonable cleaning efforts, all modeling analyses herein (Baseline and all subsequent projections) assume a buildup of 15 inches through most of the sewer, and 18 inches upstream of a constriction located at Bond and 5th Street. All other sewers are assumed to be clean.

Meteorological Conditions For Modeling Analyses

As discussed above, the Baseline condition provides a basis of comparison so that subsequent modeling scenarios can evaluate the impact of specific proposed changes affecting the sewer system. Such comparisons dictate that the same meteorological (rainfall) conditions be used in each evaluated scenario. For planning purposes, a rainfall condition that is consistent with the long-term annual average is appropriate and consistent with the federal CSO Control Policy. Long-term rainfall records measured in the New York City metropolitan area were analyzed to identify potential rainfall design years to represent long-term, annual average conditions. Statistics were compiled to determine:

- Annual total rainfall depth
- Annual total number of storms
- Annual average storm volume
- Annual average storm intensity
- Annual total duration of storms
- Annual average storm duration
- Annual average time between storms

A more detailed description of these analyses is provided under separate cover (HydroQual, 2004a). Although no year was found having the long-term average statistics for all of these parameters, the rainfall record measured at the National Weather Service gage at John F. Kennedy (JFK) International Airport during calendar year 1988 is representative of overall, long-term average conditions in terms of annual total rainfall and storm duration. Table 3-10 summarizes some of the statistics for the 1988 rainfall record and the long-term record at JFK Airport. As shown, the aggregate statistics indicate that 1988 is representative of the long-term conditions. With regard to storm intensity, an important factor impacting CSOs, the 1988 value is more than one standard deviation greater than the median, indicating that using 1988 as a design year would provide conservative results with respect to CSOs and their water quality impacts. Another characteristic that makes the 1988 rainfall record suitable as a design year is the fact that it contains critically high rainfall conditions during both a recreational period (July) and a shellfishing period (November).

As a result, the JFK 1988 rainfall record was selected as an appropriate design condition for which to evaluate sewer system response to rainfall. The JFK 1988 record has also been adopted as a design condition by New York Harbor Estuary Program to evaluate water-quality conditions in the New York/New Jersey Harbor Estuary, and by the New Jersey Department of Environmental Protection for CSO performance evaluations.

The potential impact of climate change on future meteorological conditions was not forecast for these planning analyses. However, the NYCDEP is concerned about this issue and is currently investigating how climate change could impact rainfall conditions in the New York metropolitan area. The Long-Term Control Plans will incorporate the ongoing analysis of the potential impacts of climate change on wet-weather operations, CSOs, and ambient water quality.

Table 3-10. Comparison of Annual 1988 and Long-Term Statistics JFK Rainfall Record (1970-2002) (1)

Rainfall Characteristic	Long-Term Statistics (1970-2002)		1988 Statistics	
	Median	Return Period (years)	Median	Return Period (years)
Annual Total Rainfall Depth (inches)	39.4	2.0	40.7	2.6
Average Storm Intensity (inch/hour)	0.057	2.0	0.068	11.3
Annual Average Number of Storms	112	2.0	100	1.1
Average Storm Duration (hours)	6.08	2.0	6.12	2.1

(1) (HydroQual, 2004)

3.5 DISCHARGE CHARACTERISTICS

As indicated in Section 3.4, sewer-system modeling is useful to characterize discharges from the sewer system. Because long-term monitoring of outfalls is difficult and sometimes not possible in tidal areas, sewer-system models that have been calibrated to available measurements of water levels and flows can offer a more complete and useful characterization of discharge quantities. Sewer-system models can also be used to estimate the relative percentage of sanitary sewage versus rainfall runoff discharged from a CSO. This is particularly helpful when developing pollutant loads, since it allows application of different pollutant concentrations for sanitary sewage and runoff instead of a fixed pollutant concentration for combined sewage.

Section 3.5.1 presents information related to the quantity (volume) discharged into the waterbody for the Baseline condition. Section 3.5.2 characterizes the quality (pollutant concentration) developed to assign pollutant concentrations to discharges. Section 3.5.3 summarizes the pollutant loadings discharged to Gowanus Canal for the Baseline condition. Section 3.5.4 discusses the potential for toxic discharges to Gowanus Canal, and Section 3.5.5 provides an overview of the effect of urbanization on discharges.

3.5.1 Characterization of Discharged Volumes, Baseline Condition

The calibrated watershed models described in Section 3.4 were used to characterize discharges to Gowanus Canal for the Baseline condition. Table 3-11 summarizes the results with statistics relating the annual CSO and stormwater discharges from each point-source outfall for the Baseline condition. Approximately 32 percent of the total annual CSO volume to Gowanus Canal is discharged at RH-034, the outfall associated with the Gowanus Pump Station, located at the head of the Canal. An additional 18 percent of the total annual CSO volume is discharged from OH-007, an outfall located halfway between the head of the Canal and Gowanus Expressway/Hamilton Avenue. CSO discharges from RH-034 are calculated to occur during 56 of the 100 rainfall events in the Baseline condition; discharges from RH-035 occur during 75 events.

3.5.2 Characterization of Pollutant Concentrations, Baseline Condition

Pollutant concentrations associated with intermittent, weather-related discharges are notoriously variable. In part for this reason, analyses to characterize discharged pollutants utilized estimates of the relative split of sanitary sewage versus rainfall runoff in discharged flows. Pollutant concentrations for sanitary sewage are attributed to the sanitary portion, and concentrations for stormwater are attributed to the rainfall runoff portion of the discharged flow volumes.

Table 3-12 presents the pollutant concentrations associated with the sanitary and stormwater components of discharges to Gowanus Canal. Sanitary concentrations were developed based on sampling of WPCP influent during dry-weather periods, as described elsewhere in more detail (NYCDEP, 2002). Stormwater concentrations were developed based on sampling conducted citywide as part of the Inner Harbor Facility Planning Study (Hazen and

Sawyer, 1993), and sampling conducted citywide by NYCDEP for the USEPA Harbor Estuary Program (HydroQual, 2005d).

3.5.3 Characterization of Pollutant Loads, Baseline Condition

Pollutant-mass loadings were calculated using the pollutant concentrations shown in Table 3-12, applied to the discharge volumes and sanitary/rainfall-runoff splits provided by the watershed model, as described above. Table 3-13 presents a summary of the annual discharges to Gowanus Canal for the Baseline condition.

As shown in Table 3-13 and summarized on Figure 3-7, CSOs dominate the loadings of biochemical oxygen demand (BOD), total suspended solids (TSS), and total coliform bacteria to Gowanus Canal. Moreover, CSO discharges from the Gowanus Pump Station (RH-034) represent between 45 and 71 percent of the total loadings of these pollutants.

3.5.4 Effects of Urbanization on Discharge

This section describes some of the important aspects of urbanization with respect to the watershed and presents a comparison of the discharge characteristics projected for the pastoral condition relative to the existing, urbanized condition.

The urbanization of the Gowanus Canal drainage area from a pastoral watershed to an urban sewershed is described in Section 2. The pastoral condition featured undeveloped uplands that provided infiltration of incident rainfall and contributed continuous freshwater inputs. Urbanization brought increased population, increased pollutants from sewage and industry, construction of sewer systems, and physical changes affecting the surface topography and imperviousness of the watershed. Increased surface imperviousness generates more runoff that is less attenuated by infiltration processes, and the sewer systems replaced natural overland runoff pathways with a conveyance system that routes the runoff directly to the waterbody—without the attenuation formerly provided by surrounding wetlands. As a result, more runoff is generated, and it is conveyed more quickly and directly to the waterbody. These changes also affect how pollutants are transferred along with the runoff on its way to the waterbody.

Table 3-11. Gowanus Canal Discharge Summary for Baseline Condition [1,2]

Outfall	Discharge Volume (MG)	Percentage of CSO or Stormwater Volume	Number of Discharges [3]
Combined Sewer			
RH-034	121	32.1	56
RH-035	111	29.5	75
OH-007	69	18.4	47
RH-031	35	9.4	33
OH-024	23	6.2	35
OH-006	13	3.3	33
RH-036	1.6	0.4	21
RH-038	0.9	0.2	18
OH-005	0.7	0.2	5
RH-037	0.5	0.1	16
RH-033	0.2	0.1	14
Total CSO	377	100	75
Storm Sewer			
OH-601	10	13.8	66
RH-032	1.5	2.1	38
OH-008	0.1	0.2	10
OH-602	0.1	0.2	3
Overland Runoff	62	83.8	79
Total Stormwater	74	100	79
Total	**452**	**NA**	**NA**

(1) Baseline condition reflects design precipitation record (JFK, 1988) and sanitary flows projected for year 2045 (Red Hook WPCP: 40 MGD; Owls Head WPCP: 115 MGD)
(2) Totals may not sum precisely due to rounding.
(3) Number of discharges reflects minimum modeled threshold flow of 0.01 MGD per 5-minute interval.

Table 3-12. Sanitary and Stormwater Discharge Concentrations, Baseline Condition

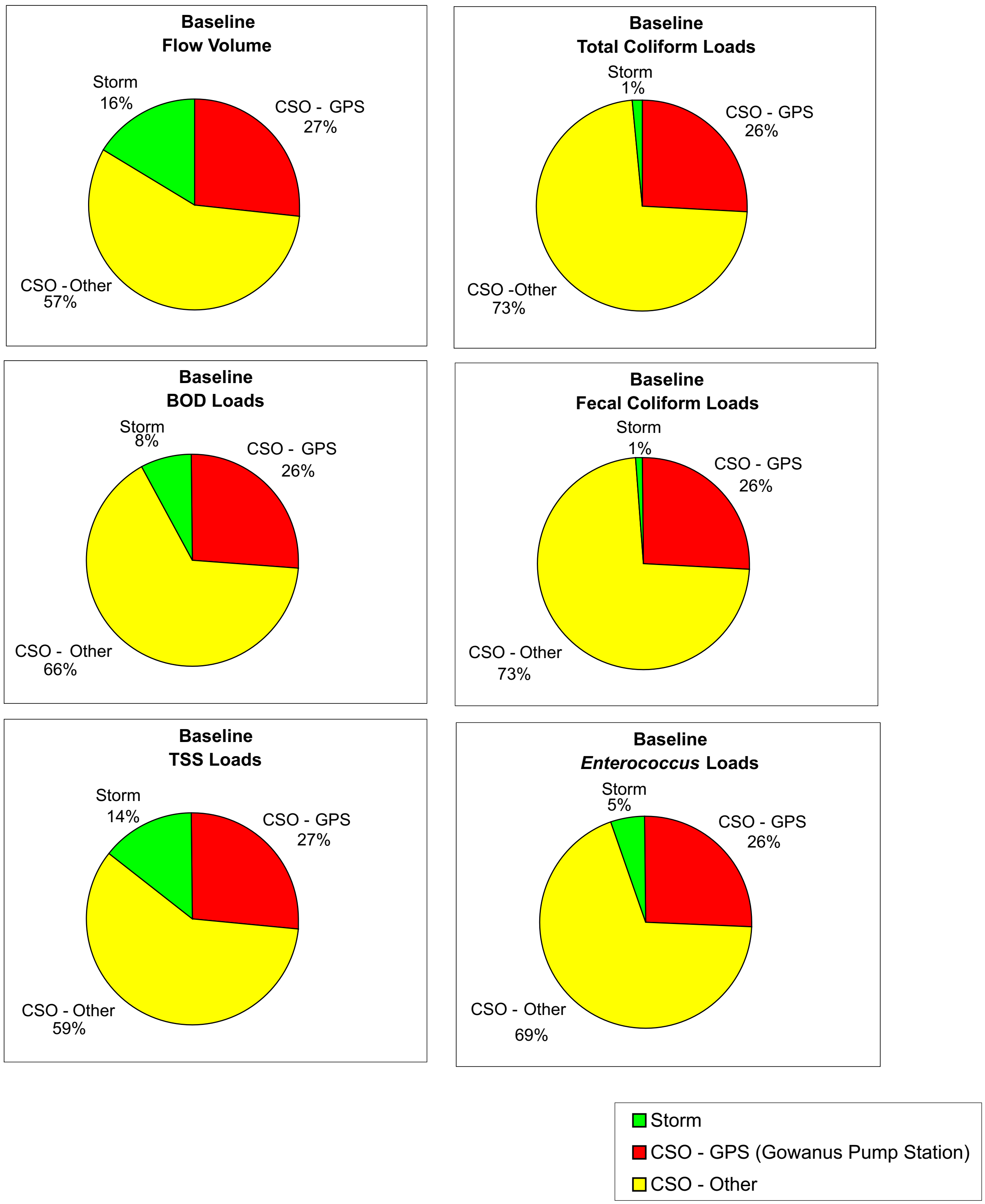
Constituent	Sanitary Concentration	Stormwater Concentration
Dissolved Oxygen, (mg/L)	1.0 mg/L	4.0 mg/L
Biochemical Oxygen Demand (BOD) (mg/L)	120 mg/L [1]	15 mg/L [2]
Total Suspended Solids (TSS) (mg/L)	115 mg/L [1]	60 mg/L [2]
Total Coliform Bacteria (MPN/100mL)	$150x10^{5}$ [1,2]	$2.0x10^{5}$ [2,3]
Fecal Coliform Bacteria (MPN/100mL) [4]	$27x10^{5}$ [1,2]	$0.3x10^{5}$ [2,3]
Enterococci (MPN/100mL) [4]	$10x10^{5}$ [1,2]	$0.7x10^{5}$ [3]

(1) NYCDEP, 2002.
(2) Hazen and Sawyer, 1993.
(3) HydroQual, 2005d.
(4) Bacterial concentrations expressed as "most probable number" of cells per 100 mL.

Table 3-13. CSO and Stormwater Discharge Loadings, Baseline Condition [1]

Constituent	GPS CSO Loading [2]	Other CSO Loading [3]	Stormwater Loading	Total Loading
Biochemical Oxygen Demand (BOD)	31,723 lbs	78,833 lbs	9,321 lbs	119,878 lbs
Total Suspended Solids (TSS)	69,290 lbs	152,631 lbs	37,285 lbs	259,207 lbs
Total Coliform Bacteria[4]	$11.5x10^{15}$ MPN	$31.9x10^{15}$ MPN	$0.6x10^{15}$ MPN	44.9×10^{15} MPN
Fecal Coliform Bacteria[4]	$2.1 x10^{15}$ MPN	$5.7x10^{15}$ MPN	$0.09x10^{15}$ MPN	7.8×10^{15} MPN
Enterococci[4]	$1.0 x10^{15}$ MPN	$2.7x10^{15}$ MPN	$0.2x10^{15}$ MPN	3.8×10^{15} MPN

(1) Loadings represent annual total during Baseline simulation.
(2) GPS CSO loadings reflect CSO discharges from the Gowanus Pump Station (RH-034).
(3) Other CSO loadings reflect all CSO discharges to study area except the GPS CSO loadings.
(4) Bacterial loadings expressed as most probable number (MPN) of cells.



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Watershed Loading Comparisons Baseline Conditions

FIGURE 3-7

Furthermore, the urbanized condition also features additional sources of pollution from CSOs and industrial/commercial activities.

Prior to construction of Gowanus Canal in the 1840s, the Gowanus Creek watershed consisted of mostly farms and mills that were on the edge of the City of Brooklyn. At that time, the population of the pre-urbanized watershed was likely about 10,000 (roughly 8 persons per acre), based on available information from the U.S. Census Bureau, which estimates that the entire population of Kings County was just over 1 million in 1900, with populations centered outside of the Gowanus area. The Gowanus Canal watershed currently had a population of approximately 108,800 (62 persons per acre) in 2000, based on U.S. Census Bureau information.

Urbanization of the watershed has altered its runoff yield tributary to Gowanus Canal by increasing its imperviousness. Imperviousness is a characteristic of the ground surface that reflects the percentage of incident rainfall that runs off the surface rather than is absorbed into the ground. While natural areas typically exhibit imperviousness of 10 to 15 percent, imperviousness in urban areas can be 70 percent or higher. As presented in Section 2, land uses in the urbanized Gowanus Canal watershed are only about two percent parks; 98 percent of the area's land uses feature rooftops, sidewalks, streets, and paved playgrounds and schoolyards. Overall, the calculated imperviousness of the Gowanus Canal watershed is about 62 percent. This represents a potential increase in runoff of up to roughly six times the pre-urbanized, pastoral condition.

In a pastoral condition, runoff from a watershed typically reaches the receiving waters through a combination of overland surface flow and subsurface transport, typically with ponding and other opportunities for retention and infiltration. Tidal wetland areas previously surrounding Gowanus Creek would have further attenuated wet-weather discharges. The urbanization of the Gowanus Canal watershed reduced infiltration and natural subsurface transport and eliminated all natural streams previously tributary to Gowanus Creek so that there are no longer any continuous freshwater tributaries to the waterbody. Runoff is transported via roof leaders, street gutters and catch basins into the combined and separate sewer system, which then discharges directly to Gowanus Canal since the wetlands have been eliminated. Urbanization has thus simultaneously decreased retention and absorption of runoff during transport and decreased the travel time for runoff to reach the waterbody. When combined with the increased runoff due to increased imperviousness of the watershed, the end result is increased peak discharge rates and higher total discharge volumes to the waterbody during wet weather.

Table 3-14 presents a summary of pre-urbanized and urbanized conditions for the Gowanus Creek and Gowanus Canal watersheds, respectively. The pre-urbanized condition is circa 1840, prior to construction of the Canal, while the urbanized condition reflects current conditions. The table demonstrates how wet-weather discharges, estimated using watershed models with the design-condition precipitation record (JFK gage, 1988), are projected to have increased from the pastoral to the urbanized condition. The total, annual wet-weather discharge in the pastoral condition was approximately 143 MG, compared to 473 MG in the urbanized condition, representing a more than three-fold increase. For the same precipitation record, the maximum discharged volume in a single storm increased by an even wider margin, from 8.8 MG in the pastoral condition to 33.6 MG in the urbanized condition. Instantaneous peak flows increased from 38.6 MGD in the pastoral condition to 246.5 MGD in the urbanized condition—an increase of over six times.

Table 3-14. Urbanization and Effects on Hydrology

Watershed Characteristic	Pastoral[1]	Urbanized[2]
Drainage Area (acres)[3]	1,286	1,758
Adjacent Wetlands (acres)[4]	439	0
Population[5]	~10,000	108,800
Imperviousness	10 %	62 %
Annual Wet-Weather Discharge (MG)[6]	143	473
Top Storm, Wet-Weather Discharge (MG)[6]	8.8	33.6
Peak Runoff Rate (MGD)[6]	38.6	246.5

(1) Pastoral conditions reflect pre-urbanized Gowanus Creek watershed, circa 1840
(2) Urbanized conditions reflect existing Gowanus Canal watershed
(3) Drainage area estimates do not include any wetlands
(4) Wetland area for pre-urbanized condition approximated from historical maps
(5) Population estimates for 1840 (pre-urbanized) and 2000 (urbanized), based on U.S. Census information
(6) Wet-weather discharge estimates generated using watershed model with JFK 1988 precipitation record; includes stormwater

Urbanization has also altered the pollutant character of wet-weather discharges from the watershed. The original rural landscape of forests, fields and wetlands represents pristine conditions with pollutant loadings resulting from natural processes (USEPA, 1997). These natural loadings, while having an impact of water quality in the receiving water, are insignificant compared to the urbanized-condition loadings from CSO and stormwater point sources.

Wet-weather discharges from a combined sewer system contain a mixture of sanitary sewage and urban runoff that is significantly stronger in pollutant concentrations than natural runoff. These pollutants include coliform bacteria, oxygen-demanding materials, suspended and settleable solids, floatables, oil and grease, and others. Table 3-15 presents a loading comparison for TSS and BOD—two pollutants with significant impact on water quality in Gowanus Canal. The loadings are based on the watershed model discharge volumes (Table 3-14) and pollutant concentrations taken from literature sources for pastoral conditions and as determined for existing conditions for the urbanized condition; stormwater concentrations used for the urbanized condition are typically higher than those for a rural or pristine condition. The table demonstrates that urbanization of the watershed has substantially increased pollutant loadings to Gowanus Canal.

Table 3-15. Effects of Urbanization on Watershed Pollutant Loadings

Annual Pollutant Load(1)	Pastoral(2)	Urbanized(3)	Change
Total Suspended Solids (kg/year)	71,500	252,500	353 %
Biochemical Oxygen Demand (kg/year)	17,900	89,600	500 %

(1) Annual pollutant loads reflect watershed model calculations for the design-condition precipitation record (JFK gage, 1988)
(2) Pastoral condition reflects pre-urbanized conditions and natural pollutant concentrations in stormwater
(3) Urbanized condition reflects existing pollutant concentrations found in CSO and stormwater discharges

3.5.5 Toxics Discharge Potential

Early efforts to reduce the amount of toxic contaminants being discharged to the New York City open and tributary waters focused on industrial sources and metals. For industrial source control for separate and combined sewer systems, USEPA requires approximately 1,500 municipalities nationwide to implement Industrial Pretreatment Programs (IPPs). The intent of the IPP is to control toxic discharges to public sewers that are tributary to sewage treatment plants by regulating Significant Industrial Users (SIU). If a proposed IPP is deemed acceptable, USEPA will decree the local municipality a "control authority." NYCDEP has been a control authority since January 1987, and enforces the IPP through Chapter 19 of Title 15 of the Rules of the City of New York (Use of the Public Sewers), which specifies excluded and conditionally accepted toxic substances along with required BMPs for several common discharges such as photographic processing waste, grease from restaurants and other non-residential users, and perchloroethylene from dry cleaning. NYCDEP has been submitting annual reports on its activities since 1996. The 310 SIUs that were active citywide at the end of 2004 discharged an estimated average total mass of 38.2 pounds per day (lbs/day) of the following metals of concern: arsenic, cadmium, copper, chromium, lead, mercury, nickel, silver and zinc.

As part of the IPP, NYCDEP analyzed the toxic metals contribution of sanitary flow to CSOs by measuring toxic metals concentrations in WPCP influent during dry weather in 1993. This program determined that of the 177 lbs/day of regulated metals being discharged by regulated industrial users only 2.6 lbs/day (1.5 percent) were bypassed to CSOs. Of the remaining 174.4 lbs, approximately 100 lbs ended up in biosolids, and the remainder was discharged through the main WPCP outfalls. Recent data suggest even lower discharges. In 2003, the average mass of total metals discharged by all regulated industries to the New York City WPCPs was less than 39.1 lbs/day, which would translate into less than 1 lb/day bypassed to CSOs from year 2003 regulated industries if the mass balance calculated in 1993 is assumed to be maintained. A similarly developed projection was cited by the 1997 NYCDEP report on meeting the nine minimum CSO control standards required by federal CSO policy, in which NYCDEP considered the impacts of discharges of toxic pollutants from SIUs tributary to CSOs (NYCDEP, 1997). The report, audited and accepted by USEPA, includes evaluations of sewer system requirements and industrial user practices to minimize toxic discharges through CSOs. It was determined that most regulated industrial users (of which SIUs are a subset) were discharging relatively small quantities of toxic metals to the NYC sewer system.

There are five SIUs within the Gowanus Canal watershed. The total permitted flow rate of these SIUs is 0.024 MGD, which corresponds to about 0.2 percent of the 14.1 MGD daily dry-weather flow generated within the watershed, or 0.01 percent of the 1,215 MGD daily dry-weather flow generated City-wide. It can be inferred from these flows that, of the 39.1 lb/day of metals in the City-wide dry-weather flow, less than 0.004 lbs/day of metals are generated in the Gowanus Canal area. Since a portion of the combined sewage generated during wet weather is captured for treatment, the potential metals load to Gowanus Canal from SIUs during wet weather is even smaller. Since no discharge from these sources occurs during dry weather, the daily average (for wet and dry weather) loading is further reduced. As a result of the small scale of this potential source, NYSDEC has not listed Gowanus Canal as being impaired by toxic pollutants associated with CSO discharges. As such, metals and toxic pollutants are not considered to be pollutants of concern for the development of this Waterbody/Watershed Facility Plan.

As discussed in Section 2.3, other potential sources of toxics to Gowanus Canal include some shoreline issues and activities, such as previous accidental fuel spills and currently regulated activities. In addition, as in any industrial waterway, fuel spills directly to the waterbody represent an additional potential source.

4.0 Waterbody Characteristics

Gowanus Canal is a tidal waterbody located in the western portion of Brooklyn, New York and is a tributary to the Gowanus Bay portion of Upper New York Bay. The headwaters of the Canal are located at Butler Street in the Carroll Gardens section. The Canal extends approximately one mile southward to Hamilton Avenue and is generally bounded by 3rd Avenue to the west, Smith Street to the east, and Butler Street to the north. Downstream, it broadens into Gowanus Bay and Upper New York Bay. The Canal has a north-south orientation and features several short (typically one city block) branches perpendicular to the main channel that serve as "turning basins" for vessels to reverse direction. Hamilton Avenue defines two distinct reaches of the Canal. The reach upstream of Hamilton Avenue is narrow, bulkheaded and shallow with water quality greatly influenced by CSO and stormwater discharges. The downstream reach quickly broadens and deepens into Gowanus Bay, and water quality is heavily influenced by New York Harbor conditions. The following describes the present-day physical and water quality characteristics of Gowanus Canal as well as its current uses.

4.1 CHARACTERIZATION METHODOLOGY

The NYCDEP's comprehensive watershed-based approach to long-term CSO control planning follows the USEPA's guidance for monitoring and modeling (USEPA, 1999). The watershed approach represents a holistic approach to understanding and addressing all surface water, ground water, and habitat stressors within a geographically defined area, instead of addressing individual pollutant sources in isolation. The guidance recommends identifying appropriate measures of success based on site-specific conditions to both characterize water quality conditions and measure the success of long-term control plans based on site-specific conditions, and in a manner that illustrates trends and results over time. The measures of success are recommended to be objective, measurable, and quantifiable indicators that illustrate trends and results over time. USEPA's recommended measures of success are administrative (programmatic) measures, end-of-pipe measures receiving waterbody measures, and ecological, human health, and use measures. USEPA further states that collecting data and information on CSOs and CSO impacts provides an important opportunity to establish a solid understanding of the "baseline" conditions and to consider what information and data are necessary to evaluate and demonstrate the results of CSO control. USEPA acknowledges that, since CSO controls must ultimately provide for the attainment of water quality standards, the analysis of CSO-control alternatives should be tailored to the applicable standards such as those for dissolved oxygen and coliform bacteria. Since the CSO Control Policy recommends periodic review and revision of water quality standards, as appropriate, investigations should reflect the site-specific, wet-weather impacts of CSOs. NYCDEP has implemented its CSO facility-planning projects consistently with this guidance and has developed these categories of information on waterbodies such as Gowanus Canal.

In accordance with this approach, the waterbody/watershed assessment of Gowanus Canal and its watershed required a compilation of existing data, identification of data gaps, collection of new data, and cooperation with field investigations being conducted by other agencies. Furthermore, NYCDEP became involved in a concurrent study being conducted by the USACE. This Gowanus Bay and Canal Ecosystem Restoration Feasibility Study required data and information for assessment and planning purposes that were very similar to the NYCDEP's requirements for the waterbody/watershed assessment. Waterbody/watershed characterization activities were conducted following the USA Project's Waterbody Work Plan. These efforts yielded valuable information for characterizing Gowanus Canal and its watershed, as well as for supporting mathematical modeling and engineering efforts. The following describes these activities.

4.1.1 Compilation of Existing Data

In order to properly characterize Gowanus Canal and its watershed, a comprehensive approach was conducted to identify past and ongoing data-collection efforts that focused on or included Gowanus Canal and nearby waterbodies. The effort facilitated a compilation of existing watersheds information and biological, water quality and sediment data. Several sources of water quality and sediment data were available in Gowanus Canal and Bay. In general, biological studies have been limited to Gowanus Bay and contiguous portions of Upper New York Bay and the East River. Since 1982, the NYCDEP has conducted facility-planning projects that collected waterbody and watershed data pertinent to this waterbody/watershed assessment. At the time of the writing of this report, the NYCDEP was conducting several ongoing programs yielding watershed and waterbody data. In addition, several other projects conducted by others have collected data in Gowanus Canal and Gowanus Bay in the not-too-distant past.

The NYCDEP studies from which existing data were found are summarized below, and associated sampling locations are presented on Figures 4-1 through 4-4. Studies conducted by other agencies follow at the end of this subsection.

Harbor Survey Program

The NYCDEP's Harbor Survey program has been monitoring water quality in New York Harbor since 1909. The Harbor Survey has been monitoring water quality in Gowanus Bay since 1984 at two stations: near the Breakwater Terminal (Station G1, recently discontinued) and near Court Street (Station G2). Sampling occurs at Harbor Survey stations on a monthly basis during winter months and weekly during summer months. In 2000, the Harbor Survey Tributary Monitoring Program added four stations in Gowanus Canal. Sampling is conducted from bridges located at Douglass Street (Station GC2), Union Street (Station GC3), Carroll Street (Station GC4) and 3rd Street (Station GC5). In 2004, an additional station was added at the 9th Street Bridge (Station GC6) in lieu of Station GC2. In March 2004, the Harbor Survey and a local community group, the Urban Divers, installed a remote sensor in the 6th Street Basin to continuously monitor several water quality parameters. Harbor Survey monitoring locations are shown on Figure 4-1.

Sentinel Monitoring Program

The NYCDEP's Sentinel Monitoring Program has collected water quality data in Gowanus Canal and Bay since 1998. Stations are sampled for fecal coliform bacteria at one station in the Canal at Hamilton Avenue and at Harbor Survey Stations G1 and G2 in Gowanus Bay. Sentinel Monitoring Program sampling stations are shown on Figure 4-1.

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Recent Receiving-Water Monitoring Locations in Gowanus Canal

FIGURE 4-1

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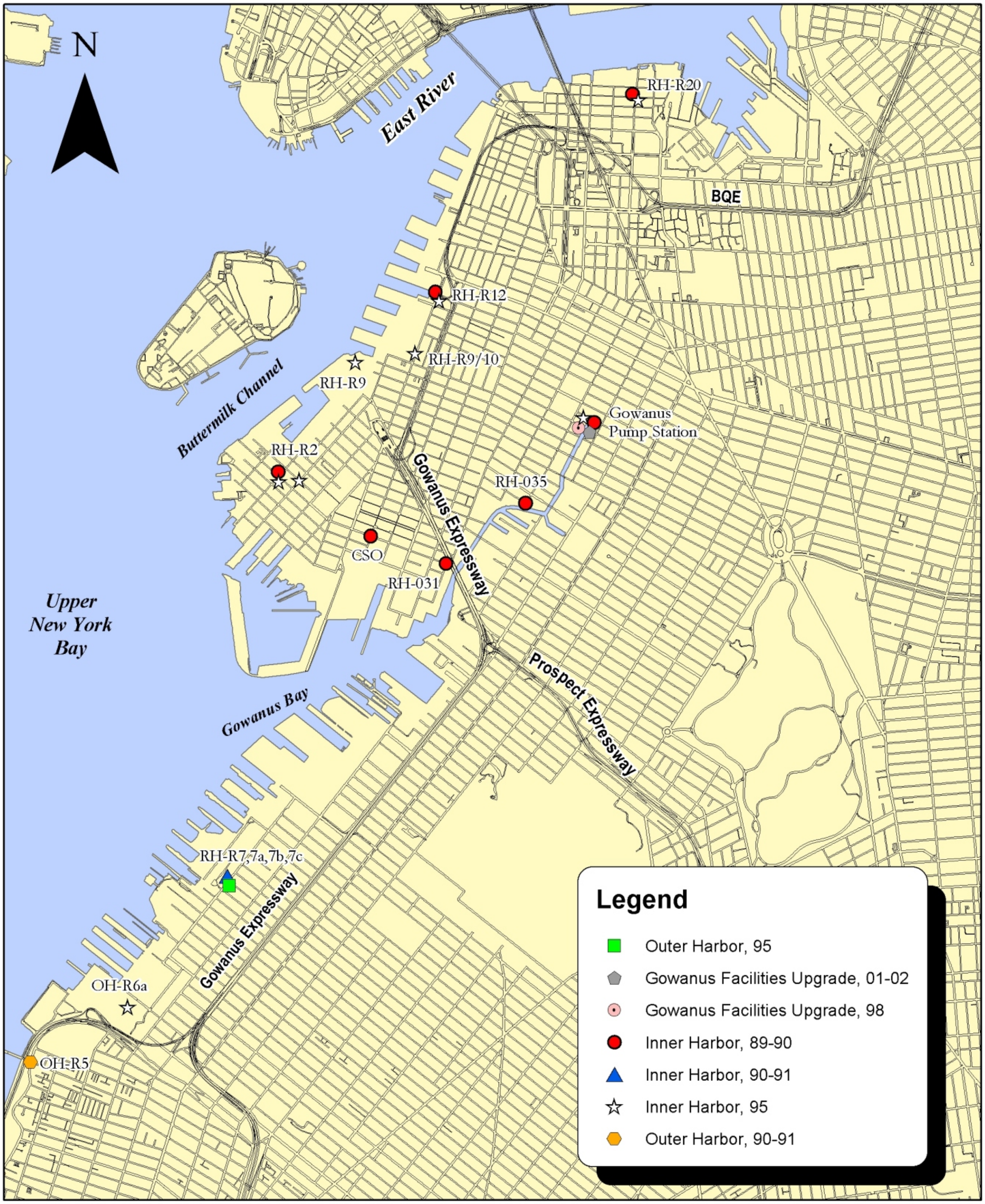
Receiving-Water Sampling Stations for Gowanus Canal 201 Facilities Plan

FIGURE 4-2

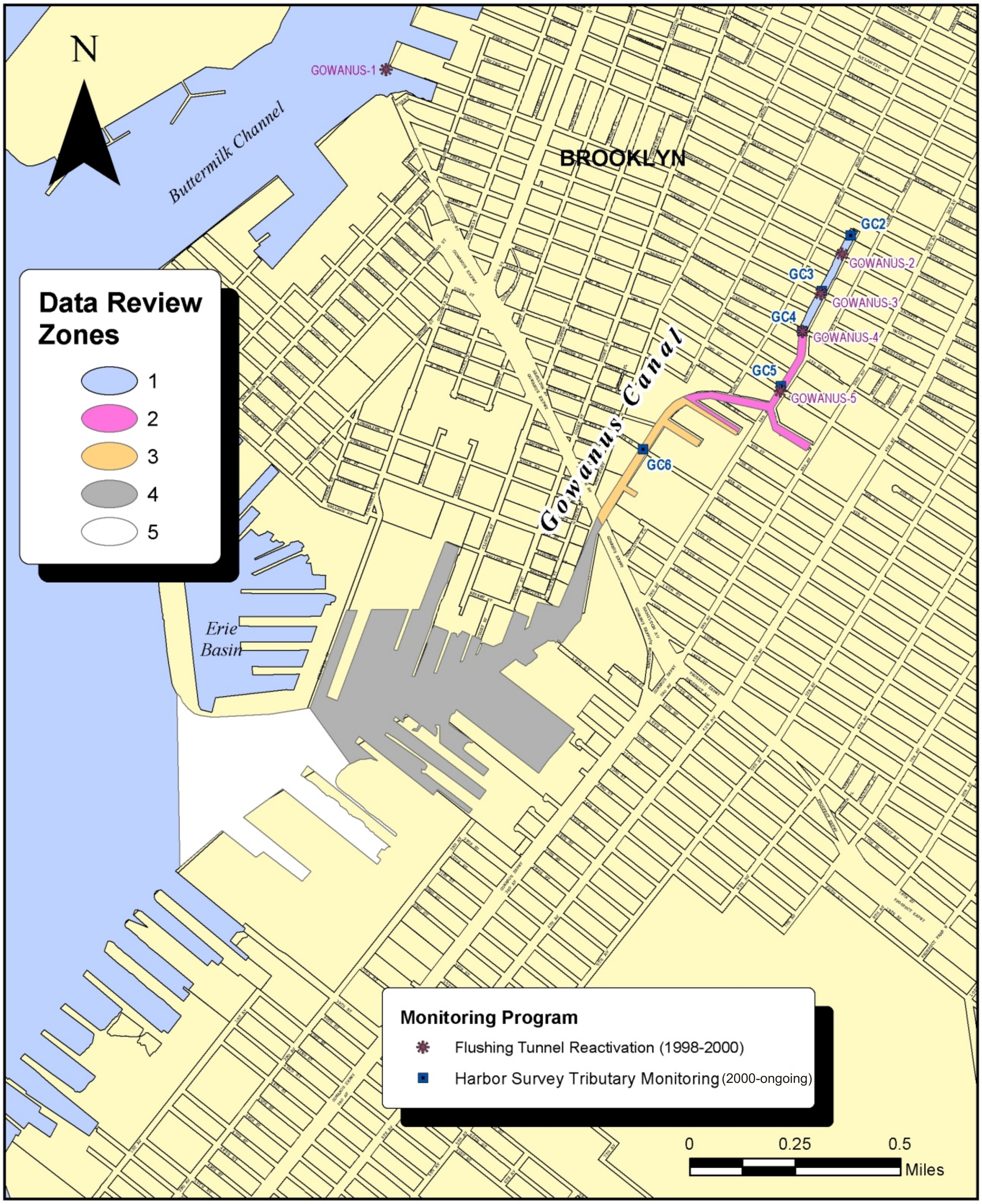


New York City
Department of Environmental Protection

Gowanus Canal Waterbody/Watershed Facility Plan

Past Sewer-System Monitoring Locations Reflecting the Gowanus Canal Sewershed

FIGURE 4-3



New York City
Department of Environmental Protection

Sampling Station Locations Associated With Flushing Tunnel Monitoring

Gowanus Canal 201 Facilities Plan

As part of the Gowanus Canal 201 Facilities Plan (NYCDEP, 1983), NYCDEP conducted field investigations that included watershed, receiving water, and sediment monitoring in the assessment area from July 1982 through April 1983. Dry weather discharges to Gowanus Canal that were occurring at that time have since been eliminated by the NYCDEP. Samples collected from sewer discharges to Gowanus Canal at several locations characterized dry- and wet-weather discharges. Receiving water and sediment samples were collected at 23 stations from Gowanus Canal, Gowanus Bay, and Upper New York Bay including Buttermilk Channel. Station locations are shown on Figure 4-2. Samples were analyzed for hydrodynamic and dissolved oxygen characterizations, as well as sediment oxygen demand (SOD), heavy metals, organics, and toxicity.

Inner Harbor CSO Facility Planning Project

The NYCDEP collected data in the assessment area for the Inner Harbor CSO Facility Planning Project from 1988 to 1991 (Hazen and Sawyer, 1990, 1993). Watershed, receiving water and sediment monitoring were conducted throughout the Upper New York Bay area, including Gowanus Canal and Bay. Watershed investigations included sewer system inspections and videotaping, local rainfall recording, and sewer system and CSO monitoring. Inspections were made of several regulators and trunk sewers, the Gowanus Pump Station, and the Bond-Lorraine Sewer. Rainfall data were collected throughout the Upper New York Bay watershed, including a station at the Gowanus Pump Station. Sewer system monitoring was conducted at several locations in the Gowanus Canal and Bay watershed to characterize sewer system flow and CSO. The locations of these monitoring sites are shown on Figure 4-3. Three dry and two wet weather surveys of the Canal were paired with special studies to characterize water quality and sediment conditions and to identify sources of impairments. A dye study, a bathymetric survey, and tidal monitoring were conducted in the Canal to characterize hydrodynamic conditions. Receiving water samples were collected at five stations in Gowanus Canal and Bay to characterize dissolved oxygen and coliform bacteria. Sampling stations are shown on Figure 4-3. Special studies were also conducted to characterize odors, coliform bacteria die-off, suspended solids settling, sediment oxygen demand, sediment flux, and priority pollutant concentrations in CSO and sediment. In addition, as part of a process to acquire dredging permits, water quality and sediment samples were collected at the head end of the Canal and analyzed for priority pollutants and other parameters in 1994 and 1997.

Outer Harbor CSO Facility Planning Project

Watershed and receiving water monitoring were conducted by the NYCDEP during its Outer Harbor CSO Facility Planning Project from 1989 to 1990 (Hazen and Sawyer, 1992). Receiving water monitoring was conducted throughout Lower New York Bay and adjacent waterbodies, but not in the Gowanus Canal waterbody/watershed assessment area. Rainfall and sewer system monitoring was conducted in the Owls Head WPCP service area from 1990 to 1991, although not at locations tributary to the waterbody/watershed assessment area. Additional sewer system monitoring was conducted during subsequent planning at several locations from September through December 1995 and November through December 1996. Rainfall and sewer system monitoring locations in the Owls Head WPCP service area are shown on Figure 4-2.

Pre- and Post-Monitoring of Gowanus Canal Flushing Tunnel

As discussed further in Section 4.2.2, Gowanus Canal's limited capacity for exchange and dispersal was recognized early during the urbanization of the watershed. In an attempt to rectify this situation, the Gowanus Canal Flushing Tunnel was put into service in 1911 as an engineering solution to improve water quality in the Canal. Although the Flushing Tunnel operated for over 50 years, it became inoperable in the 1960s. Plans to rehabilitate and return the Flushing Tunnel to service included special monitoring of the Canal both before and after reactivation of the Flushing Tunnel in March 1999.

The NYCDEP collected hydrodynamic, water quality, and biological data in Gowanus Canal and Buttermilk Channel from 1998 through 2000 as part of a special monitoring program to characterize conditions pre- and post-reactivation of the Flushing Tunnel. Samples were collected monthly at three stations in Gowanus Canal, one station in Gowanus Bay, and at one station in Buttermilk Channel to characterize dissolved oxygen. Water quality sampling stations are shown on Figure 4-4. Monthly samples were collected in the Canal at four locations (near the head, 4^{th} Street Basin, Hamilton Avenue, and Gowanus Bay) to characterize benthic macroinvertebrates. Nekton/plankton sampling was conducted at the inlet and outlet of the Flushing Tunnel, once before and once after reactivation. Finally, velocity measurements in the Canal were recorded at two locations near the Flushing Tunnel outlet for several months before and after reactivation.

In addition to the sampling described above, the NYCDEP Harbor Survey has performed extra monitoring as part of the Tributary Monitoring Program at locations in Gowanus Canal on several occasions since 1999 when the Flushing Tunnel was deactivated temporarily for maintenance and repairs. The purpose of this special monitoring was to assess the impact that tunnel deactivation had on water quality in the Canal.

Gowanus Canal Facilities Upgrade

NYCDEP recently performed sewer system monitoring while planning for its ongoing Gowanus Canal Facilities Upgrade. The sampling program characterized sewer system flows at the Gowanus Pump Station by monitoring its influent and effluent flows. In 1998 and 2001-2002, monitoring was conducted at various locations around the pump stations as shown on Figure 4-3. Sewer system cleaning was underway in the Bond-Lorraine Sewer at the time of the waterbody/watershed assessment. This activity yielded information on the structural conditions in the sewer.

Data Collected by Other Agencies

Data has been collected by other agencies and organizations in the waterbody/watershed assessment area and in the vicinity of Gowanus Canal. The remainder of this section summarizes those studies and programs that contributed to the existing database for Gowanus Canal and the surrounding areas.

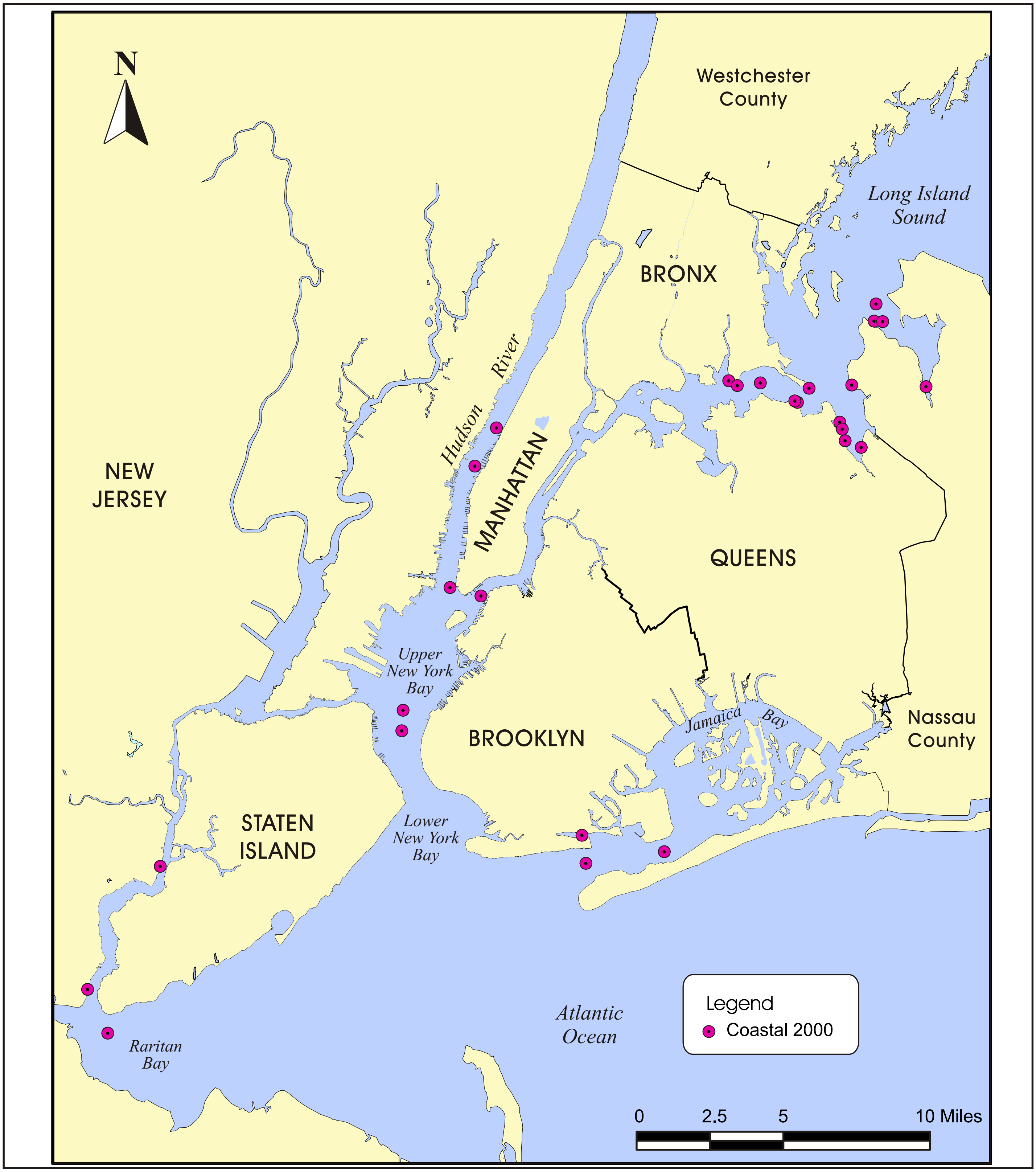
The USEPA Regional Environmental Monitoring and Assessment Program (REMAP) has evaluated sediment quality throughout New York Harbor, as has the agency's more recent five-year National Coastal Assessment (a.k.a. "Coastal 2000") program (Figure 4-5). The New York State Department of Transportation (NYSDOT) conducted studies of the biota of the East River at the Queensboro Bridge (TAMS, 1999), while the New York City Public Development Corporation studied the ecology of Wallabout Bay in the East River (EEA, 1991). The USACE performed sediment profile imagery and benthic sampling in Jamaica Bay, Upper New York Bay, Newark Bay, Bowery Bay, and Flushing Bay during June and October, 1995. In Upper New York Bay, the USACE conducted a two-year study of flatfish distribution and abundance (USACE, 1998). A series of fish surveys was made of Gowanus Canal in 2001 by the Marine Sciences Research Center of Stony Brook University (NYCDEP, 2001). The data from these programs are useful for comparing Gowanus Canal to similar waterbodies in the New York Harbor to ascertain its relative aquatic and ecological health.

A significant source of data on fish populations in New York Harbor comes from numerous studies associated with electric power generating station cooling water systems. Along with cooling water, intakes inadvertently withdraw planktonic biota and smaller fish incapable of escaping the pressure gradients generated by pumping. The organisms either pass through the cooling system (entrainment) or are trapped against the screens and other protective barriers (impingement). Permit conditions at these facilities require entrainment and impingement sampling, providing an abundance of data on fish populations and other aquatic organisms. These data are biased towards younger life-stages (fish eggs and larva) and smaller fish species, but can provide evidence of the viability of fish species in the waterbody. Local power plants include the East River plant in lower Manhattan; the Arthur Kill plant on Staten Island; and the Ravenswood, Astoria and Poletti plants on the East River. ENSR (1999) reported on the East River generating station, but the most recent summary of data at these power plants was produced by Sunset Energy Fleet LLC, in its Article X application to the New York State Public Service Commission, to build and operate a power plant in Gowanus Bay (Sunset Energy Fleet, 2002). Sunset Energy also collected and analyzed numerous samples of benthic infauna and ichthyoplankton, in Gowanus Bay in 1999 and 2000. These data are useful for comparative and baseline evaluations, but do not generally provide meaningful information on the effects of water pollution control efforts by NYCDEP.

4.1.2 Biological and Habitat Assessments

As indicated in the preceding section, a substantial database existed prior to the waterbody/watershed assessment. However, review of the existing database identified several key gaps, including: watershed information relating to runoff characteristics, dry-weather flow conditions, regulator configurations, and outfall status; waterbody bathymetry; biotic characterizations; physical, chemical, and biological sediment characterizations; and toxicity characterizations in the water column and sediment.

The NYCDEP conducted field investigations as part of the Gowanus Canal waterbody/watershed assessment and other ongoing NYCDEP projects to fill gaps in watershed characteristics. Runoff characteristics (such as percent imperviousness or runoff coefficients) and dry weather flow conditions were investigated by monitoring sewer system flows. In 2003, the NYCDEP conducted monitoring at several locations in the Red Hook WPCP service area,



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Gowanus Canal Waterbody/Watershed Facility Plan

Coastal 2000 Sampling Locations in New York Harbor

FIGURE 4-5

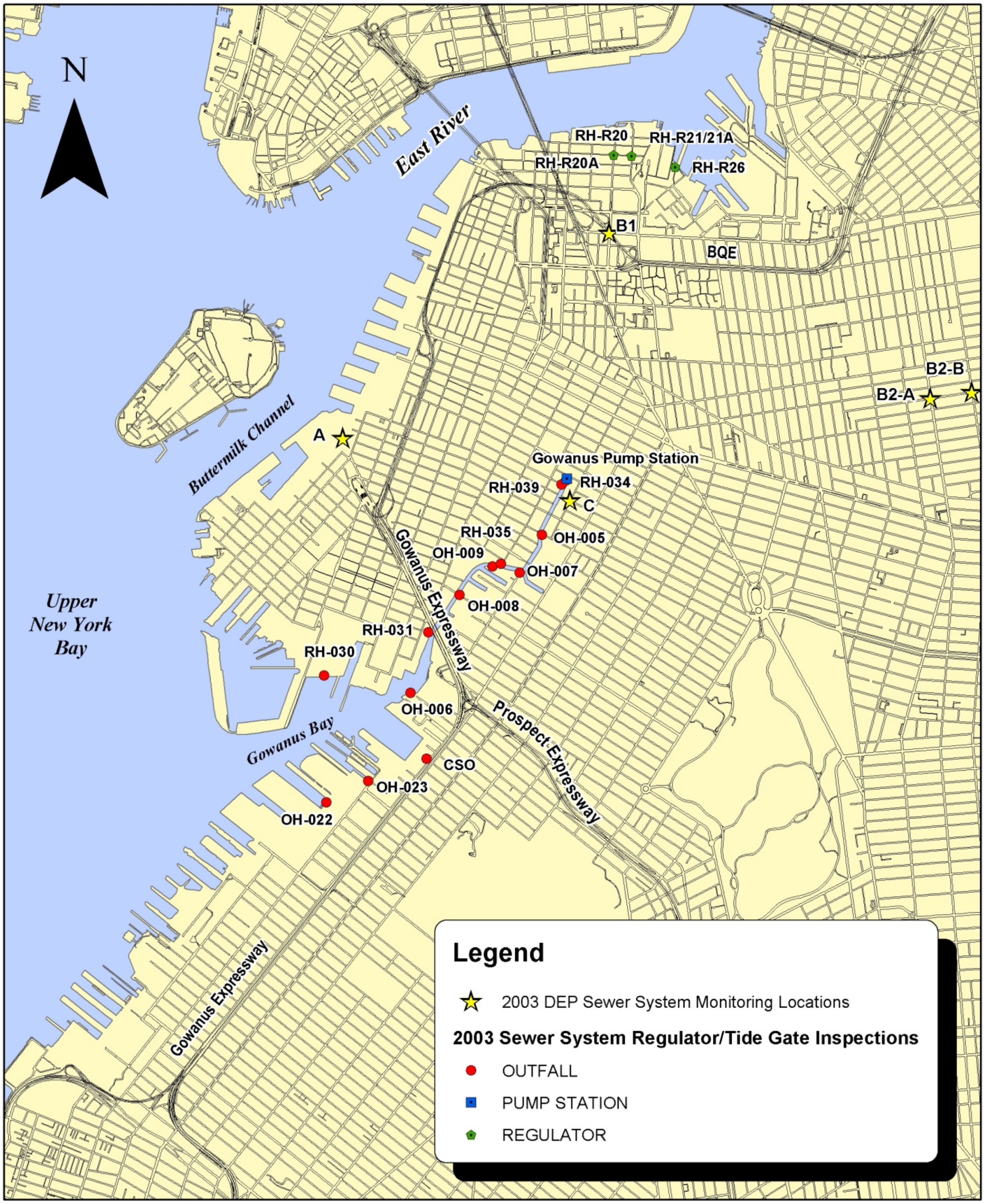
including areas tributary to Gowanus Canal. In 2003, field inspections were also conducted of regulators, tide gates, outfalls, and other system components in the Red Hook and Owls Head WPCP service areas tributary to Gowanus Canal. The locations of these investigations are shown on Figure 4-6.

Following long-term control plan guidance, the NYCDEP's waterbody/watershed assessments required characterizations of combined sewer and stormwater discharges to calculate pollutant loads and assess impacts on receiving waters during wet weather events. Sanitary sewage is a component of combined sewage but very little recent coliform bacteria data were available to characterize New York City's sanitary sewage. Moreover, the federal Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000 requires adoption of state water quality standards for enterococci in coastal recreational waters, but very little local data is available for enterococci. Therefore, a sampling program was conducted during the summer of 2002 to collect total and fecal coliform bacteria and enterococci data that would be reasonably representative of New York City's sanitary sewage. Influent sampling of all 14 NYCDEP WPCPs was conducted. Each WPCP was sampled on at least five distinct days, with samples collected several times during the day and on a random basis such that no WPCP was sampled on two successive days or on the same day of the week. At least one day of dry weather (preferably two or more) was required prior to the sampling event to assure that sample collection represented sanitary sewage only.

The widths and depths of Gowanus Canal were surveyed in 1989 during the Inner Harbor CSO Facility Planning Project. The survey recorded the widths and depths of Gowanus Canal, its turning basins, and Gowanus Bay. However, because construction and other activities in the study area likely affected bathymetry after 1989, NYCDEP conducted a new bathymetric survey in June 2003 to characterize waterbody depths throughout Gowanus Canal, its turning basins, and Gowanus Bay.

Use evaluations for fish and aquatic life require identifying regulatory issues (aquatic life protection and fish survival), selecting and applying the appropriate criteria, and determining the attainability of criteria and uses. According to guidance published by the Water Environment Research Foundation (Michael & Moore, 1997; Novotny et. al., 1997), biological assessments of use attainability should include "contemporaneous and comprehensive" field sampling and analysis of all ecosystem components. These components include phytoplankton, macrophytes, zooplankton, benthic invertebrates, fish and wildlife. The relevant factors are dissolved oxygen, habitat (substrate composition, organic carbon deposition, sediment pore water chemistry), and toxicity.

Biological components and factors were prioritized to determine what information was most needed relative to existing data or information expected to be generated by other ongoing studies, and/or which biotic communities would provide the most information relative to the definition of use classifications and the applicability of particular water quality criteria and standards. The biotic communities selected for sampling included subtidal benthic invertebrates (which, being largely immobile, have historically been used as indicators of environmental quality); epibenthic organisms colonizing standardized substrate arrays suspended in the water column (thus eliminating substrate type as a variable in assessing water quality); fish eggs and



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Watershed Field Investigation Locations (2003)

FIGURE 4-6

larvae (their presence being related to fish procreation); and juvenile and adult fish (their presence being a function of habitat preferences and/or dissolved oxygen tolerances).

These field investigations were executed under a harbor-wide biological Field Sampling and Analysis Program (FSAP) designed to fill ecosystem data gaps for Gowanus Canal. The NYCDEP's FSAPs were designed and implemented in conformance with USEPA's Quality Assurance Project Plan guidance (USEPA, 1998, 2001a, 2001b), its standard operation and procedure guidance (USEPA, 2001c), and in consultation with USEPA's Division of Environmental Science and Assessment in Edison, NJ. The FSAPs collected information to identify uses and use limitations within waterbodies assessing aquatic organisms and factors that contribute to use limitations (dissolved oxygen, substrate, habitat and toxicity). Some of these FSAPs were related to specific waterbodies; others to specific ecological communities or habitat variables throughout the harbor; and still others to trying to answer specific questions about habitat and/or water quality effects on aquatic life. NYCDEP conducted several FSAPs during the USA Project that included investigations of Gowanus Canal and Bay.

The NYCDEP conducted its Harbor-Wide Ichthyoplankton FSAP in 2001 to identify and characterize ichthyoplankton communities in the open waters and tributaries of New York Harbor (HydroQual, 2001b). Information developed by this FSAP identified what species are spawning, as well as where and when spawning may be occurring in New York City's waterbodies. The FSAP was executed on a harbor-wide basis to assure that evaluations would be performed at the same time and general water quality conditions for all waterbodies. Sampling was performed at 50 stations throughout New York Harbor, its tributaries, and at reference stations outside the harbor complex. The locations of sampling stations are shown on Figure 4-7. One station was located in Gowanus Bay. Samples were collected using a fine-mesh plankton net with two replicate tows taken at 50 stations in March, May and July 2001. In August 2001, 21 of the stations, including one in Gowanus Canal, were re-sampled to evaluate ichthyoplankton during generally the worst case temperature and dissolved oxygen conditions.

The NYCDEP conducted a Harbor-Wide Epibenthic Recruitment and Survival FSAP in 2001 to characterize the abundance and community structure of epibenthic organisms in the open waters and tributaries of New York Harbor (HydroQual, 2001c). The recruitment and survival of epibenthic communities on hard substrates was evaluated because these sessile organisms are good indicators of long-term water quality. This FSAP provided a good indication of both intra- and inter-waterbody variation in organism recruitment and community composition. Artificial substrate arrays were deployed at 37 stations throughout New York Harbor, its tributaries, and at reference stations outside the Harbor complex. The locations of sampling stations are shown on Figure 4-8. One station was located in Gowanus Bay. The findings of previous waterbody-specific FSAPs indicated that six months was sufficient time to characterize the peak times of recruitment, which are the spring and summer seasons. Therefore arrays were deployed in April 2001 at two depths (where depth permitted) and retrieved in September 2001.

A special field investigation was conducted during the summer of 2002 to evaluate benthic substrate characteristics in New York Harbor tributaries (HydroQual, 2002a). The FSAP had two goals. The first goal was to assist in the assessment of physical habitat components and their impacts on overall habitat suitability and water quality. The second goal was to assist in the calibration of the water quality models as they compute bottom sediment concentrations of

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Harbor-Wide Ichthyoplankton Sampling Stations (2001)

FIGURE 4-7

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Harbor-Wide Epibenthic Recruitment and Survival Sampling Stations (2001)

(TOC). TOC is an indicator of high ammonium (NH_4) and hydrogen sulfide (H_2S) concentrations, and as such is a surrogate for overall substrate quality. Physical characteristics of benthic habitat directly and critically relate to the variety and abundance of the organisms living on the waterbody bottom. These benthic organisms represent a crucial component of the food web and, therefore, directly affect the survival and propagation of fish. Samples were collected from 103 stations in New York Harbor tributaries using a petit ponar grab sampler in July 2002. The locations of sampling stations are shown on Figure 4-9. Seven of the stations were located in Gowanus Canal and Bay. Two samples from each station were tested for TOC, grain size, and percent solids.

A Subtidal Benthos and Ichthyoplankton Characterization FSAP was executed by the NYCDEP during the summer of 2003 (HydroQual, 2003a). The main objectives of the FSAP included reinforcing relationships between fish propagation and habitat and characterizing benthic invertebrate fauna in Gowanus Canal and other waterbodies that were not investigated during previous FSAPs. Benthos sampling was conducted using a petit ponar grab sampler in Gowanus Canal, Newtown Creek, Sheepshead Bay and Coney Island Creek. Samples from each station were tested for TOC, grain size, and percent solids, while additional samples were collected for characterizing benthic invertebrate communities. Ichthyoplankton was sampled at several stations in and around Gowanus Canal. The locations of sampling stations are shown on Figure 4-10. Four stations were located in Gowanus Canal and Bay. All field investigations were conducted during June and July of 2003.

The NYCDEP conducted a Tributary Toxicity Characterization FSAP in 2003 to determine whether toxicity is a significant issue of concern for NYCDEP's waterbody evaluations (HydroQual, 2003b). Under this FSAP, water column and sediment samples were collected from a total of 20 locations in Gowanus Canal, Newtown Creek, Flushing Bay and Creek, the Bronx River, and Westchester Creek in August of 2003. Additional toxicity sampling was also performed in the Bronx River as part of the Bronx River FSAP (HydroQual, 2000a) and in several other waterbodies, such as Jamaica Bay tributaries including Paerdegat Basin, Fresh Creek, Hendrix Creek, Bergen Basin, and Thurston Basin (HydroQual, 2000b). Overall, toxicity sampling was conducted at 37 locations as shown on Figure 4-11. Three stations were located in Gowanus Canal and Bay. Water column toxicity was tested using seven-day survival and growth toxicity tests with Sheepshead minnow and seven-day survival, growth and consistency toxicity tests with mysid shrimp. Sediment chronic toxicity was evaluated using 28-day whole sediment chronic toxicity tests with *Leptocheirus plumulosus*. Survival, growth and propagation of the species were evaluated. In addition to the toxicity tests, sediment samples were collected using an Ekomar dredge sampler and tested for TOC, percent solids, and grain size to help determine the benthic substrate characteristics of the subtidal sediments related to sediment toxicity (if any).

As described above, NYCDEP executed numerous physical, chemical and biological FSAPs to fill several key data gaps. The FSAPs were executed according to procedures defined in a Field and Laboratory Standard Operating Procedure (SOP) that was revised and enhanced as new investigations were identified and additional procedures were required. The SOP follows USEPA's Quality Assurance Project Plan (QAPP) guidelines (USEPA, 1998, 2001b) to assure quality assurance and quality control (QA/QC). All data collected during these FSAPs were compiled in a relational database with QA/QC. Figure 4-12 provides a composite map of the biological FSAP sampling station locations in Gowanus Canal and Bay.

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Tributary Benthos Characterization Sampling Stations (2002)

FIGURE 4-9

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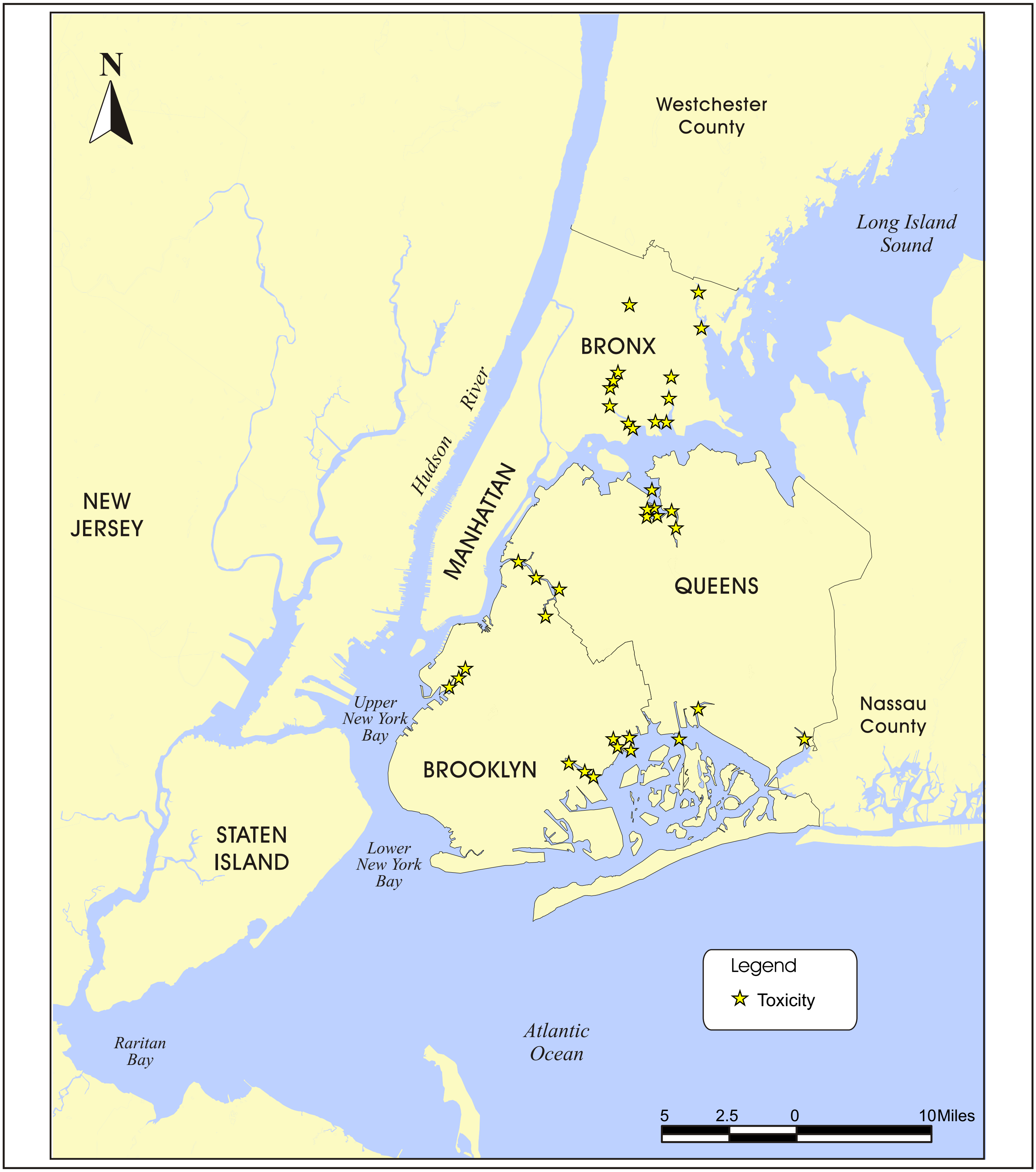
Subtidal Benthos and Ichthyoplankton Characterization Sampling Stations (2003)

FIGURE 4-10



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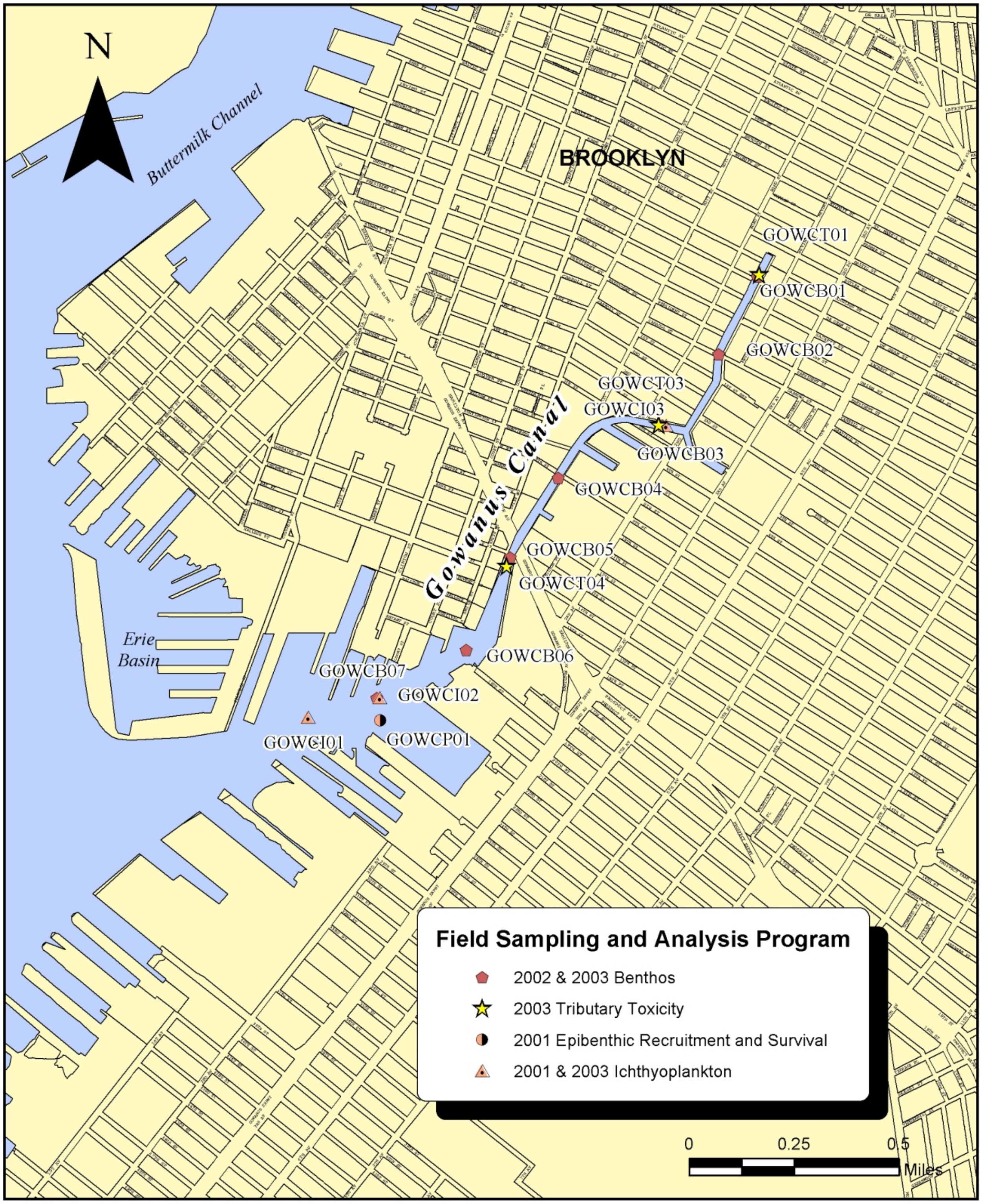
Tributary Toxicity Characterization Sampling Stations (2000, 2001 and 2003)

FIGURE 4-11



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Gowanus Canal and Bay Biological FSAP Sampling Locations

4.1.3 Other Data Gathering Programs

Other data-gathering programs also provided additional data and information for use herein. One program is associated with USACE's Gowanus Bay and Canal Ecosystem Restoration Feasibility Study. The other program is associated with pre- and post-monitoring conducted for an element of the Inner Harbor CSO Facilities Plan. Information and data available from these programs is discussed below.

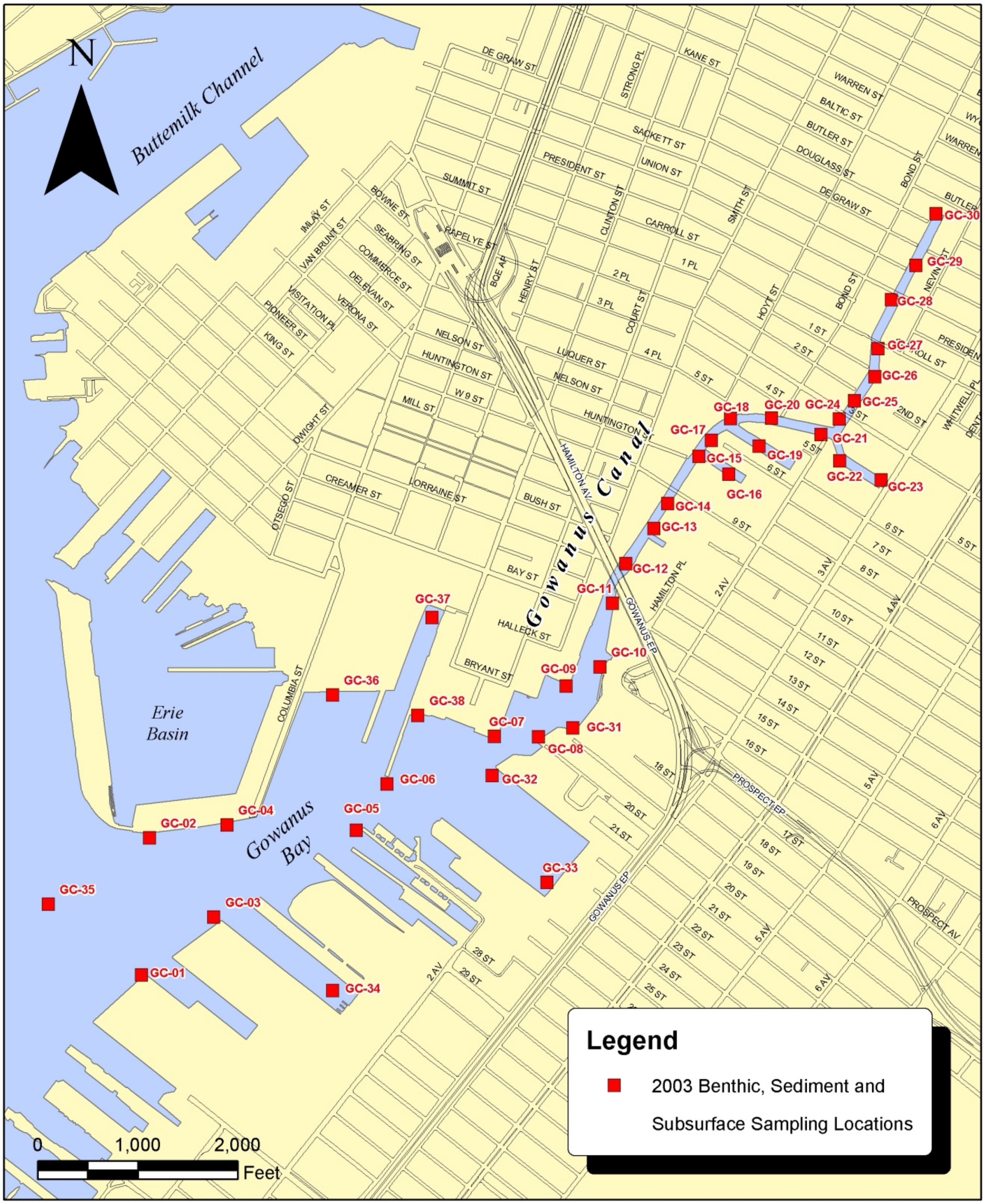
Gowanus Bay and Canal Ecosystem Restoration Feasibility Study

Concurrent to the NYCDEP's waterbody/watershed assessment of Gowanus Canal, the USACE is conducting its Gowanus Bay and Canal Ecosystem Restoration Feasibility Study. The NYCDEP is the study's non-federal sponsor, funding 50 percent of the study. At the time of writing this report, the feasibility study was assessing environmental problems and potential solutions in Gowanus Canal and Bay related to ecosystem restoration. The USACE describes the study as investigating restoration measures such as hot-spot clean-up of off-channel contaminated sediments, contaminant reduction measures, creation of wetlands, water quality improvements, and alteration of hydrology/hydraulics to improve water movement and water quality. The study was being implemented following a Project Management Plan (USACE, 2001) that was developed in concert with the NYCDEP. The schedule of the study coincided with the NYCDEP's waterbody/watershed assessment. However, some field investigations were scheduled to be conducted after the NYCDEP concluded its assessment. The USACE study area included all waters and watersheds of Gowanus Canal, its turning basins, and Gowanus Bay.

In the summer of 2003, the USACE conducted benthic, sediment, and subsurface investigations in Gowanus Canal and Bay at approximately 30 locations (USACE, 2003a & 2003b). The benthic investigation was conducted to identify all invertebrate species inhabiting the study area. The sediment investigation was conducted to characterize sediments throughout the study area at various depths. Samples were analyzed for concentrations of pesticides, poly-chlorinated bi-phenols (PCB), volatile and semi-volatile organics, bacteria, and priority pollutant metals. The subsurface investigation was conducted to determine the soil properties of the sediments of Gowanus Canal and Bay. Standard penetration test borings were conducted to a depth of 30 feet below mean low water. Samples were collected and tested for grain size distribution, moisture content, unit weight, specific gravity, and Atterburg Limits (liquid and plastic limits). Testing necessary for stability and dredgeability analysis (Triaxial (CU) test and unconfined compressive test for clays) were also conducted. All investigations were conducted at the same locations shown on Figure 4-13.

4.1.4 Receiving Water Modeling

Receiving water models are used to simulate both the movement of the water (hydrodynamics) and biological/chemical processes (water quality) within a waterbody. Receiving water models are particularly useful for characterizing a waterbody's response to hypothetical scenarios, such as design environmental conditions and engineering alternatives, and evaluating the resulting compliance with water quality standards and criteria. Major inputs to the receiving water models include landside discharges, exchange at the open boundaries of the waterbody, and other physical and kinetic forcing functions. This section generally describes the tools employed for receiving water modeling of the Gowanus Canal waterbody/watershed



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Gowanus Canal Waterbody/Watershed Facility Plan

USACE Gowanus Bay and Canal Ecosystem Restoration Feasability Study Sampling Locations

FIGURE 4-13

assessment area. A detailed description of these receiving water models and their calibration is provided in the supporting Water Quality Modeling Report (HydroQual, 2007b).

The NYCDEP constructed receiving water models during its Inner Harbor CSO Facility Planning Project to simulate hydrodynamics and water quality Gowanus Canal and Bay. Figure 4-14 depicts the segmentation of the receiving water models that were constructed to simulate all of Gowanus Canal and its turning basins, as well as Gowanus Bay to its boundary with Upper New York Bay. The model is three dimensional: each grid shown on Figure 4-14 has 10 layers in the vertical. The model kinetics are time-variable, with output generally supplied on an hourly basis.

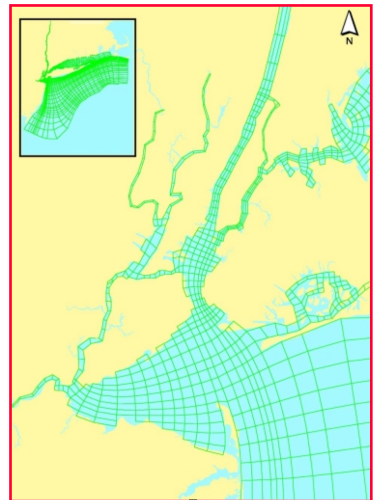
The hydrodynamic component of the Gowanus Canal and Bay receiving water model simulates the temperature and salinity as well as the physical movement of the waters in Gowanus Canal and Bay. Given forcing functions at the model boundaries as well as inputs such as landside discharges, the hydrodynamic model determines the volume and velocity of water at any time and location within the model domain. These results are then passed to the water quality model, which uses the hydrodynamic model calculations of transport and dispersion and performs kinetic calculations to simulate temperature, salinity, total suspended solids, biochemical oxygen demand, dissolved oxygen, and coliform bacteria. The water quality model also includes a time-varying sediment component that computes the interaction between the water column and sediments.

As noted above, landside discharges to Gowanus Canal represent one type of forcing function or input to the Gowanus Canal and Bay receiving water model. These landside discharges are provided by the watershed/collection system model, as described in Section 3.4. Another type of forcing function to the Gowanus Canal and Bay receiving water model are conditions at the Gowanus Canal receiving model boundary (i.e., Gowanus Bay). These boundary conditions impact both the hydrodynamics and the water quality within Gowanus Canal. To properly simulate the appropriate boundary conditions, another receiving water model was used. This model, NYCDEP's System-Wide Eutrophication Model (SWEM), is a three-dimensional, time-variable, coupled hydrodynamic/eutrophication water quality model of the New York/New Jersey Harbor and New York Bight system. SWEM, which was developed to evaluate water quality impacts associated with upgrading WPCPs and improving nutrient removal capabilities, was calibrated using results of a comprehensive field monitoring program and underwent an extensive peer review from a Model Evaluation Group (MEG) that was convened by the New York/New Jersey Harbor Estuary Program and the Long Island Sound Study Nutrient Work Group. A more detailed description of the model is provided in the NYCDEP's Newtown Creek Water Pollution Control Project, East River Water Quality Plan (HydroQual, 2001f, 2001g, 2001h).

Figure 4-15 illustrates how the watershed and SWEM models provide the appropriate forcing functions for the Gowanus Canal receiving water model. The Gowanus Canal receiving water model was calibrated using water quality data collected in 1989 as part of the Inner Harbor CSO Facility Planning Project. The receiving water model was then validated using data collected in 1999. A detailed description of the Gowanus Canal receiving water model, its calibration and validation is presented in the supporting Water Quality Modeling Report (HydroQual, 2007b).

Gowanus Canal Receiving Water Model Segmentation

FIGURE 4-14



InfoWorks (SWMM)
Red Hook WPCP
Owls Head WPCP

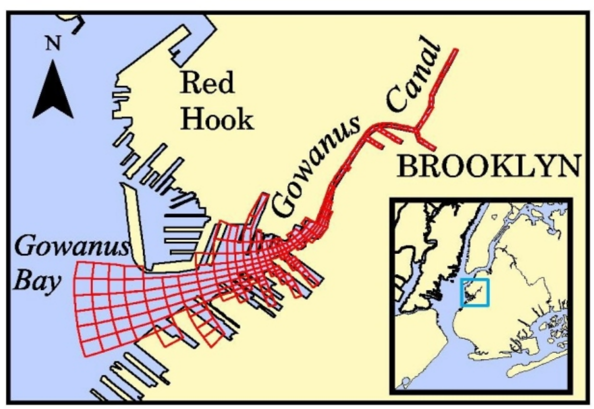
↓

Watershed Models
(CSO & Stormwater Loads)

System-Wide
Eutrophication Model
(Boundary Conditions)

↓

Gowanus Canal
Receiving Water Model



Gowanus Canal Receiving Water Model

Gowanus Canal Mathematical Modeling Framework

FIGURE 4-15

Subsequent sections of this report describe how the Gowanus Canal receiving water models were used to characterize certain scenarios and evaluate expected compliance with water quality standards and criteria.

4.2 PHYSICAL WATERBODY CHARACTERISTICS

This section describes the physical characteristics of Gowanus Canal. Section 4.2.1 presents the overall dimensions, depths, branches, and classification of the Canal. Section 4.2.2 briefly describes the hydrodynamic features that affect the Canal. Section 4.2.3 discusses the character of the Canal's benthos and substrate. Section 4.2.4 summarizes the shoreline characteristics throughout the Canal. Section 4.2.5 describes waterbody access to the Canal.

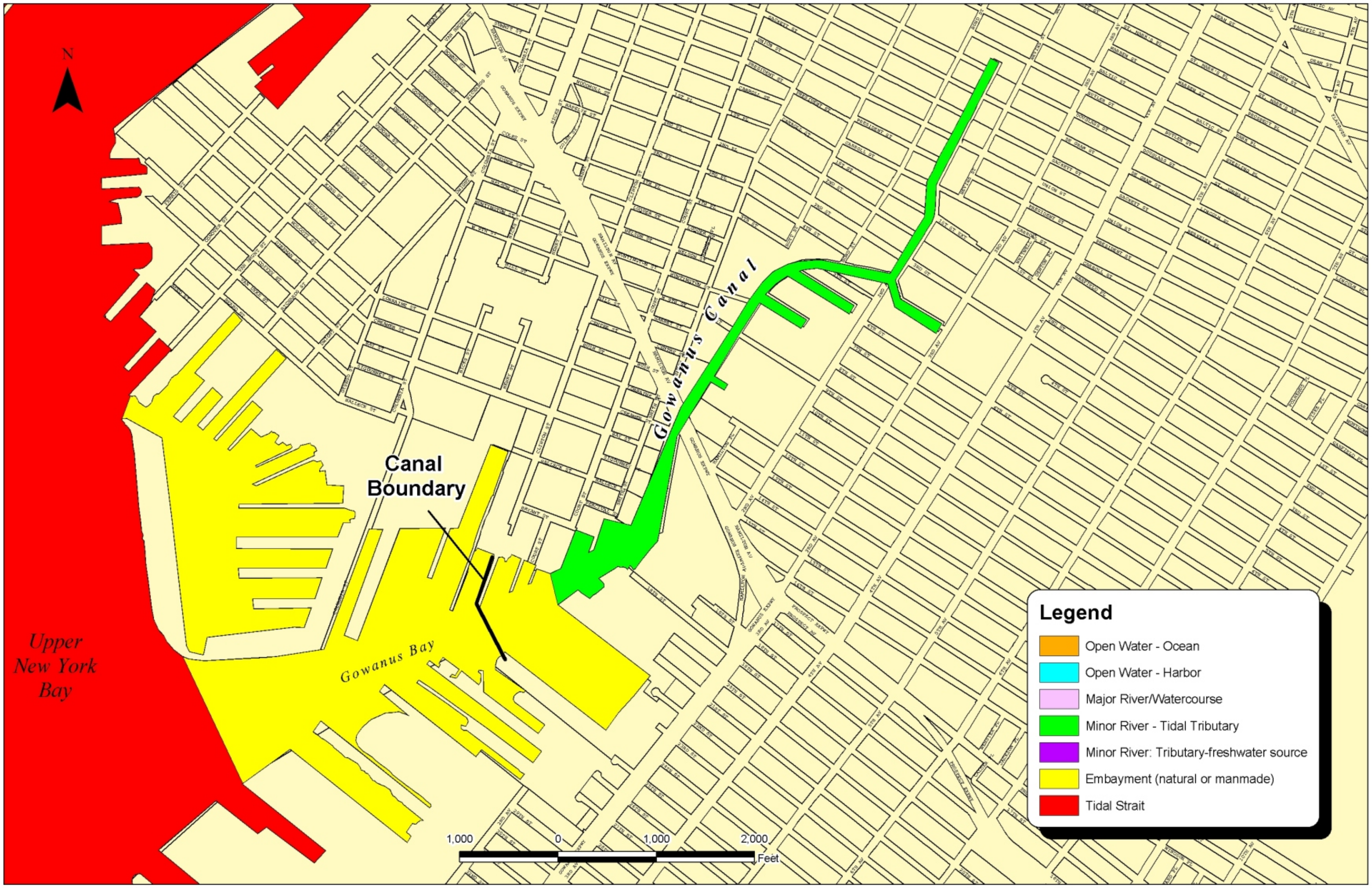
4.2.1 General

The Gowanus Canal waterbody assessment area is herein considered to extend roughly 8,500 feet from the head end (near Butler Street) to its mouth, between the end of Clinton Street to the west and the end of 25th Street to the east (Figure 4-16). The entire waterbody is classified as a saline tributary to Upper New York Bay according to Title 6 of the NYCRR, Chapter X, Part 891. Between 22nd Street and 39th Street (which is beyond the assessment area), the waterbody is classified as an "embayment." Between the head and 22nd Street, the waterbody is classified as a "minor river, tidal tributary." Though this classification implies that the Canal is a tributary, the only freshwater inflows to the waterbody are wet-weather discharges from CSO and stormwater.

There are two elevated bridges and five street-level bridges crossing Gowanus Canal. The Gowanus Expressway and subway-system bridges are elevated and do not restrict vessel traffic in the Canal. The City of New York operates all five street-level bridges, four of which are drawbridges crossing the Canal at Hamilton Avenue, 9th Street, Union Street, and 3rd Street. The Carroll Street bridge is a retractable bridge, the oldest of only four of this type in the nation. These bridges, particularly the Gowanus Expressway and Hamilton Avenue bridges, provide a useful landmark to gauge location.

The portion of Gowanus Canal that is north of the Gowanus Expressway/Hamilton Avenue is about 5,600 feet long, 100 feet wide, and ranges in depth from 4 to 16 feet at mean low water (MLW). South of Hamilton Avenue, the waterbody is approximately 2,900 feet long, 100 to 1,000 feet wide, and has depths ranging between 16 and 35 feet MLW.

North of Hamilton Avenue, there are four short basins that branch from the main channel: the 4th Street, 6th Street, 7th Street, and 11th Street Basins. These basins are not part of the main navigational channel and experience limited maritime traffic. They are primarily used as "turning basins" for vessels to reverse direction during transit. The basins become increasingly shallow with distance from the main channel and several basins have exposed sediments during low tide. Figure 4-17 illustrates Gowanus Canal bathymetry measured during a survey in July 2003.



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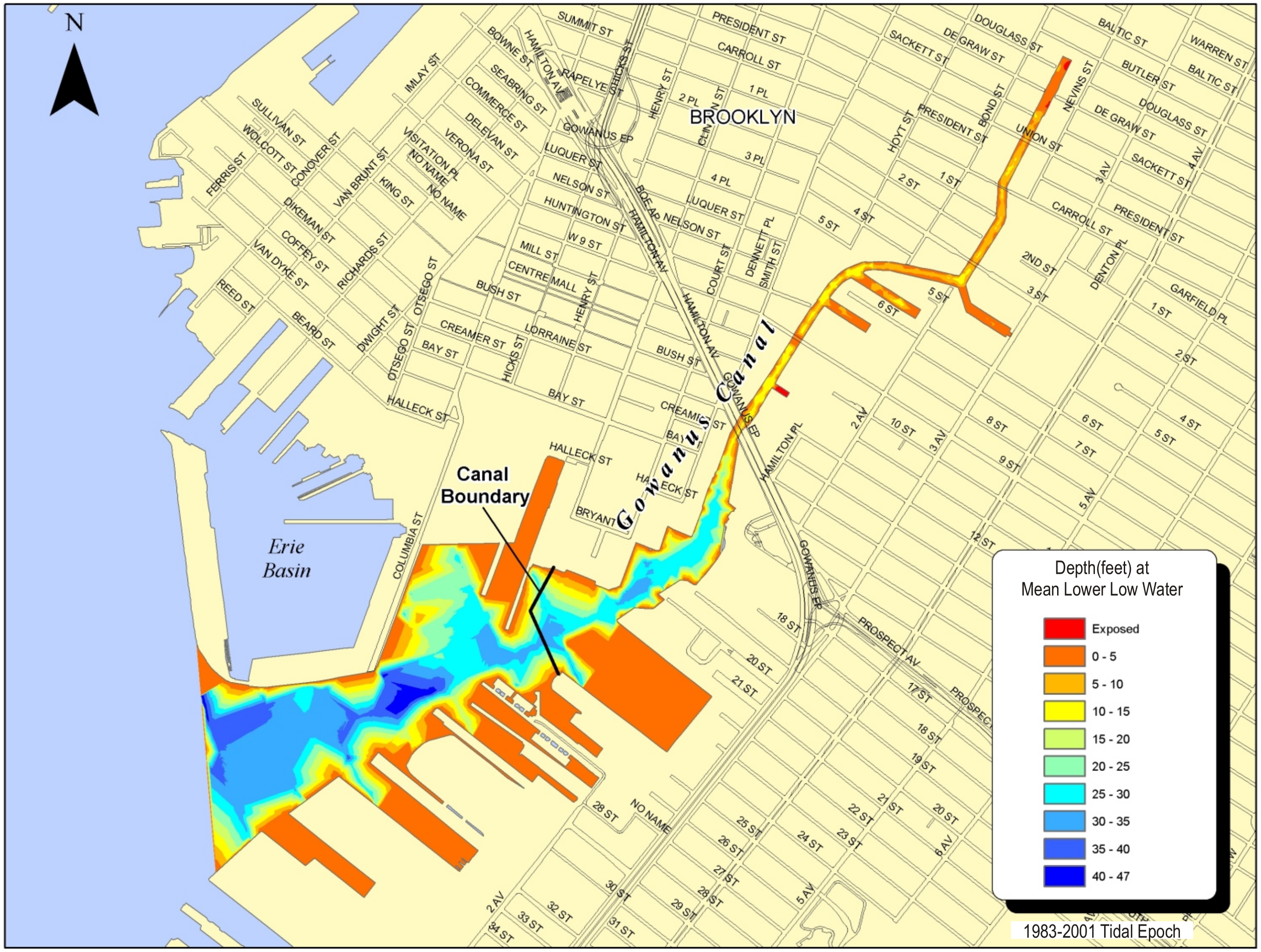
Gowanus Canal Waterbody/Watershed Facility Plan

Gowanus Canal Waterbody Types

FIGURE 4-16



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Gowanus Canal Waterbody/Watershed Facility Plan

Gowanus Canal Bathymetry July 2003

FIGURE 4-17

4.2.2 Hydrodynamics

Gowanus Canal is a tidal waterbody opening to Gowanus Bay and Upper New York Bay, and experiences a semi-diurnal tidal cycle with a vertical tidal range that varies from 4.7 to 5.7 feet. As a narrow, dead-end tributary with no freshwater inflow other than intermittent, wet-weather discharges, the Canal has low current speeds and a limited exchange of water with Gowanus Bay/Upper New York Bay.

Gowanus Canal's limited capacity for exchange and dispersal was recognized early during the urbanization of the waterbody, and water-quality degradation had become serious enough that in the mid 1800s, the Brooklyn Bureau of Sewers designed the Gowanus Canal Flushing Tunnel as an engineering solution to enhance the dispersion of Canal waters. The Flushing Tunnel was designed as a relatively flat-sloped, 12-foot-diameter, brick-lined, 6,280-foot-long tunnel, intended to operate such that water would be pumped from the Canal to Buttermilk Channel. After a lengthy construction period, the Flushing Tunnel began operating on June 21, 1911 and pumped about 325 MGD in either direction through the mid 1960s, when corrosion to pumping-system elements and other factors rendered it inoperable. As part of the Inner Harbor CSO Facility Plan, NYCDEP restored the pumping facility and reactivated the Flushing Tunnel on March 5, 1999. Since that time, it has conveyed an average of 150 MGD of water from Buttermilk Channel to Gowanus Canal. A more thorough discussion of the Flushing Tunnel is provided in Section 5.

4.2.3 Benthic Character

Gowanus Canal's limited capacity for exchange produces a stilling effect that allows suspended solid materials to settle to the bottom of the waterbody. Heavier solids and organic material discharged during wet-weather from CSOs and stormwater have created a sediment mound near the head of the Canal. This mound becomes exposed at some points during low tide, when noxious odors are released from the anaerobic decay of the highly organic material. Similarly, lighter materials discharged during wet-weather or imported from waters beyond the Canal have settled throughout the Canal. These settled materials build up over time and need to be removed via periodic dredging to maintain navigable depths throughout the Canal.

USACE ended regular maintenance dredging of the Canal in 1955. The last dredging project conducted by the USACE for navigational purposes was performed in 1971, when portions of Gowanus Bay and Canal were dredged. At that time, 73,708 cubic yards of dredged material was removed from the Canal between 28th Street and the Hamilton Avenue Bridge. The upper reaches of Gowanus Canal were dredged by the NYCDEP in 1975. The Canal was again dredged by the NYCDEP in August and September 1998 as part of the Flushing Tunnel reactivation efforts. This dredging activity was limited to a small section of the head end at Butler Street, where 1,100 cubic yards of material was removed to facilitate construction. Figure 4-17 presents the bathymetry measured in Gowanus Canal and Gowanus Bay in 2003.

As described previously in Section 4.1, past and recent field investigations have characterized the sediments of Gowanus Canal and Bay. Primary among these is the 2003 study performed by the U.S. Army Corps of Engineers (USACE, 2003b). For the purposes of defining surficial geology/substrata, those areas where bottom sample grain size indicated more than 50 percent sand were interpreted herein as sand. Areas where samples were more than 50 percent mud/silt/clay were interpreted as mud/silt/clay. The waterbody bottom is typically covered with a layer of very wet, very soft, dark gray to black, highly plastic clay, often with a trace of sand and some occasional gravel. Areas exhibiting these characteristics are represented as mud/silt/clay on Figure 4-18.

Historical discharges by CSOs and stormwater have impacted almost the entire Canal bottom, which can be described as "black mayonnaise" - a dark, black material containing large amounts of organic matter and a low percentage of solids. This is most predominately observed upstream of Hamilton Avenue. Sampling programs report that clay samples typically produced an odor similar to decaying organic material, and a hydrocarbon-like sheen was exhibited in some samples. Beneath this clay layer, sands, silty sands and poorly-graded sands, often with traces of gravel, can be found.

In those areas of Gowanus Canal and Bay where clay was identified, the depth to a sand layer (as measured from the mudline to the uppermost sand layer identified in core samples) averaged approximately 9 feet, with a range of 2 to 13 feet throughout the waterbody/ watershed assessment area. At the head of the Canal, north of 3rd Street, a sand layer is located approximately 8 feet below the waterbody bottom. Between Hamilton Avenue and 3rd Street, the average depth to a sand layer is approximately 10.3 feet. From 23rd Street to Hamilton Avenue, the average depth to sand is 9.8 feet, and, in Gowanus Bay south of 23rd Street, the sand layer is located approximately 9 feet below the surface of the waterbody bottom.

There are several areas where no clay layer can be found in Gowanus Canal and Bay. These areas include the Bay at 20th Street, 18th Street and Halleck Street, and in the Canal just south of the 9th Street Bridge, at the mouth of the 7th Street basin, in and near the 6th Street basin, near 2nd Avenue, at 1st Street, and at Carroll Street. Sand was typically reported in these areas, although surface gravel was observed near the mouth of the 6th Street turning basin.

4.2.4 Shoreline

The shorelines of Gowanus Canal are entirely altered, consisting almost exclusively of bulkheads, with some areas of rip-rap and piers, as illustrated on Figure 4-19. All shorelines are generally bulkheaded with wood or steel, especially upstream of Hamilton Avenue. Areas of rip-rap are located along the eastern shore, between 11th Street and the Gowanus Expressway and between 17th Street and 19th Street. Along the western shoreline, rip-rap is located between Sigourney Street and Halleck Street and at the eastern terminus of Bryant Street. Piers are only located in Gowanus Bay along the eastern shoreline, from 21st Street to 25th Street, and on the western shoreline between Court Street and Clinton Street. Multi-barrel CSO outfalls at the head of the waterbody have concrete bulkheads. Other CSO and stormwater outfalls can be found along the length of the waterbody and are protected by visible head walls.

Most shorelines of Gowanus Canal and Bay are owned by private commercial and industrial users. There are no marinas or recreational boat moorings in these waterbodies, although there are several locations where private recreational boats are tied to bulkheads or makeshift docks. Many city streets end at Gowanus Canal, terminating with concrete and steel barriers and fencing. Bulkheading and rip-rap has rendered all shorelines vertical in nature up to street level.

Gowanus Canal Surficial Geology

FIGURE 4-18

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Existing Physical Characteristics of Gowanus Canal Shorelines

FIGURE 4-19

In 1999, the Gowanus Canal Community Development Corporation commissioned a bulkhead inventory survey (Adam Brown, 2000). The impetus of the survey was a concern for bulkhead integrity possibly threatened by 1) a marine borer attack on timber bulkheads, enabled by improved water quality due to reactivation of the Gowanus Canal Flushing Tunnel, and 2) dredging that could undermine bulkhead stability. A preliminary structure inventory was conducted between December 1999 and April 2000 to quantify the type, extent and general condition of Gowanus Canal retaining structures, from grade to mean low water. The survey was based on visual examinations of the structures without physical or laboratory testing. The survey found evidence of marine borer activity and structural deterioration that indicated existing bulkheads are merely adequate to support the present loading conditions. Dredging the Canal could change lateral loading conditions and further threaten bulkhead stability. The survey recommended that a more complete structural analysis of bulkhead integrity be performed if dredging is to be conducted.

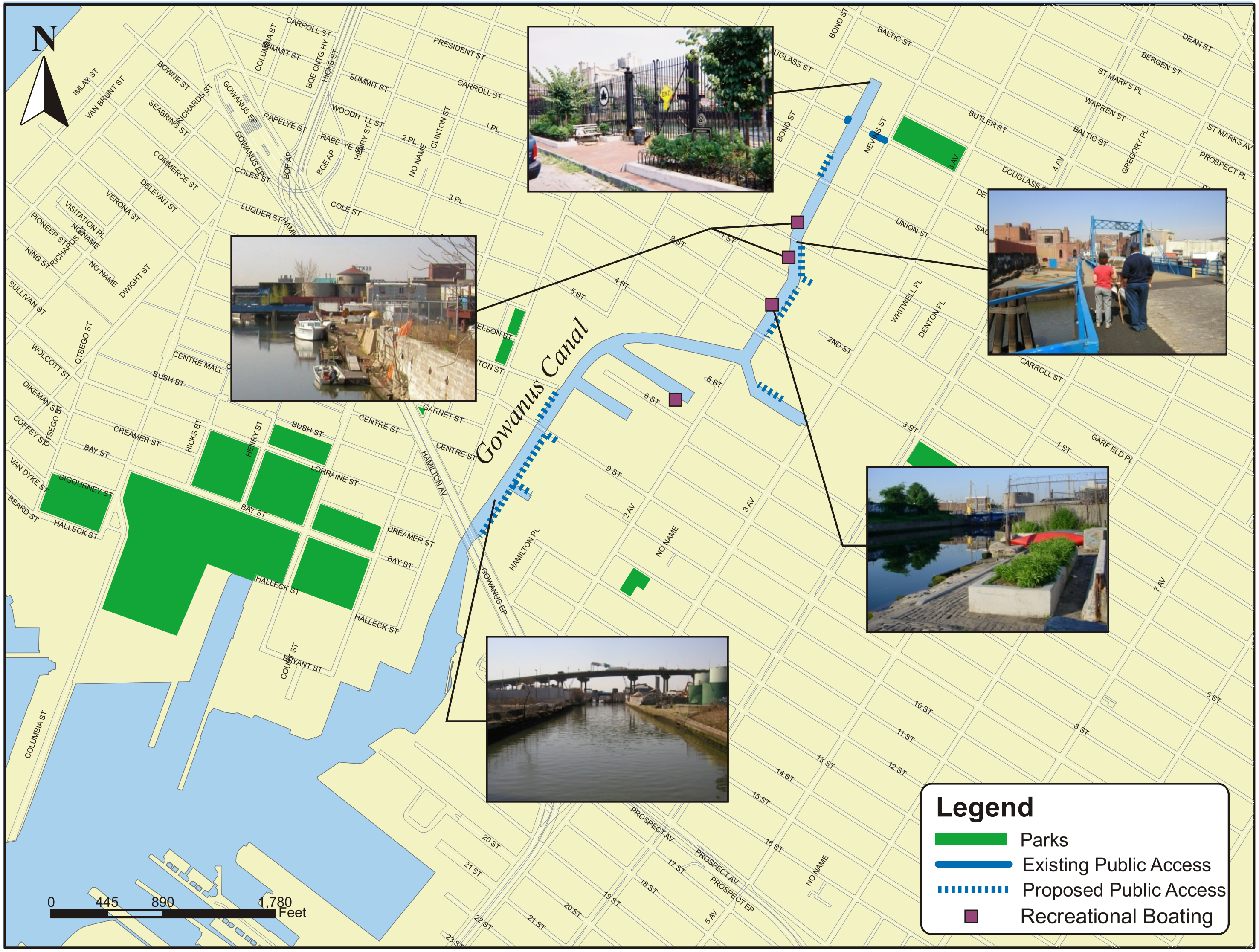
4.2.5 Waterbody Access

Public waterbody access to Gowanus Canal is mostly precluded by the commercial and industrial function of the waterbody and its riparian zones. There are no beaches, parks, marinas, or other recreationally oriented facilities on Gowanus Canal. Waterbody access has been traditionally facilitated at street ends and bridge crossings. Improvements have been made in recent years to these existing access points by street-greening and bridge restoration activities. There are also isolated locations where private riparian users have constructed makeshift docks for keeping recreational boats in the Canal. Local community organizations are planning several projects that may facilitate additional public access in the future.

Many local streets terminate at Gowanus Canal. End-of-street greening activities have improved these locations by creating a park setting with landscaping and benches. These locations can be found towards the head end at Douglass Street, Degraw Street, and 2nd Street. The 2nd Street location is the only location that allows access to the water and it serves as a launching site (over a bulkhead) for a local canoeing club, the Gowanus Dredgers Canoe Club. Remaining street ends are either fenced or have other uses that preclude access other than viewing the Canal from afar. Most bridge crossings have walkways and provide views of the Canal. Linear public access is being planned at multiple locations in the Canal from the head end down to Hamilton Avenue. Figure 4-20 displays the locations of the existing and planned public waterbody access points on Gowanus Canal.

4.3 CURRENT WATERBODY USES

Gowanus Canal was fully developed for maritime commerce by the mid 1800s. Today, usage of the Canal remains primarily industrial, though water-dependent uses have diminished from historic levels as area industries have transitioned to lighter commercial uses. Limited recreational uses such as private boating, fishing/crabbing, and scuba diving also occur within the Canal. Most shorelines are bulkheaded and public access to the Canal is limited to views from bridges and street-ends, as shown on Figures 4-19 and 4-20.



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Gowanus Canal Waterbody/Watershed Facility Plan

Public Waterbody Access Points

FIGURE 4-20

Plates 4-1 through 4-6 provide photographic examples of uses in the Canal, beginning at the head and moving toward the mouth at Gowanus Bay. Plate 4-1 depicts the head of the Canal from the Union Street bridge. The bulkheads, floatables boom at Sackett Street, a barge, and the head end of the Canal are visible. The image also demonstrates how public access to the Canal is typically limited to street ends, as private properties have frontage on the Canal. Several street end gardens have been set up in this area (Figure 4-20).

Plates 4-2 and 4-3 show the area immediately upstream and downstream of the Carroll Street bridge. These images a utility (Verizon) property on the eastern side of the Canal, as well as a small number of private watercraft tie-ups and docks along the western side of the Canal, which indicates recreational boating activity based from the Canal. The recreational boating includes motorboats as well as unpowered crafts. Just south of the Carroll Street bridge, the Gowanus Dredgers Canoe Club, a local recreation and environmental advocacy organization, launches canoes over a deteriorated bulkhead at the end of 2nd Street on the western shore of the Canal (Figure 4-20, second from right). The Urban Divers, a local environmental advocacy and educational organization, conducts public environmental education programs on Gowanus Canal, including private water-quality testing. Some members of the group scuba dive in the Canal and have produced underwater video footage.

Waterbody usage in the Canal becomes increasingly industrial south of the 3rd Street bridge and on toward Gowanus Bay. The many active industrial and maritime uses include the following properties, which generate barge and tugboat traffic in the Canal:

- Ferrara Concrete –west side of the Canal, south of 3rd Street (Plate 4-4)
- Bayside Fuel Oil –west side of the Canal, south of 9th Street (Plate 4-5)
- Greco Concrete –west side of the Canal, north of 9th Street (Plate 4-5)
- Amerada Hess –west side of the Canal, south of Bryant Street (Plate 4-6)

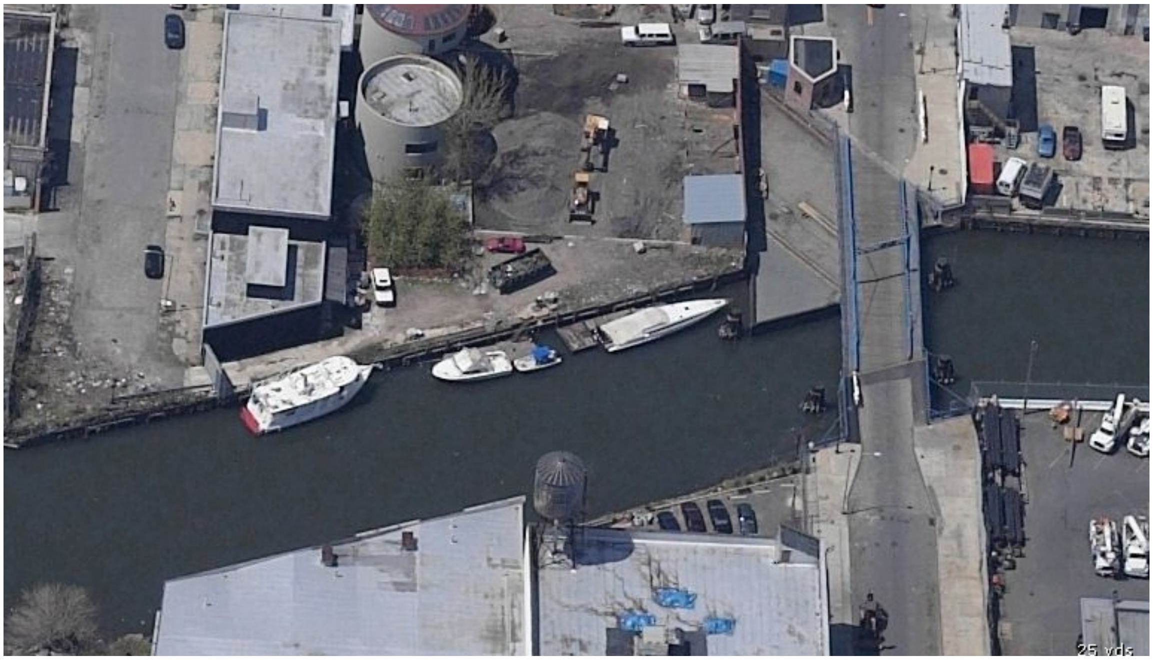
Bathing does not occur in any organized fashion within the Canal. There are no official or unofficial swimming areas in the Canal, and its physical characteristics (such as shoreline character) and maritime uses (barge and boat traffic) functionally preclude bathing.

4.4 OTHER POINT SOURCES AND LOADS

Sections 2.3 and 3.3 discussed existing combined- and storm-sewer discharges, nonpoint sources, and other potential sources of loadings to Gowanus Canal. In addition to those sources, the NYCDEP Shoreline Survey Program has identified numerous point source discharges to Gowanus Canal. Approximately 144 outfalls were identified by the Shoreline Survey, of which about 126 were not already addressed elsewhere in this report as combined-sewer or storm sewer outfalls. The Shoreline Survey program classified most (94) of these remaining outfalls as "general," some (24) as "storm or highway drains," and the rest as "direct" or "SPDES permitted." According to surveys done in 1990 and 1992, five of the outfalls in this last grouping exhibited dry weather flow totaling about 2,100 gallons per day. The Shoreline Survey reports that only one of the discharges (with a flow of 432 gallons per day) was found to potentially require abatement and was scheduled for investigation in 1994. No further information was available at the time of the writing of this report.

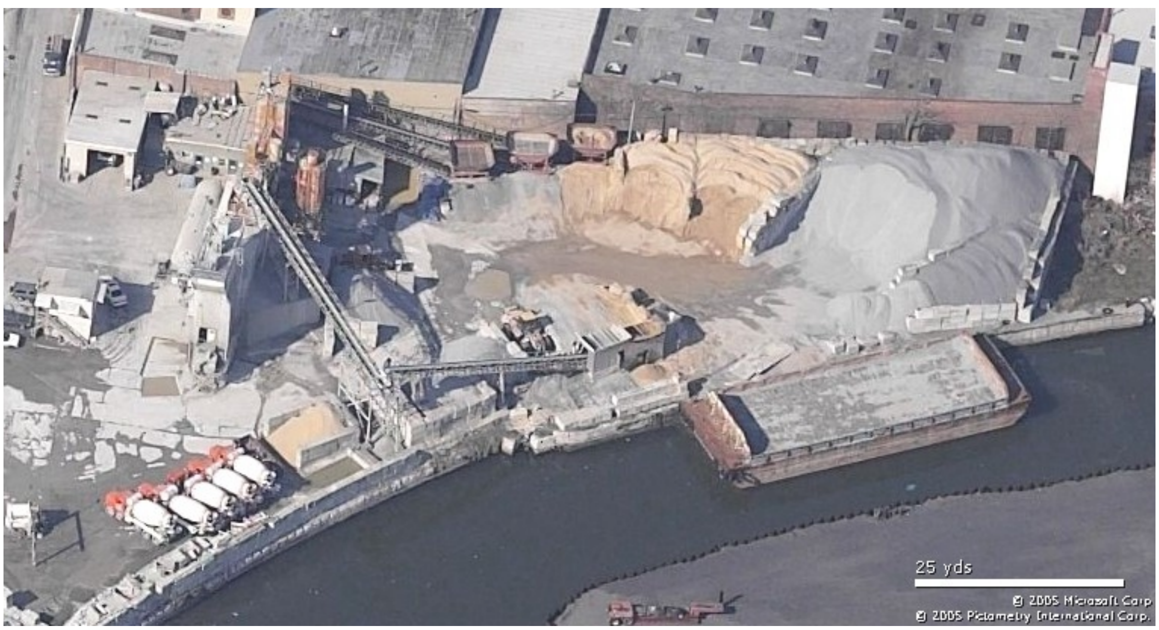
Plate 4-1: Head of Gowanus Canal. Looking north: floatables boom at Sackett St., barge, and head end.

Plate 4-2: Recreational Boating and Tugboat Activity. Looking south toward Carroll St. bridge.



Ⓒ 2006 Pictometry International Corp.

Plate 4-3: Recreational Boating Activity. Looking west between First St. and Carroll St.



Ⓒ 2006 Pictometry International Corp.

Plate 4-4: Barge activity at Ferrara Concrete yard. Looking west near Bond St and 5th St.

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Plate 4-5: Barge activity at Bayside Fuel Oil plant. Looking north toward Smith St. and Mill St.

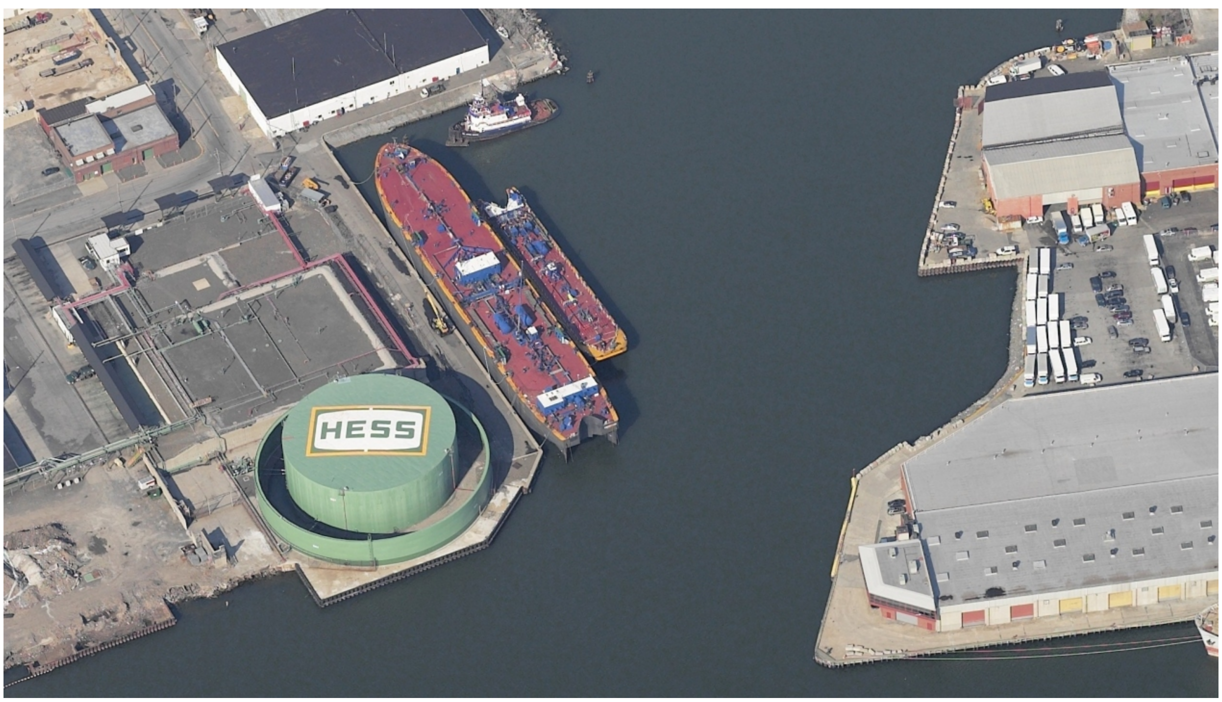

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Plate 4-6: Barge, tugboat, and shipping activity. Looking north toward mouth of Gowanus Canal at 22nd St.

The New York State SPDES database lists three permitted sites that could discharge to Gowanus Canal. These sites are the Universal Fixture Corporation (SPDES permit NY0036668), the Astoria Generating Company's Gowanus Gas Turbine site (SPDES permit NY0201006), and the Amerada Hess Corporation's Brooklyn Terminal (SPDES permit NY0110001). Of these SPDES-permitted sites, the Universal Fixture Corp. discharge represents cooling/process effluent, and the other two represent stormwater runoff from barges or loading docks, respectively. Table 4-1 presents a summary of the SPDES permit limits for these sites as well as a summary of available measured monitoring data. As shown, the permitted pollutants include metals and solvents as well as pH and oil and grease. With the exception of the foaming agent limit from barge runoff and a single excursion in pH from the Universal Fixture Corp, the permit limits appear to be met consistently. While these sites could represent potential sources of toxics-related pollutants, they do not appear to represent sources of pollution that would affect the dissolved oxygen or bacteriological levels in the Canal.

Overall, the total contribution of flow from these additional point sources was determined to be insignificant relative to CSO and stormwater inputs. The 154 MGD average induced flow resulting from the Flushing Tunnel, as described elsewhere in this report, further diminishes the significance of these inputs.

4.5 CURRENT WATER QUALITY CONDITIONS

As described in Section 4.1, NYCDEP and others have conducted a number of field investigations in Gowanus Canal since 1982. These investigations documented water quality problems such as low dissolved oxygen and aesthetics problems such as exposed sediments, odors, and floatables. As described in Section 1.2.3, Gowanus Canal appears on the NYSDEC "Section 303(d) List of Impaired Waters" due to "dissolved oxygen/oxygen demand" from "urban/storm/CSO" inputs (NYSDEC, 2007).

Improving water quality in Gowanus Canal has been the subject of several studies and projects since 1982. Analyses performed as part of the Gowanus Canal 201 Facility Plan Water Quality Study (1982) and the Inner Harbor CSO Facility Planning Project (1993) indicated that the Canal's limited capacity for pollutant dispersal was a primary factor affecting water quality, and both studies recommended rehabilitation of the Gowanus Canal Flushing Tunnel, an existing but inoperable engineering control designed to improve circulation and exchange of Canal waters by pumping water through a 12-foot diameter tunnel from Upper New York Bay at Buttermilk Channel to the head of Gowanus Canal (as described in Section 5.7.1). As described in Section 4.1.1, water quality was monitored both before and after the Flushing Tunnel was returned to service in 1999.

As presented in the remainder of this section, the Inner Harbor Project rehabilitation of the Flushing Tunnel succeeded in returning the Tunnel to service, and the Flushing Tunnel was shown to be effective at improving water quality in the Canal. However, the pumping system was found to be deficient in terms of both the flushing rates it achieved and, more significantly, its reliability. As described in Section 5.8, the Gowanus Facilities Upgrade Project developed a plan to improve these aspects of the flushing system.

Table 4-1. NYSDEC Permitted Dischargers to Gowanus Canal

Facility Name	NPDES Number	Pipe Number	Type of Discharge	Statistics for Measured Parameters	Permited Flow	Monitored Flow	Chromium hexavalent	Total Chromium	Total Copper	Total Nickel	Total Cyanide	pH	Water Temperature	Oil and Grease	Benzene	Ethylbenzene	Toluene	Xylene	Foaming Agents
							Maximum Permitted Concentrations (mg/L)												
							0.1	1.0	0.8	2.0	1.1	6.0 - 9.0	90.0	15.0	0.1	0.1	0.1	0.1	0.1
					gpd	*gpd*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*su*	*F*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
Universal Fixture Corp.	NY0036668	001	Industrial Wastewater and Non-Contact	Sample		56	18	18	18	18	9	17	18						
				Minimum		697	0.0001	0.0001	0.0018	0.0001	0.0003	5.2	69						
				Average		699	0.0002	0.0002	0.0110	0.0005	0.0005	6.8	71						
				Maximum	6,000	703	0.0006	0.0010	0.0392	0.0070	0.0006	7.5	72						
Astoria Generating Co., LC Gowanus Gas Turbine	NY0201006	001	Stormwater	Sample		39								39	15	15	15	15	
				Minimum		200								2.10	0.0005	0.0005	0.0005	0.0005	
				Average		10,656								8.98	0.0005	0.0005	0.0005	0.0005	
				Maximum		30,000								14.50	0.0005	0.0005	0.0005	0.0005	
	NY0201006	002	Stormwater	Sample		42								42	15	15	15	15	
				Minimum		200								4.0	0.0005	0.0005	0.0005	0.0005	
				Average		10,120								10	0.0005	0.0005	0.0005	0.0005	
				Maximum		30,000								15	0.0005	0.0005	0.0010	0.0010	
	NY0201006	003	Stormwater	Sample		38								38	13	13	15	14	
				Minimum		200								2.0	0.0005	0.0005	0.0005	0.0005	
				Average		10,282								8.0	0.0005	0.0005	0.0005	0.0005	
				Maximum		30,000								14.8	0.0005	0.0005	0.0005	0.0005	
	NY0201006	004	Stormwater	Sample		36								36	15	15	2	15	
				Minimum		200								2.0	0.0005	0.0005	0.0005	0.0005	
				Average		10,717								6.9	0.0005	0.0005	0.0005	0.0005	
				Maximum		30,000								14.6	0.0005	0.0005	0.0005	0.0005	
Amerada Hess Corp.	NY0110001	001	Stormwater	Sample		8						8		8	1	1	1	1	2
				Minimum		6,000						6.9		5.0	0.001	0.001	0.001	0.002	0.109
				Average		26,143						7.3		5.5	0.001	0.001	0.001	0.002	0.123
				Maximum		72,000						8.4		8.4	0.001	0.001	0.001	0.002	0.136

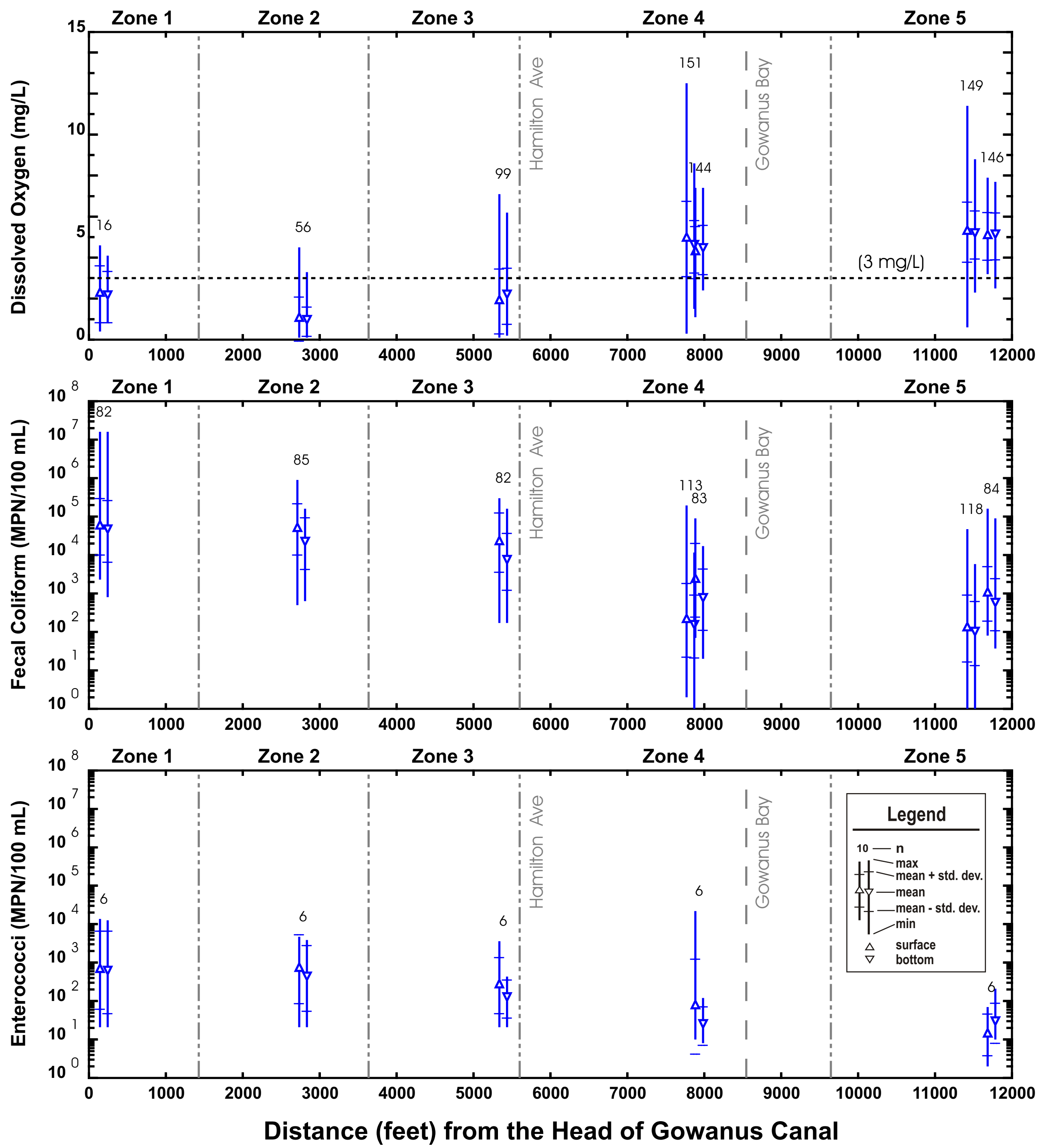
4.5.1 Measured Water Quality Prior to Flushing Tunnel Reactivation

In 1982, the Gowanus Canal 201 Facility Plan Water-Quality Study established that water quality in Gowanus Canal was significantly impaired. The Inner Harbor CSO Facility Planning Project reinforced that finding with wet-weather, dry-weather, and special sediment surveys conducted from May through September 1989. These surveys indicated that much of the waterbody was hypoxic (low dissolved oxygen) or anoxic (no dissolved oxygen), particularly following a wet-weather event and particularly near the head of the Canal. High levels of coliform bacteria, TSS, and BOD were also observed following wet-weather events. In addition, floatables, noticeable odors, and poor water clarity were documented. New York State placed Gowanus Canal on its 303(d) listing of impaired waterbodies due to "dissolved oxygen/oxygen demand" caused by "urban/storm/CSO" discharges (NYSDEC, 2007).

Figure 4-21 presents the water quality measured at various locations in Gowanus Canal during the summer months (June to September) from 1984 to 1998. During this period of time, water quality was measured at seven different locations in the Canal—at least one station in each of the five "zones" shown on Figure 4-1. For each location, Figure 4-21 presents the average at the surface (upward-pointing triangles) and bottom (downward-pointing triangles), the standard deviations (horizontal bars at plus/minus one standard deviation), the maximum and minimum measurements (ends of vertical range bars), and the number of samples (value shown just above range bar). The top panel demonstrates that dissolved oxygen levels in the Canal—particularly upstream of Hamilton Avenue—were typically below the New York State water quality standard of 3.0 mg/L (Class SD) and that there was little difference between surface and bottom measurements at any given time. Dissolved oxygen levels downstream of Hamilton Avenue and in Gowanus Bay were higher and more variable. The second panel displays the indicator bacteria (fecal coliform) levels in the Canal, though the existing Class SD designation is not associated with uses requiring indicator bacteria standards. As expected, the fecal coliform levels generally decrease downstream toward Gowanus Bay.

4.5.2 Receiving Water Modeling Analysis of Water Quality

A receiving water model of Gowanus Canal and Bay was constructed as described in Section 4.1.4 to simulate hydrodynamics and water quality in the Canal. The modeling analysis indicated that the depressed dissolved oxygen levels in the Canal were the result of CSO discharges in conjunction with limited hydraulic flushing. The top panel of Figure 4-22 presents the components of the dissolved oxygen deficits throughout Gowanus Canal and Bay, as determined using the receiving water model as an annual average for conditions matching those prior to reactivation of the Flushing Tunnel. The graphic shows that, of the 9.5-mg/L "maximum" (saturation) level of dissolved oxygen, all factors together consume as much as about 8 mg/L at the head of the Canal to as little as about 2 mg/L near the mouth of the Canal. At the head of the Canal, CSO discharges are responsible for about 6 mg/L of the 8-mg/L deficit, with the remainder of the deficit resulting from sediment oxygen demand (SOD) and deficit imported from the model boundary at Gowanus Bay/Upper New York Bay. Discharges from the single outfall at the Gowanus Pump Station (RH-034) dominate the CSO impacts throughout the entire Canal. Moving away from the head, the impact of CSO discharges and SOD diminishes and the relative impact of the boundary deficit increases.



Dissolved Oxygen, Fecal Coliform and Enterococci Concentration Before Reactivation of Flushing Tunnel June-September, 1984-1998

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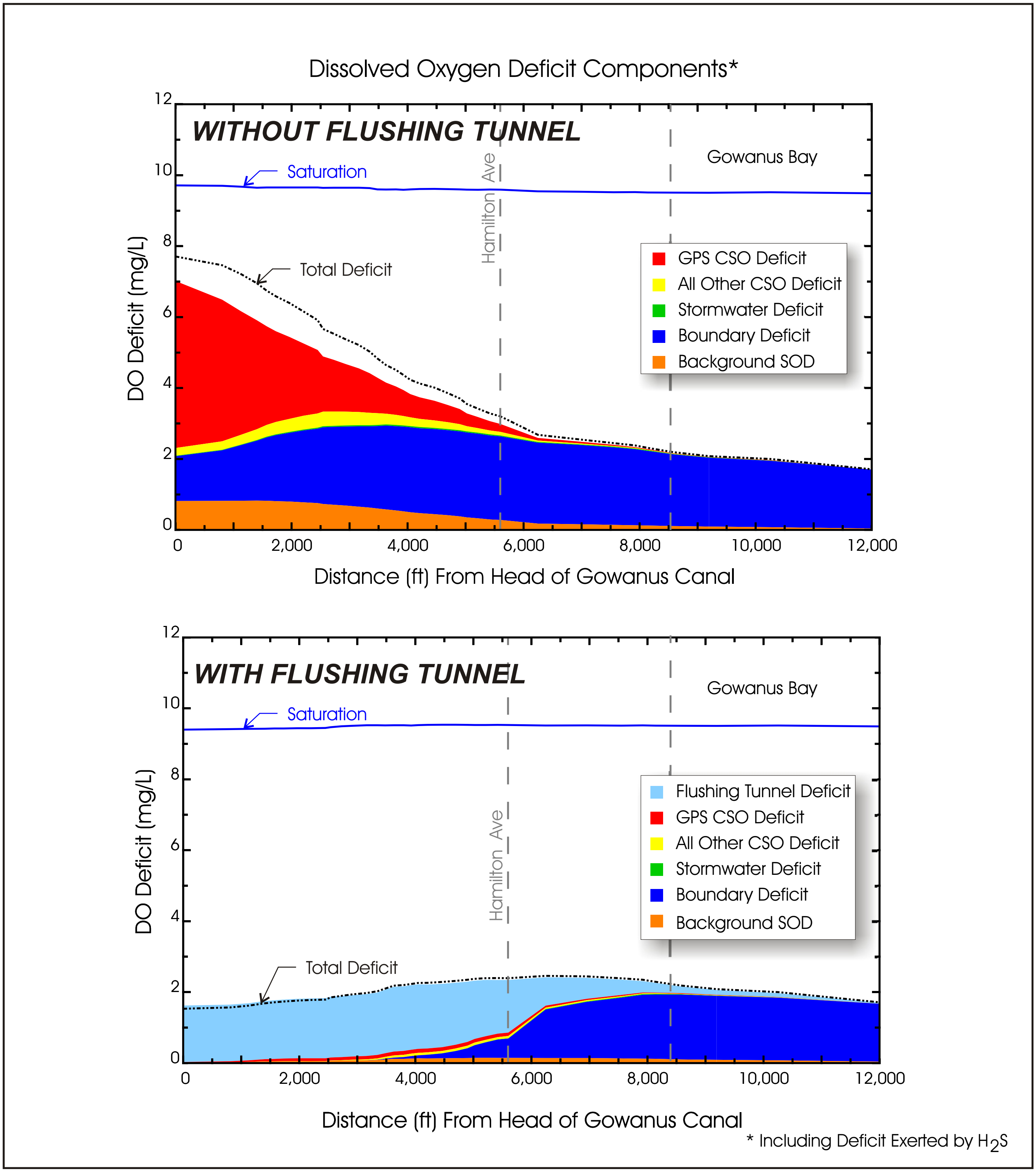

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Gowanus Canal Waterbody/Watershed Facility Plan

Dissolved Oxygen Deficit Components Without and With Gowanus Canal Flushing Tunnel

FIGURE 4-22

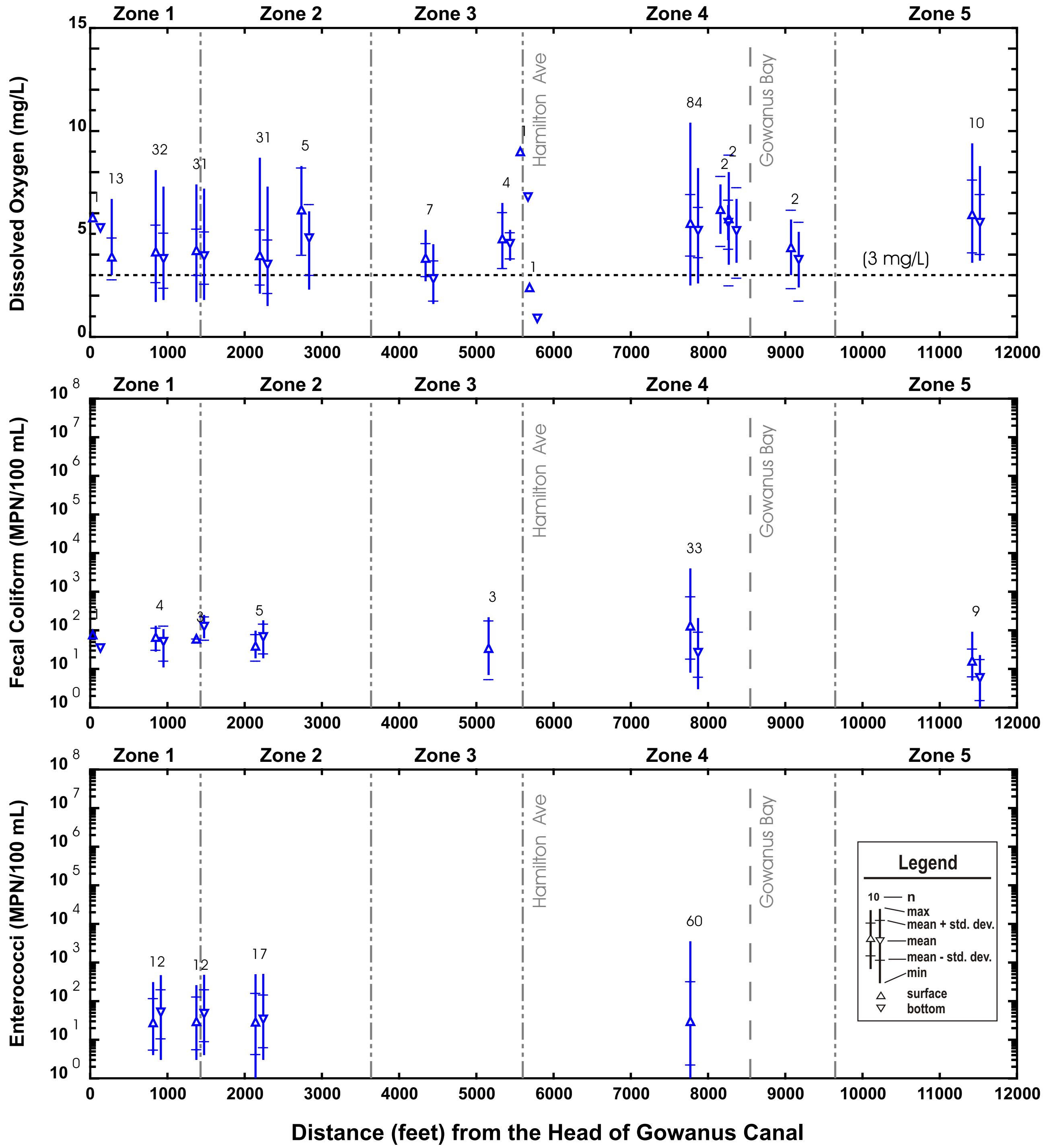
In order to assess the potential benefit of reactivating the Flushing Tunnel, the receiving water model was modified to include the pumping of water from Buttermilk Channel to the head of the Canal per the Inner Harbor CSO Facilities Plan. The predicted results of this action, as shown on the bottom panel of Figure 4-22, were dramatic, with the maximum deficit from all factors decreasing to about 2.5 mg/L from 8 mg/L. The relative impact from CSOs diminishes significantly, and instead the deficits associated with the boundaries—Buttermilk Channel and Gowanus Bay—dominate the deficit within the Canal.

According to the modeling analysis, reactivating the Flushing Tunnel would deliver Upper New York Bay water to the Canal and would not only supply higher dissolved oxygen concentrations but would also improve the Canal's assimilative capacity for pollutant discharges by enhancing circulation and exchange with the Gowanus Bay boundary. The artificial circulation would provide for a flushing action that would help to minimize sedimentation near the head of the Canal. Based on analyses like this, the Inner Harbor CSO Facility Plan, finalized in 1993, included the recommendation to rehabilitate the Gowanus Canal Flushing Tunnel. This work was completed and the Tunnel was reactivated on March 5, 1999.

4.5.3 Comparison of Measured Water Quality Before and After Flushing Tunnel Reactivation

As a result of implementation of the Inner Harbor CSO Facility Plan, the Gowanus Canal Flushing Tunnel was rehabilitated and reactivated on March 5, 1999. As described in Section 4.1.1, several data collection programs have monitored Gowanus Canal water quality and other conditions before and/or after the Flushing Tunnel reactivation. The ongoing NYCDEP Harbor Survey program has monitored constituents at one Canal location downstream of Hamilton Avenue (station G2, Figure 4-1) with a twice-monthly frequency year-round both before and after the Tunnel reactivation. Inner Harbor CSO Facility Plan studies involved sampling at four locations throughout the Canal (see Figure 4-1) from May through September 1989 through 1991. The NYCDEP collected hydrodynamic, water quality, and biological data at five locations in the Canal and Buttermilk Channel (Figure 4-4) from November 1998 through March 2000 as part of a special study to characterize conditions before and after the reactivation of the Tunnel (Hazen and Sawyer, 2001). In 2000, the Harbor Survey Tributary Monitoring program began regular monitoring at four locations in Gowanus Canal (Figure 4-4). The Harbor Survey has also performed extra monitoring at these stations on several occasions when the Flushing Tunnel was deactivated temporarily for maintenance and repairs. In addition, the NYCDEP's Sentinel Monitoring Program also collects fecal coliform data in Gowanus Canal and Bay (Figure 4-1). Water quality monitoring was also performed during the execution of USA Project FSAPs. Data collected during these monitoring programs can be used to characterize Gowanus Canal water quality conditions before and after reactivation of the Gowanus Canal Flushing Tunnel.

Figure 4-23 presents the water quality measured at various locations in Gowanus Canal during the summer months (June to September) from 1999 through 2005 (i.e., after the Flushing Tunnel had been reactivated). During this period of time, dissolved oxygen was measured at 15 locations in the Canal, with at least one station in each of the five "zones" shown on Figure 4-1. At each sampling station, Figure 4-23 presents the average at the surface (upward-pointing triangles) and bottom (downward-pointing triangles), the standard deviations (horizontal bars at plus/minus one standard deviation), the maximum and minimum measurements (ends of vertical



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Dissolved Oxygen, Fecal Coliform and Enterococci Concentrations After Reactivation of Flushing Tunnel June-September, 1999-2005

Gowanus Canal Waterbody/Watershed Facility Plan

FIGURE 4-23

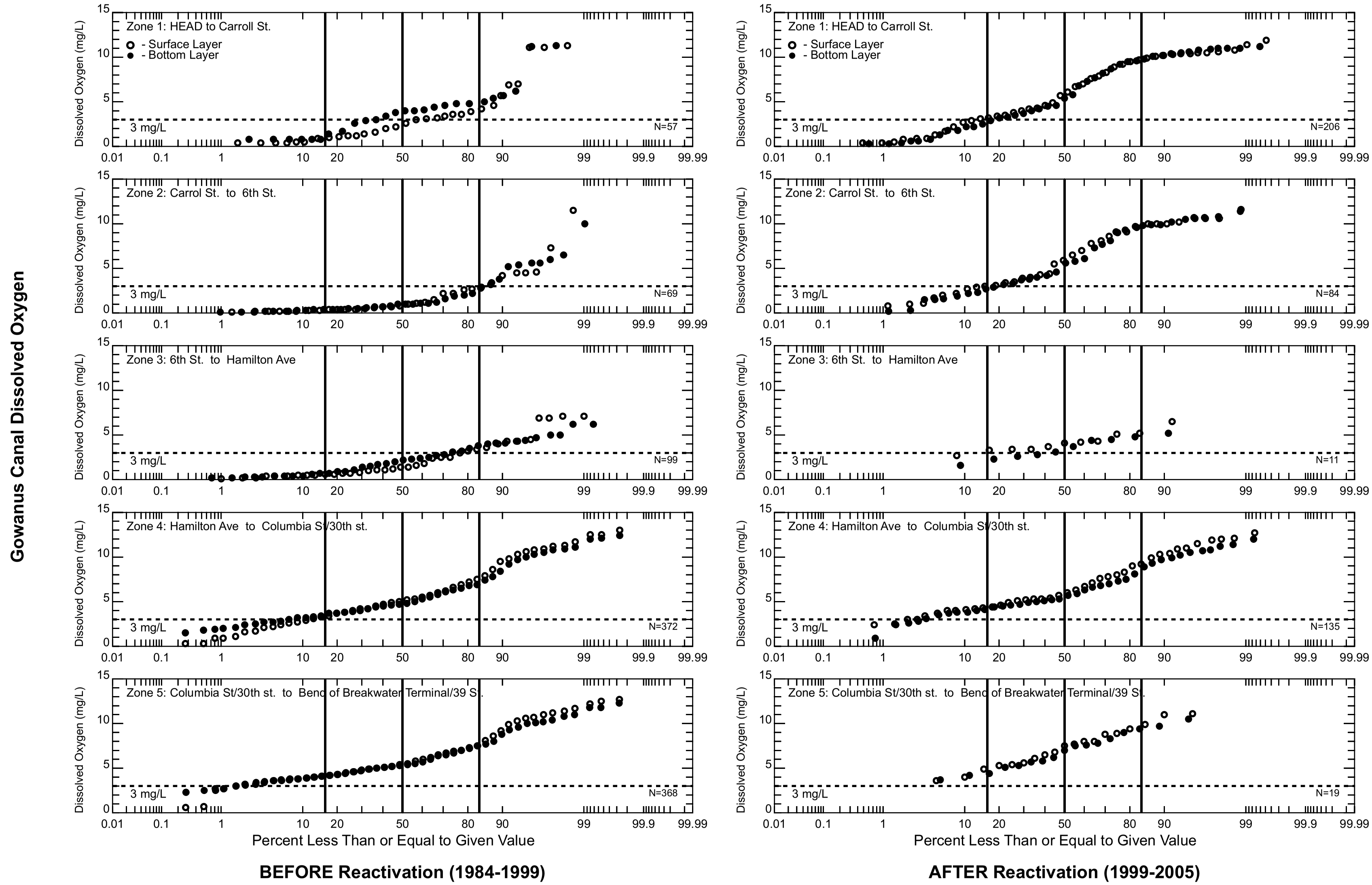
range bars), and the number of surface samples (value shown just above range bar). Comparison of Figure 4-23 to Figure 4-21 demonstrates the measured impact of reactivating the Flushing Tunnel in early 1999.

The top panel of Figure 4-23 presents the dissolved oxygen levels measured over six summers with the Flushing Tunnel active in its present configuration, and includes sampling performed during occasions when the Flushing Tunnel was inactive due to low-tide conditions or shutdowns for maintenance or repair. Inspection of the graphic shows average measurements above 3.0 mg/L at all sampling stations having more than one observation. (A single observation made during the USA study tributary toxicity sampling in 2003 at station GOWCT04—see Figure 4-12—was lower than other measurements made at the Hamilton Avenue Bridge.) These measurements represent a significant improvement over levels measured in summer periods prior to the reactivation of the Flushing Tunnel (Figure 4-21).

The middle and bottom panels of Figure 4-23 present similar displays for measured fecal coliform and enterococci bacteria levels. As shown, the fecal coliform levels in the Canal upstream of Hamilton Avenue appear to be roughly three orders of magnitude lower with the Flushing Tunnel active versus without the Flushing Tunnel, though the low number of measurements made during the post-activation period may not provide conclusive results. Similarly, enterococci bacteria levels also appear to improve by at least one order of magnitude with the Flushing Tunnel active, but the low number of measurements made during the pre-activation period may not provide conclusive results.

In order to better compare water quality conditions before and after reactivation of the Flushing Tunnel, data collected within certain "data review zones" (as shown on Figure 4-1) were grouped and displayed in a probability format to show the relative variation in the data before and after reactivation of the Flushing Tunnel. Figure 4-24 presents the dissolved oxygen data measured near the surface (open circles) and near the bottom (closed circles) within each data review zone (with the top panel corresponding to the zone nearest the head, and subsequent panels moving toward Gowanus Bay). "N," the number of surface observations included in each grouping, is indicated in the lower right corner of each panel. The probability scale shows the percentage of observations less than or equal to the ordinate value. Data collected prior to reactivation of the Flushing Tunnel is shown in the left column, while data after reactivation is shown in the right column. (Data presented in the right column include measurements taken when the Flushing Tunnel was not operating due to low-tide conditions or shutdowns for maintenance or repair.) A horizontal line designates 3 mg/L, which corresponds to the Class SD standard for dissolved oxygen.

Figure 4-24 demonstrates how, before reactivation of the Flushing Tunnel (left column), dissolved oxygen concentrations upstream of Hamilton Avenue were typically less than 3 mg/L and frequently near zero. In Zone 2 (second panel), more than 80 percent of the observed dissolved oxygen levels were less than 3 mg/L, and roughly half of all measurements were less than 1 mg/L. After reactivation (right column), observed dissolved oxygen concentrations improved significantly, particularly in the upstream portions of the Canal. Median concentrations improved to above 3 mg/L in all zones, and the frequency of concentrations lower than 3 mg/L dropped to less than 20 percent in Zones 1 and 2 (top two panels).



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Gowanus Canal Waterbody/Watershed Facility Plan

Dissolved Oxygen Concentrations Before and After Flushing Tunnel Reactivation

FIGURE 4-24

Figure 4-25 is a similar presentation for fecal coliform, which serves as an indicator of water quality (no bacteria standard is applicable in Gowanus Canal.) The data demonstrate that the Flushing Tunnel reduced fecal coliform concentrations by an order of magnitude or more throughout the Canal.

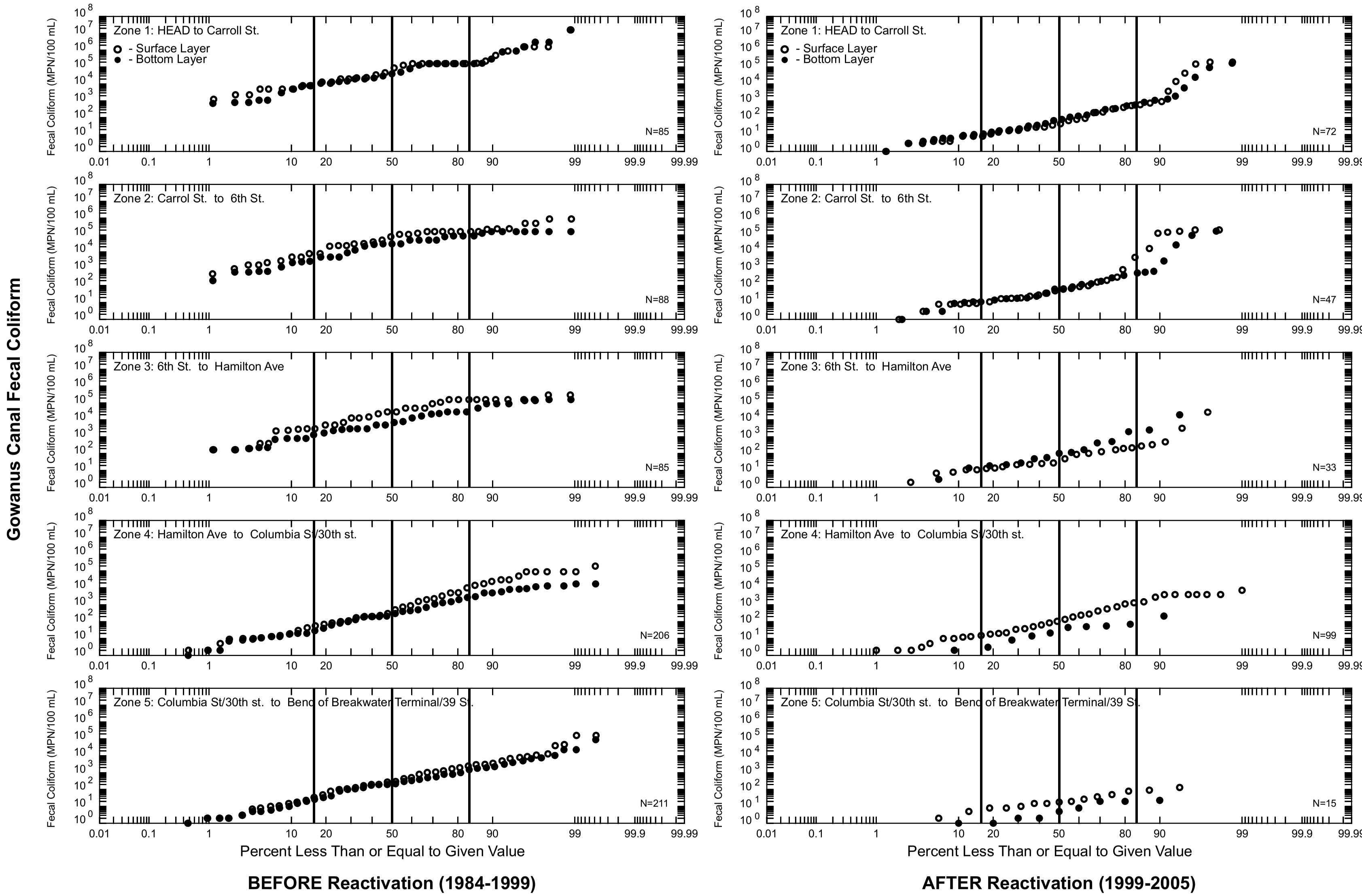
Although the monitoring data demonstrate that the reactivation of the Flushing Tunnel vastly improves water quality in Gowanus Canal, the flushing system was found to be deficient in terms of the achieved flushing rates and with respect to the reliability of the pumping system. Although the design capacity of the pumping system is 300 MGD, it is able to deliver an average of only about 154 MGD, due in part to its susceptibility to tidal conditions (the system shuts down at low tide) and in part to a significant occlusion in the Flushing Tunnel itself. Due to a lack of redundancy, nonstandard equipment, and the fact that critical system elements are submerged, the system has also proved to be unreliable and costly to repair and maintain. The Gowanus Facilities Upgrade Project has developed cost-effective solutions to address the deficiencies in the present system (see Section 5.9.2). The upgrades would increase the pumping rate to an average of about 215 MGD.

4.5.4 Receiving Water Modeling Analysis - Baseline Condition

As stated in Section 4.1.4, mathematical modeling is a useful tool to evaluate the impacts of engineering alternatives and other factors on water quality and uses in a particular waterbody. The mathematical modeling framework (Figure 4-15) developed for the Gowanus Canal waterbody/watershed assessment area includes a "landside" (rainfall-runoff/collection system) model for the watershed, a receiving water model with hydrodynamic and water quality components for Gowanus Canal and Bay, and the SWEM model to establish boundary conditions in Upper New York Bay.

A critical issue in evaluating engineering alternatives and assessing the attainment of water quality and water use goals is the selection of a representative condition for which the criteria and standards can be evaluated. Using this representative "Baseline" condition allows a host of different engineering alternatives to be evaluated on a common basis so that differences in impacts are attributable to differences in the alternatives. Because water quality conditions in Gowanus Canal are impacted by wet weather factors, selection of a precipitation condition directly affects the evaluation of whether water quality goals are assessed. The selection of a rainfall "design year" can be arbitrary, but for planning purposes, a long-term, annual average condition is appropriate and is consistent with the CSO Policy (USEPA, 1995a). The design year should also reflect population and water use conditions that are consistent with the planning horizon. Finally, the Baseline condition should reflect the state of facilities prior to implementation of long-term CSO controls.

As indicated above, all model simulations were conducted using a common set of conditions appropriate for long-term planning. The Baseline condition represents the state and operation of the sewer system and other facilities in a manner that predates implementation of any long-term CSO abatement plans, but does include implementation of the CSO Policy nine minimum controls and existing permit requirements regarding system wet-weather capacity, and a projected future condition with regard to population and water use. For the landside/watershed model, the specific design conditions established for the Baseline scenario were discussed in



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Fecal Coliform Concentrations Before and After Flushing Tunnel Reactivation

FIGURE 4-25

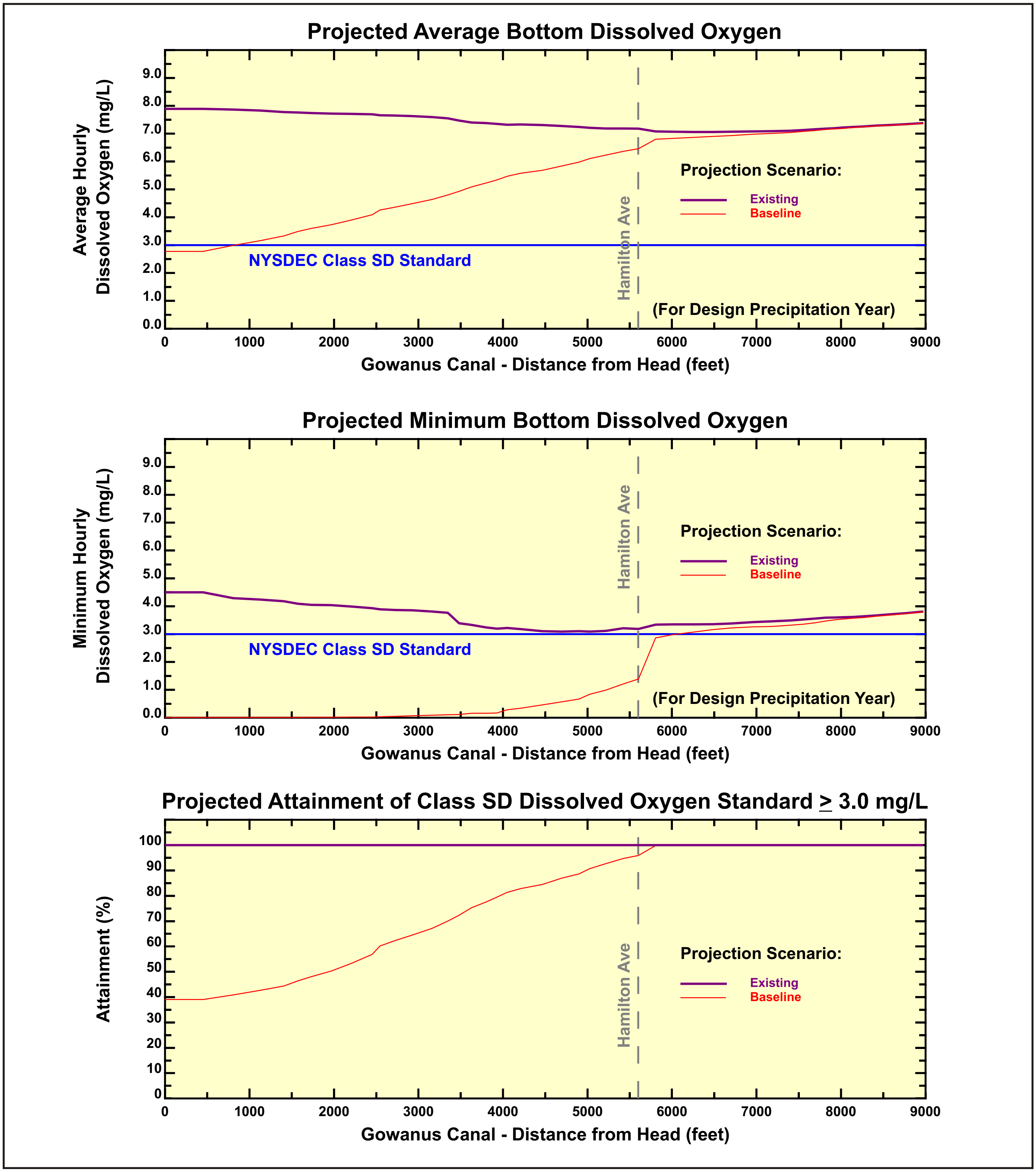
Section 3.4.3. Relative to water-quality modeling, the Baseline design condition incorporates the Baseline landside discharges (CSOs and stormwater), and applies meteorological, tidal, and other boundary information (water temperature, wind, tidal elevation, tidal currents, etc.) associated with the 1988 design precipitation year, as appropriate. The Baseline design condition does not include operation of the Gowanus Canal Flushing Tunnel.

In summary, the Baseline design condition represents the following:

- A typical annual precipitation record (JFK 1988) having long-term average total rainfall volume and storm duration;
- Other environmental conditions (meteorology, tidal conditions, water temperature and salinity, winds, etc.) corresponding to the 1988 calendar year selected above;
- Dry-weather flow rates at year 2045 projections; for the Red Hook (40 MGD) and Owls Head (115 MGD) WPCPs;
- Wet-weather capacity from 2003, as determined from the "top-ten storm" analysis at the Red Hook (113 MGD) and Owls Head (235 MGD) WPCPs and at the Gowanus Pump Station (28.5 MGD);
- Gowanus Pump Station discharging flow to the Bond-Lorraine Sewer (per current conditions);
- Sedimentation levels in sewers associated with reasonable maintenance. In most cases, sewers were modeled as clean conduits. However, in the 72-inch-diameter Bond-Lorraine Sewer, where sedimentation buildup has been a chronic problem, modeling analysis assumed 15 inches through most of the sewer and 18 inches upstream of the constriction at Bond and 5th Streets.
- No operation of the Gowanus Canal Flushing Tunnel.

To illustrate the impact of the reactivated Gowanus Canal Flushing Tunnel, a second model simulation was also performed. In this "Existing" scenario, all conditions were identical to the Baseline, except that the Gowanus Canal Flushing Tunnel was added to match its current operational parameters: a tide-dependent flow rate varying from 0 MGD at low tide to 195 MGD at high tide, and an average daily flow rate of 154 MGD.

Results of the receiving water model for the Baseline and Existing conditions are summarized in Figures 4-26 and 4-27. Figure 4-26 presents the calculated dissolved oxygen spatially as annual averages (top panel), annual minima (middle panel), and in terms of the percentage of annual hours projected to attain the Class SD standard of not less than 3 mg/L (bottom panel). With respect to the Baseline condition, the graphics show that dissolved oxygen levels gradually increase moving away from the head of the Canal, where concentrations average under 3.0 mg/L. Minimum dissolved oxygen concentrations are less than 3 mg/L (and hence are not expected to meet the current Class SD water quality standards) in most of the Canal, with only the 2,500 feet near the mouth calculated to meet that criterion at all times. As a whole,



Projected Average and Minimum Dissolved Oxygen and Attainment of Applicable Class SD Standard Baseline and Existing Conditions

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Gowanus Canal Waterbody/Watershed Facility Plan

FIGURE 4-26

Gowanus Canal compliance is determined by dissolved oxygen at the spatial minimum (the head), where the Class SD standard is met about 39 percent of the time. With the Flushing Tunnel activated, projected dissolved oxygen levels dramatically improve throughout the Canal. The lowest dissolved oxygen concentrations are projected to occur between 4,000 and 5,000 ft from the head (roughly, between the 5^{th} Street and Hamilton Avenue), where minimum hourly values are at or just above 3 mg/L. As a result, the projected attainment of the SD criterion is 100 percent.

Figure 4-27 presents the calculated concentrations of total coliform (top panel), fecal coliform (middle panel), and enterococci (bottom panel) as geometric means and ranges for hourly model projections for a typical year along the length of the Canal. With respect to the Baseline condition, calculated concentrations for these indicator bacteria generally decrease from the head of the Canal toward the mouth. Geometric mean concentrations calculated for total coliform range from the order of 100 MPN/100mL near the mouth to about 3,000 MPN/100mL at the head, where the maximum concentration is on the order of 5 million MPN/100mL. Geometric mean concentrations calculated for fecal coliform range from the order of 30 MPN/100mL near the mouth to about 700 MPN/100mL at the head, where the maximum concentration is on the order of 1 million MPN/100mL. Geometric mean concentrations calculated for enterococci range from the order of 10 MPN/100mL near the mouth to about 400 MPN/100mL at the head, where the maximum concentration is on the order of 50,000 MPN/100mL. With respect to the Existing condition, pathogen levels are projected to decrease significantly near the head, but not near the mouth. At the head, geometric mean total coliform, fecal coliform, and enterococci concentrations are projected to be on the order of 200, 40, and 7 MPN/100 mL, respectively, and are roughly an order of magnitude lower than the Baseline projections. Similarly, maximum values are projected to be on the order of 1 million, 20,000, and 10, 000 MPN/100 mL, respectively, all nearly an order of magnitude lower than the Baseline projections.

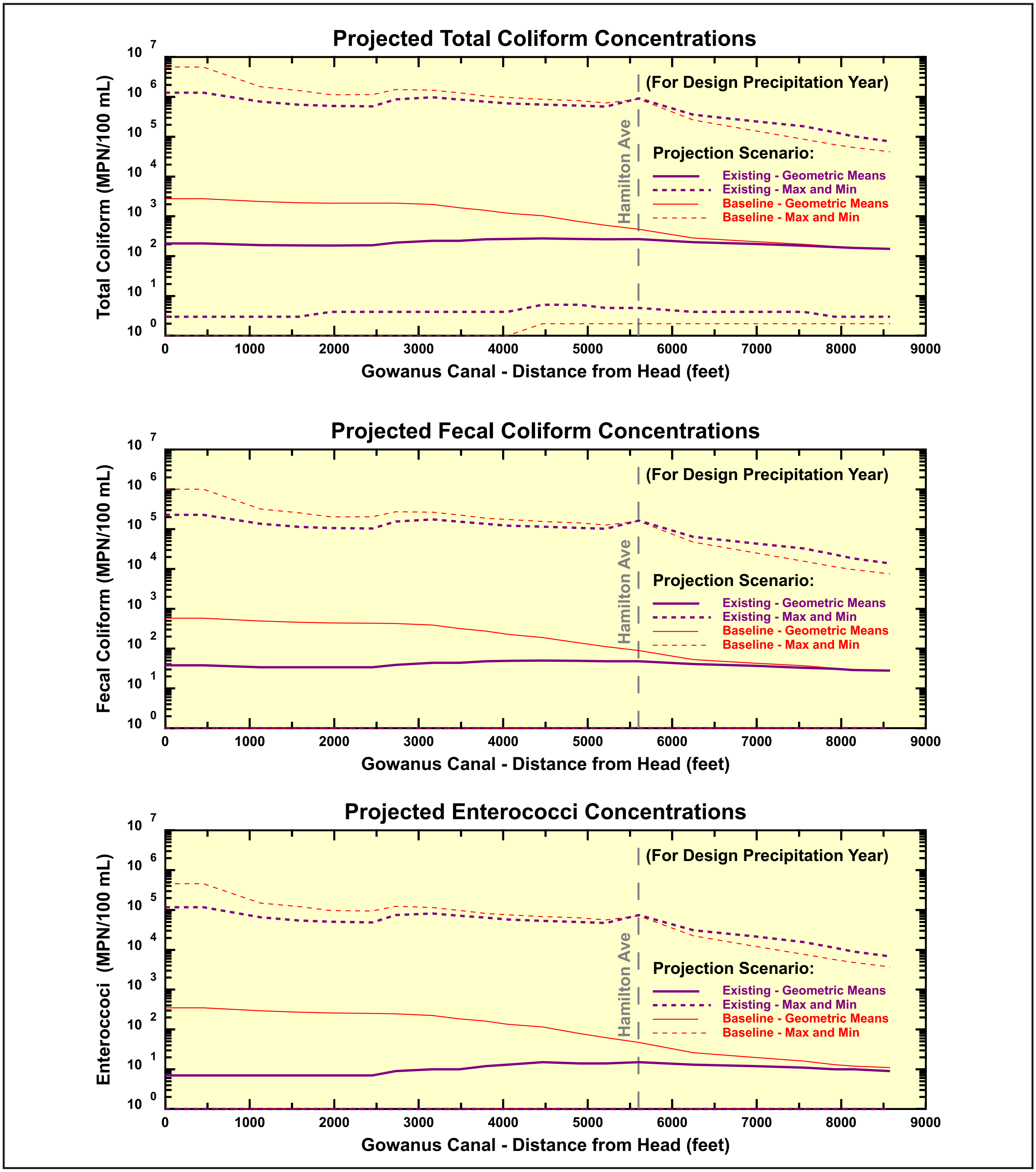
Gowanus Canal is an urban waterbody subject to industrial uses. The NYSDEC recognizes this in its designation of Gowanus Canal as a Class SD waterbody, for which contact recreational use criteria are not applicable.

4.5.5 Pollutants of Concern

As described in Section 1.2.3, the Final New York State 2006 Section 303(d) List of Impaired Waters identifies Gowanus Canal as an impaired waterbody with the cited cause as dissolved oxygen and oxygen demand due to urban runoff, storm water, and CSO discharges. The field investigations and water quality modeling analyses discussed above in Section 4 confirm these findings, and also indicate that floatables represents an additional pollutant of concern as an aesthetics issue.

4.5.6 Other Pollutants and Water Quality Issues

Beyond the pollutants of concern described in Section 4.5.5, other water quality issues of interest include levels of indicator bacteria, exposed sediment mounds and associated odors, and toxicity in the water column and sediments.



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Gowanus Canal Waterbody/Watershed Facility Plan

Projected Pathogen Concentrations Baseline Conditions

FIGURE 4-27

Indicator Bacteria

Gowanus Canal's waterbody classification of SD does not support recreational uses and hence no indicator bacteria standards are applicable. However, indicator bacteria can provide a measure of water quality.

CSO Sediment Mounds and Odors

The CSO sediment mounds in Gowanus Canal represent an aesthetic issue, primarily due to the odors that are released when the sediments are exposed at low tide.

Water Column and Sediment Toxicity

Water column and sediment toxicity tests were conducted by the NYCDEP's USA Project in 2003, which was described in Section 2.1.2. Toxicity tests performed on water column samples taken at the three sampling stations in Gowanus Canal were negative. Sheepshead minnow survival exceeded 97 percent, and mysid shrimp survival was 95 percent, at all three stations, although in both cases growth was lower than observed at the respective control group stations. The growth results may reflect natural variability among water samples rather than a response to local stressors. With the exception of the sediment sample taken from the head of Gowanus Canal (GOWCT01), the toxicity of sediments to the amphipod, *Leptocheirus plumulosus*, was apparently sufficient to have caused almost 100 percent mortality before the chronic growth tests could be completed (28 days). This result was expected, based on the sensitivity of the amphipod relative to other types of organisms. In contrast, amphipod survival in the sample collected from the head of Gowanus Canal was 80 percent, and growth was exceeded only by the control and one sample collected from near the mouth of the Bronx River. Given the variability in sediments resulting from Flushing Tunnel operation, the sediment sample taken at the head of Gowanus Canal may not have been representative of the area as a whole although it may reflect a positive effect of NYCDEP's reactivation of the Gowanus Canal Flushing Tunnel.

Results of Toxicity Characteristic Leaching Procedure (TCLP, a laboratory procedure designed to determine the mobility of contaminants) reported by Sunset Energy Fleet (2002) indicated that lead, chromium, cadmium, mercury and PCBs exceeded regulatory criteria for Resource Conservation and Recovery Act (RCRA) listed hazardous constituents in Gowanus Bay sediments. These results are consistent with those reported by the USACE (USACE, 2003b), which compared contaminant levels in Gowanus Canal sediments to the NYSDEC Technical and Administrative Guidance Memorandum (TAGM) cleanup levels for land-based hazardous waste sites.

The NYSDEC TAGM 4046 Determination of Soil Cleanup Objectives and Cleanup Levels addresses the restoration of inactive hazardous waste sites, specifically individual Federal Superfund, State Superfund, 1986 Environmental Quality Bond Act Title 3, and Responsible Party sites; categories in which Gowanus Canal does not fit. The TAGM levels are not enforceable remediation targets for cleanup of marine sites, but almost forty contaminants detected by the USACE exceeded these guidance values, spanning heavy metals, PCBs, volatile and semi-volatile organic compound lists, strongly indicating a contamination problem in bottom sediments in Gowanus Canal.

The data collected by the USACE was reviewed by NYCDEP's USA Project and compared to other past and ongoing related data collection efforts in New York Harbor. The other data sources included unpublished data collected in 1994 and 1997 by NYCDEP for planning dredging activities in Gowanus Canal, similar data collected by the NYCDEP in 2001 for dredging Paerdegat Basin, and preliminary data collected by the New York/New Jersey HEP Contaminant Assessment and Reduction Project (CARP) from 1998 through 2001. The comparison indicated that USACE and NYCDEP data collected in Gowanus Canal and Bay are generally similar to data collected in other waterbodies of New York Harbor with regard to the existence of prevalent sediment contaminants. Relevant regulatory targets and procedures were not in place at the time of the writing of this report. However, such regulatory structures are being developed through the HEP CARP with a scheduled completion in 2006.

4.6 BIOLOGY

Due to its industrial and urban development history over the past century, Gowanus Canal has been highly disturbed, resulting in an ecosystem predominated by species tolerant of environmental degradation, and by species that can utilize artificial habitat. The shorelines are entirely altered, consisting almost exclusively of bulkheads, with some areas of rip-rap and piers. No areas of natural shoreline or natural upland areas are located within or adjacent to the waterbody, and no high value wetlands such as coastal or intertidal marshes remain. An estuarine aquatic community such as an undisturbed Gowanus Canal would be expected to have the following:

- Rooted plants in wetland or submerged aquatic beds;
- Benthic invertebrates, such as mussels, clams, snails, crabs, sponges, and worms that are associated with natural substrates found in intertidal and subtidal zones;
- Epibenthic algae and invertebrates that live on available substrates within the waterbody (sometimes called "fouling" communities);
- Phytoplankton (microscopic algae) and zooplankton (microscopic invertebrates) that live in the water column;
- Finfish of all life stages, including eggs, larvae (ichthyoplankton), juveniles and adults; and
- Reptiles and amphibians

The operation of the Gowanus Canal Flushing Tunnel creates a unique water quality and physical habitat situation by changing the hydrodynamics of Gowanus Canal. The flow introduced at the head of the Canal provides an entry portal for aquatic life from Upper New York Bay and contributes to the development of an atypical salinity gradient and circulation pattern. Because the Canal is a confined waterbody with bulkheads throughout its length, the flushing flow will tend to create uniform habitat conditions. The position of the Flushing Tunnel intake in Buttermilk Channel may introduce more open water aquatic life forms than the Canal entrance in Gowanus Bay. These physical factors are important considerations in characterizing the Canal ecosystem and in the future management of water quality and aquatic life.

Recent data were collected for each of the above categories of aquatic life, both in Gowanus Canal and throughout the New York Harbor complex. These data afforded a focused evaluation of the Gowanus Canal ecosystem and its context within the waters of the region. The principal sources of data were USA Project FSAPs (HydroQual, 2001a-e, 2002a-b, 2003a-b) that were initiated in the year 2000. To supplement FSAP findings, additional data were provided from other studies conducted by NYCDEP (Hazen and Sawyer, 2001), the USACE (1998, 2003), and Sunset Energy Fleet (2002). The following sections summarize fish and aquatic-life uses of Gowanus Canal, based on these studies of the waterbody and adjacent areas.

4.6.1 Submerged Aquatic Vegetation

There are no significant colonies of rooted aquatic vegetation within Gowanus Canal. NYSDEC tidal wetlands maps designate the entire waterbody as a littoral zone, a shallow-water habitat that does not include coastal fresh marsh, intertidal marsh, or other vegetative wetlands designations. The National Wetland Inventory (NWI) maps classify the Canal as "estuarine, subtidal, open water, excavated," which also suggests the absence of aquatic vegetation. Areas of sea lettuce (*Ulva* sp.) and other macroalgae that drift with the currents may be present on the bottom from time to time, similar to other areas of New York Harbor, but submerged aquatic vegetation, such as eelgrass (*Zostera marina*), was not identified, and is not likely to exist in Gowanus Canal or Bay.

4.6.2 Benthic Invertebrates

During June 2003, the NYCDEP's USA Project found that the most abundant invertebrates in Gowanus Canal were annelid worms (polychaetes and oligochaetes), followed by amphipods and small mollusks (see Tables 4-2 and 4-3). The 2002 Sunset Energy Fleet study of Gowanus Bay also showed dominance by polychaetes (75 percent) and oligochaetes (10 percent) (Sunset Energy Fleet, 2002), as did the 1995 USACE study of Upper New York Bay (USACE, 1998), and the 1997 and 1999 NYCDEP studies of Gowanus Canal (Hazen and Sawyer, 2001). However, the NYCDEP study identified only seven taxa at the head of the Canal in 1999, whereas 17 taxa were identified in 2003, with the difference including seven additional polychaetes, two additional amphipods (*Ampelisca* sp. and *Unciola* sp.), and some shrimp of the family *Crangonidae*. The *Ampelisca* sp., *Unciola* sp., and *Crangonidae* family are considered to include species less tolerant of environmental degradation than most annelids, suggesting that improvement in ecological health had occurred between 1999 and 2003. However, samples from both years were dominated by the polychaetes *Polydora* and *Capitella*, which are among the more degradation-tolerant benthic invertebrates. Densities of these worms were not significantly different between June 1999 and June 2003 at the head of the Canal. A complete listing of taxa collected during subtidal benthos sampling by the USA Project in 2000-2002 can be found in Appendix Exhibit B-1.

Sampling locations near the 4^{th} Street Basin and at Hamilton Avenue yielded fewer taxa than were collected at the head of the Canal. This suggests that the ecological response to the reactivation of the Gowanus Canal Flushing Tunnel may have been spatially limited. Although dissolved-oxygen concentrations during each of these sampling events were above 4 mg/L at all locations, the mid-section sampling locations are more remote from the Flushing Tunnel discharge and are in deeper water than the sampling location at the head of the Canal.

Table 4-2. List of Taxa Found in USA Project Samples From Gowanus Bay and Canal

Taxa	Benthos (Canal)	Artificial Panels (Bay)	Ichthyoplankton (Canal and Bay)
Aoridae	x		
Ammodytes americanus			x
Ampharetidae	x		
Amphithoidae		x	
Ampeliscidae	x		
Anchoa mitchelli			x
Balanus eburneus		x	
Botryllus schlosseri		x	
Brevoortia tyrannus			x
Capitellidae	x		
Cirratulidae	x		
Clupeidae			x
Crangonidae	x		
Crepidula plana		x	
Cumacea	x		
Diadumene lineata		x	
Dyspanopeus sayi		x	
Eteone	x		
Eumida sanguinea		x	
Gammaridae	x		
Gobiosoma bosc			x
Hydroida		x	
Isopoda	x		
Leptocheirus pinguis		x	
Menidia menidia			
Molgula manhattensis		x	
Myoxocephalus			x
Mytillus edulis		x	
Nereis succinea	x	x	
Oligochaeta	x		
Ophelia	x		
Panopeus herbstii		x	
Pholis gunnellus			x
Phyllodoce sp.	x		
Polydora sp.	x		
Prionotus			x
Pseudoplueronectes americanus			x
Sabella microthalmia		x	
Sciaenidae			x
Scoloplos sp.	x		
Scopthalmus aquosus			x
Streblospia benedictii	x		
Syngnathus fuscus			x
Tautoga onitis			x
Tautogolabrus adspersus			x
Unciola	x		
Xanthidae		x	

Table 4-3. Comparison of Benthic Grab Sample Results at Similar Stations During Different Studies

Date	Station[(1)]	Total Taxa	Total Count/m^2	Percent Composition by Count/m2					
				% Polychaetes	% Amphipods	% Bivalves	% Gastropods	% Oligochaetes	% Other
April-1999	dep-01	7	975	33.3	59	5.1	2.6		
	dep-02	3	175	100					
	dep-03	9	1800	95.8		2.8	1.4		
	dep-04	11	21000	28.9		69.9	1.2		
April-2003	ace-30	4	N/A	41.1	11.8			5.9	41.2[(2)]
	ace-21	2	N/A					20	80[(2)]
	ace-11	1	N/A						100[(2)]
	ace-35	10	N/A	23.5	5.9	20.6	2.9	17.6	29.5[(2)]
June-1999	dep-01	7	3075	95.1	4.9				
	dep-02	3	575	100					
	dep-03	7	925	94.6	2.7				2.7
	dep-04	17	13625	28.4		71	0.6		
June-2003	gowcb01	17	1730[(3)]	84.4[(3)]	2.5	Tr		5.2[(3)]	7.6
	gowcb03	7	7910[(3)]	78.8[(3)]	Tr			20.9[(3)]	Tr
	gowcb05	7	4060[(3)]	56.9[(3)]				42.8[(3)]	
	(bay)	(not sampled)							

(1)Stations arranged from head to bay, within dates (head, 4th street, Hamilton Avenue, bay)

(2)Mostly nematodes

(3)Excludes "annelid pieces

Comparisons of these studies with 2003 USACE data show conflicting findings. At least some of the differences can be explained by differences in sampling and data reduction methods, as well as the distribution of organisms within the sampling region. For example, the USACE data are dominated by nematodes rather than annelids, but sample densities are not available, and samples from nearby USACE stations contained the expected abundance of capitellids and other polychaetes, along with more oligochaetes. Nematodes are considered to be tolerant of habitat degradation, and may predominate locally in an area of exceptional degradation. Another notable difference between the USACE data and those of the other studies is that surface and bottom dissolved-oxygen levels reported for all stations throughout Gowanus Bay and Canal were less than 1.0 mg/L in the USACE data. Based on a review of the data and report (USACE, 2003a), a meter problem or data reporting problem was determined to be the only reasonable explanation for this anomalous data set.

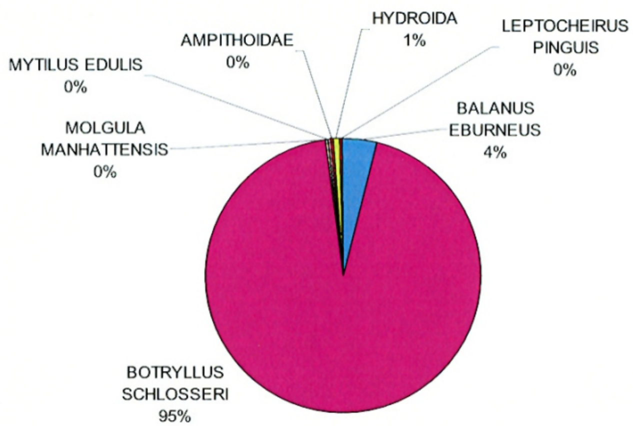
4.6.3 Epibenthic Communities

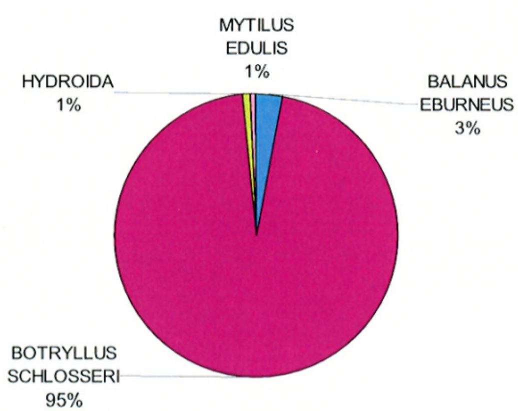
Epibenthic communities are sessile (attached), and thus can be good indicators of water quality at a particular location. Artificial substrate arrays were deployed by the USA Project in Gowanus Bay and at other locations in New York Harbor to document epibenthic colonization and growth. The arrays were deployed in 2001 from April through June (spring) and from July through September (summer). Figures 4-28 and 4-29 present images of representative growth on the artificial substrates. Growth on the Gowanus Bay arrays was dominated by golden star tunicates (*Botryllus schlosseri*) and "sea grapes" (*Molgula manhattensis*). They are visible on Figures 4-28 and 4-29, respectively, as the small gelatinious yellow organisms (golden star tunicates) and the purple organisms (sea grapes). Throughout the Harbor, golden star tunicates were found more frequently on panels exposed from April through June than from July through September, with a higher average biomass per plate (3.54 grams/plate vs. 0.54 grams/plate) during April through June. In contrast, the sea grapes were found more frequently following summer exposures, and at higher average biomasses than in spring exposures. Sea grape biomass exceeded golden star tunicate biomass at the end of both the spring- and summer-exposure periods.

Other organisms recovered from individual substrate arrays included sessile species such as barnacles (*Balanus* sp.), blue mussels (*Mytilus edulis*), and the orange-striped green anemone (*Diadumene lineata*). Motile species such as the clam worm (*Nereis succinea*), the feather-duster worm (*Sabella microphthalma*), the slipper snail (*Crepidula plana*), the amphipod (*Leptocheirus pinguis*), and the Atlantic and Say mud crabs (*Panopeus herbstii* and *Dyspanopeus sayi*, respectively).

A notable difference between surface- and bottom-water arrays was that mud crabs were only found in the surface arrays in Gowanus Canal, while they were present at both depths elsewhere in New York Harbor. The Say mud crab has been found to be very sensitive to low levels of dissolved oxygen in laboratory bioassays (USEPA, 2000).

Taxa identified as indicator species based on their presence or absence in contaminated waterways of the mid-Atlantic are listed in Table 4-4, along with their occurrence in select Harbor waterbodies. Most of the individual organisms present in Gowanus Canal and other waterbodies are rated as "pollution tolerant," such as the numerically dominant polychaete and oligochaete annelid worms. However, representatives of "pollution-sensitive" taxa were also





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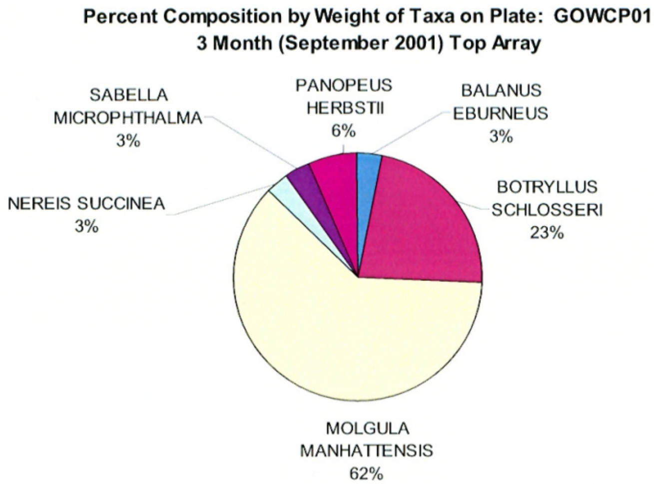
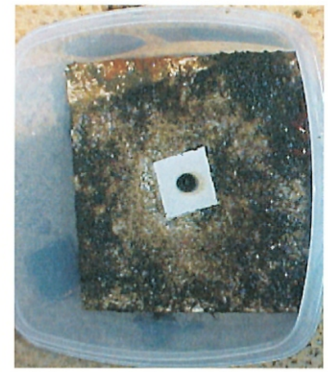
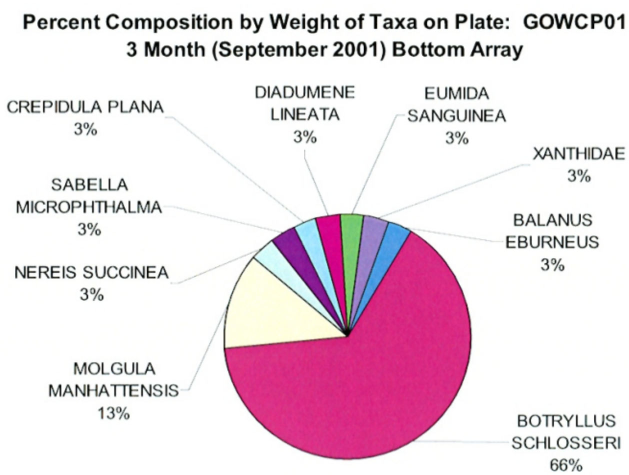
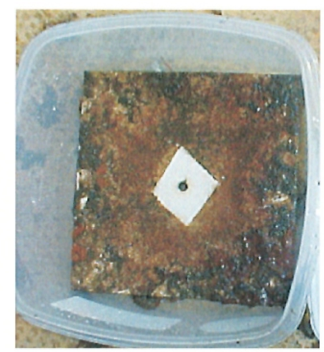
Epibenthic Organisms Colonizing Artificial Substrates in Spring

FIGURE 4-28









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Epibenthic Organisms Colonizing Artificial Substrates in Summer

FIGURE 4-29

Table 4-4. Presence of Indicator Taxa by Station and Waterbody

Pollution-Sensitive Taxa	Gowanus Bay (Panels Only)	Gowanus Canal (Benthos Only)	Other Tributaries (Panels and Benthos)	Open Waterbodies
Molluscs				
Acteocina canaliculata				x
Anadara ovalis				x
Mercenaria mercenaria			x	x
Mya arenaria			x	x
Spisula solidissima			x	
Telina agilis			x	
Arthropods				
Ampelisca sp.*		x	x	x
Carcinus maenus			x	
Crangon sp.*	x	x	x	x
Cyathura polita				x
Dyspanopeus sayi	x		x	x
Gammaridae	x	x	x	x
Nereis pelagica				
Polychaetes				
Ampharete sp.*		x	x	
Polygordius sp.*			x	
Total Number of Pollution-Sensitive Taxa			5	5
Pollution-Tolerant Taxa				
Molluscs				
Mytulus edulis	x			
Mulinia lateralis			x	x
Nucula proxima				x
Oligochaetes				
Oligochaeta*		x	x	x
Polychaetes				
Capitella sp.*		x	x	x
Lumbrinereis sp.*			x	
Heteromastis sp.*		x		
Nereis sp.*	x	x	x	x
Polydora sp. *		x	x	
Streblospio benedicti		x	x	x
Total Number of Pollution-Indicative Taxa			4	5
* not necessarily species level				

identified at several locations, albeit in comparatively low densities and in the relatively higher quality habitats of Jamaica Bay, the Hutchinson River, and Fresh Creek. Many of the sensitive taxa were amphipods, including *Ampelisca abdita*, *A. vadorum*, *Jassa* sp., *Gammarus* sp., and *Unciola* sp., among others. Note that some of the taxa in Table 4-4 are listed at the genus level (e.g., *Ampelisca* spp.). Even though the species found in the Harbor may not be the same as those identified as being sensitive elsewhere in the mid-Atlantic, the underlying presumption is that all species within those genera share similar tolerances. Other epibenthic species not represented in the hard-substrate arrays are listed in Appendix Exhibit B-2, and include a wide variety mollusks (clams, snails), crabs, shrimp, sponges, starfish, and jellyfish, as well as the ubiquitous blue crab (*Callinectes sapidus*) and hermit crabs (*Pagurus* spp.). These and other similar species may inhabit Gowanus Bay and portions of Gowanus Canal when conditions are favorable. These species can be expected to make greater use of the Canal as dissolved oxygen and substrate conditions improve.

4.6.4 Phytoplankton and Zooplankton

No phytoplankton or zooplankton samples were taken during FSAPs executed during NYCDEP's USA Project. However, NYCDEP sampled zooplankton in 1997 and 1999 to evaluate the effects of reactivating the Gowanus Canal Flushing Tunnel (Hazen and Sawyer, 2001). Results for comparable months in these two years are summarized in Table 4-5.

The reactivation of the Flushing Tunnel appears to have improved the diversity and abundance of zooplankton and other planktonic organisms, although it is not clear whether this abundance was the result of more favorable conditions or the result of direct entrainment by the Flushing Tunnel. The results show more individuals per unit volume spanning more taxa, with a more even distribution across those taxa following reactivation. Prior to reactivation, over 92 percent of all organisms collected in May were copepods (*Acartia* spp.); following reactivation, less than 45 percent of all organisms were copepods. In addition, polychaetes and fish larvae became prevalent, and the temporal diversity, relative abundance and distribution became more typical of waterbodies in the New York Harbor complex.

4.6.5 Ichthyoplankton

Fourteen taxa of fish eggs and/or larvae were identified in Gowanus Canal and Bay during NYCDEP's Harbor-Wide Ichthyoplankton FSAP in 2001 (Table 4-2). The most common were: winter flounder (*Pseudopleuronectes americanus*) larvae, present from late February through early June; windowpane flounder (*Scophthalmus aquosus*) eggs and larvae, present in May and June; wrasses (*Labridae*) family, bay anchovy (*Anchoa mitchelli*), and menhaden (*Brevoortia* sp.) eggs, all present from June through August; and naked goby (*Gobiosoma bosc*) eggs and larvae, also present from June through August. Appendix Exhibit B-3 alphabetically lists taxa collected during the Harbor-Wide Ichthyoplankton FSAP in 2001 for the East River, Jamaica Bay, other waterbodies, and all waterbodies. Appendix Exhibit B-4 lists how each species ranked in the 2001 sampling program based on cumulative densities (i.e., count per hundred cubic meters per station, summed over all stations and months).

Ichthyoplankton data for Gowanus Bay and Upper New York Bay are shown in Table 4-6, illustrating the similarity between the two contiguous waterbodies. A third station, in the Canal near Hamilton Avenue, was sampled in March 2001 (not shown in Table 4-6). Those

**Table 4-5. Taxa Caught in Zooplankton Samples
Before and After Reactivating the Gowanus Canal Flushing Tunnel**

Taxa	May 1997			May 1999	
	Count/m3	Percent of Total		Count/m3	Percent of Total
Pseudocalanus newmanni	0.1	2.5		0	0
Acartia hudsonica	2.1	52.5		0	0
Acartia spp.	1.6	40		2.6	44.8
Cyclopoidia	0.1	2.5		0	0
Barnacle larvae	0.1	2.5		0	0
Chaetognaths (Sagitta)	0	0		0.18	1
Polychaete larvae	0	0		1.93	10.09
Decapod zoea	0	0		2.6	14.7
Caridae larvae	0	0		3.8	2.2
Fish eggs and larvae	0	0		4.18	23.7
(anchovy and menhaden)					
Miscellaneous					3.51
Total		100			100

Source: Hazen and Sawyer, 2001

Table 4-6. Ichthyoplankton Concentrations (Count/100m3) in Gowanus Bay and Upper New York Bay Stations in 2001

		March		May		July	
Species	**Life Stage**	**Gowanus Bay**	**Upper New York Bay**	**Gowanus Bay**	**Upper New York Bay**	**Gowanus Bay**	**Upper New York Bay**
Bay Anchovy	Egg			8.4		1.2	
	Larvae						
Cunner	Egg			460.2	285.8	281.2	1501
	Larvae				1.7		
Gobies	Egg						
	Larvae					4.7	10
Grubby	Egg						
	Larvae	10.4	12.1	0.5	1.7		
Herring	Egg				24.4		
	Larvae			1.5			
Menhaden	Egg			1.27	28.6		
	Larvae			0.6			0.5
Sand Lance	Egg						
	Larvae	1.5	1.8				
Tautog	Egg			146.2	186.3	24.8	47.5
	Larvae			0.5			
Windowpane Flounder	Egg			54.7	153		
	Larvae			13.7			
Winter Flounder	Egg						
	Larvae	103.1	156.1		1.7		
Note: Average Two Reps/Station							

results also paralleled Gowanus Bay and Upper New York Bay results, with 3.9 grubby larvae/100m^3; 0.5 sand lance (*Ammodytes americanus*) larvae/100m^3; and 70.1 winter flounder larvae/100m^3. This similarity demonstrates that the communities of Upper New York Bay form "boundary" condition for the Gowanus Canal system, an important consideration for evaluating alternative scenarios in relation to ecological conditions in the Canal. In addition, the data from June and July 2003 showed similar patterns of species composition and abundance between stations in Gowanus Bay and Canal and in Buttermilk Channel, reinforcing the expectation that organisms are being entrained by the operation of the Gowanus Canal Flushing Tunnel.

4.6.6 Fish

NYCDEP conducted otter trawl and gill net sampling for the USA Project while executing its FSAPs in the East River (HydroQual, 2001d) and Jamaica Bay (HydroQual, 2001e) in 2001, and during the Supplemental Aquatic Life Characterization of the East River and Jamaica Bay in 2002 (HydroQual, 2002b). Although no samples were taken from Gowanus Canal during these FSAPs, the waters surrounding the Canal and other Harbor waters may be the general source for recruitment of fishes to the Canal, and many of the species found in these studies may occur in the Canal. Appendix Exhibit B-5 summarizes fish taxa collected during finfish trawls in 2000-2002 for NYC's USA Project. Appendix Exhibit B-6 summarizes other taxa collected during these trawls. In the East River and Upper New York Bay, numerous other finfish sampling programs associated with power plant intakes have been performed, providing a comprehensive database on fish species of the area. One of these studies, performed by Sunset Energy Fleet (2002), provided a summary of fishes collected in the East River and Upper Bay (Table 4-7). Further, NYCDEP performed limited trawl sampling in Gowanus Bay as part of its Gowanus Canal Flushing Tunnel reactivation analysis (Hazen and Sawyer, 2001).

Using small otter trawls and experimental (variable mesh) gill nets, NYCDEP's USA Project sampling effort caught nearly half of the species listed in Table 4-8. The most frequently caught species were Atlantic menhaden, blueback herring (*Alosa aestivalils*), bay anchovy, bluefish (*Pomatomus saltatrix*), striped bass (*Morrone saxatilis*), winter flounder, weakfish (*Cynoscion regalis*), and scup (*Stenotomus chrysops*), as shown in Table 4-9. Some species not caught in fish nets used in the USA Project FSAPs were caught in ichthyoplankton tows, indicating the presence of that fish species in New York Harbor, as was the case for sand lance, blennies (*Blennidae*), rock gunnel (*Pholis gunnelus*), mackerel (*Scomberomorus* sp.), killies (*Cyprinodontidae*), and silver perch (*Bairdiella chrysoura*). Based on the average sizes of specimens caught in fish nets during the USA Project, older age groups of some species (blueback herring, scup, winter flounder, windowpane flounder) use the waterbodies in spring, whereas the young-of-the-year of these species and others are abundant during summer. Detailed length-frequency distributions for individual species caught in relatively high numbers during NYCDEP's USA Project in 2000 through 2002 at Harbor-wide stations are shown in Appendix Exhibits B-7 through B-15.

Fish sampling in New York Harbor over the past 30 years has provided a database on species composition, relative abundance and seasonal movement patterns of fish that shows consistent patterns and trends. This database can be used to assess the potential for fish occurrence in Gowanus Canal. In addition, water-quality improvements over the past 30 years have made all of New York Harbor available for use by fish with the exception of isolated backwaters, or areas of limited water circulation and high organic loads. Until the reactivation of

Table 4-7. Fish Species of the East River/Upper New York Bay System

Species	Adults Only	Stage Adults and IP	IP Only	Adults and YOY		Species	Adults Only	Stage Adults and IP	IP Only	Adults and YOY
Alewife[1]	X					Orange Filefish	X			
American Eel		X				Oyster Toadfish	X			
American Goosefish	X					Pigfish	X			
American Sand Lance[3]		X				Pinfish	X			
American Shad	X					Pollack	X			
Atlantic Croaker	X					Rainbow Smelt	X			
Atlantic Herring[1]		X				Red Hake				X
Atlantic Mackerel	X					Rock Gunnel[3]		X		
Atlantic Menhaden[2,3,4]		X				Rough Silverside			X	
Atlantic Moonfish	X					Scrawled Cowfish	X			
Atlantic Needlefish	X					Scup[2,4]	X			
Atlantic Seasnail	X					Sea Horse	X			
Atlantic Silverside[1]	X					Seaboard Goby		X		
Atlantic Tomcod[1,)2				X		Silver Hake[2]		X		
Bay Anchovy[1,2,3,4]		X		X		Silver Perch	X			
Black Sea Bass		X				Smallmouth Flounder		X		
Blackcheek Tonguefish			X			Speckled Worm Eel	X			
Blueback Herring[1,2,4]				X		Spiny Dogfish	X			
Bluefish[4]	X					Spot			X	
Bluegill	X					Spotfin Butterflyfish	X			
Butterfish		X				Spotted Hake		X		
Conger Eel[1]	X					Striped Anchovy			X	
Crevalle Jack	X					Striped Bass[4]	X			
Cunner[3]		X				Striped Cusk-Eel		X		
Feather Blenny[2]	X					Summer Flounder[2,4]		X		
Fourbeard Rockling[2]		X				Tautog[2,3]		X		
Fourspine Stickleback	X					Threespine Stickleback	X			
Fourspot Flounder		X				Weakfish[2,4]		X		
Gray Snapper	X					White Catfish	X			
Goby Family[2,4]		X		X		White Perch	X			
Grubby[2]		X				Windowpane[2,3]		X		
Herring Family[3]		X				Winter Flounder[1,2,3,4]		X		X
Herring Family(3)		X								
Inshore Lizardfish	X									
Lined Seahorse	X									
Little Skate	X									
Longhorn Sculpin				X						
Lookdown	X									
Mummichog	X									
Naked Goby[3]				X						
Northern Kingfish	X									
Northern Pipefish[1,3]				X						
Northern Puffer				X						
Northern Searobin	X									
Northern Sennet	X									
Northern Stargazer				X						

[1] Most abundant species impinged at power plants
[2] Most abundant species of ichthyoplankton and/or Young-of-the-Year (YOY) entrained by power plants, or found in Sunset Energy ichthyoplankton samples
[3] Species found in 2001-2003 DEP ichthyoplankton samples
[4] Species most frequently caught by experimental gill nets and/or small otter trawls used in DEP sampling efforts.
Source: Sunset Energy Fleet (2002)

Table 4-8. Fish Species Collected by USA Project FSAPs
Ranked by Total Numbers Caught

Spring					Summer			
Taxa	Total No. Collected	Frequency	Average Length (mm)		Taxa	Total No. Collected	Frequency	Average Length (mm)
Winter Flounder	47	21/42	289		Weakfish	1239	49/138	74.9
Striped Bass	120	12/42	256.5		Bluefish	151	37/138	321.3
Atlantic Menhaden	82	9/42	301.1		Striped Bass	220	36/138	243.7
Atlantic Silverside	31	7/42	97.7		Atlantic Menhaden	233	33/138	325.4
Windowpane	16	6/42	279.6		Summer Flounder	36	26/138	345.9
Tautog	5	5/42	146		Bay Anchovy	564	25/138	37
Bay Anchovy	7	4/42	84.6		Winter Flounder	394	23/138	82.25
Scup	3	3/42	178.3		Scup	210	19/138	96.2
Northern Pipefish	6	3/42	145.7		Blueback Herring	246	15/138	36.46
Naked Goby	2	2/42	42.5		Butterfish	72	14/138	27.1
Blueback Herring	3	2/42	280		Cunner	20	9/138	59.7
Atlantic Herring	7	2/42	249.5		Striped Searobin	14	8/138	302.7
Menhaden	3	1/42	265.5		Spot	46	8/138	138.27
American Eel	1	1/42	600		Black Sea Bass	13	7/138	160.3
Black Sea Bass	1	1/42	78		Yellowfin Menhaden	30	7/138	344.3
Cunner	1	1/42	62.5		Atlantic Silverside	15	5/138	60.9
Spotted Hake	1	1/42	74		Northern Searobin	8	4/138	63.3
Small-Mouth Flounder	1	1/42	not recorded		Gizzard Shad	17	4/138	440.1
					American Eel	3	3/138	321
					Naked Goby	2	2/138	33
					Tautog	2	2/138	194
					Windowpane	2	2/138	68
					Smooth Dogfish	3	2/138	605.3
					Snailfishes	3	2/138	29.6
					Northern Pipefish	5	3/138	97.5
					Searobins	10	2/138	38.75
					Herrings	6	1/138	382.2
					Mummichog	2	1/138	40
					Spotted Hake	2	1/138	145
					Crevalle Jack	1	1/138	44
					Cusk	1	1/138	75
					Fawn Cusk-Eel	1	1/138	93
					Fourbear Rockling	1	1/138	210
					Leopard Searobin	1	1/138	48
					Leopard Toadfish	1	1/138	130
					Lookdown	1	1/138	55
					North American Searobins	1	1/138	36
					Northern Puffer	1	1/138	54
					Northern Stargazer	1	1/138	22
					Sand Tiger Shark	1	1/138	1448

Table 4-9. Top Ten Ichthyoplankton Stations Per Each of the Top Eight Species Collected in 2001 (Page 1 of 2)

Species	Location*	Eggs (Count/100m^3)		Location*	Larvae (Count/100m^3)
TAUTOGOLABRUS ADSPERSUS	UBAYI02	1787.18		HUCHI02	2.85
(Cunner)	KVNKI02	1771.81		UBAYI02	1.74
	EASTI01	1267.93		FLSHI01	1.68
	EASTI02	1114.23		NEWTI02	1.62
	MILLI02	867.22		BRNXI02	1.57
	HUCHI02	848.95		EASTI04	1.21
	EASTI03	686.66		EASTI03	1.18
	BRNXI01	646.00		HARLI01	0.79
	CONEI01	620.28		ARTHI02	0.64
	GOWCI01	602.39		KVNKI01	0.60
ANCHOA MITCHELLI	NOBAI01	5267.21		BRNXI02	45.04
(Bay Anchovy)	JAMBI02	2020.77		HUCHI02	41.16
	MILLI01	876.88		HUCHI01	36.98
	THURI01	580.50		FLSHI01	13.70
	RARII02	524.76		THURI01	12.91
	KVNKI01	489.46		EASTI04	11.71
	ARTHI02	446.17		HUDRI01	11.36
	MILLI02	380.84		HUDRI02	10.44
	CONEI01	303.50		FLSHI02	8.65
	JAMBI04	239.55		ALLYI01	6.22
CLUPEIDAE	JAMBI02	2976.74		ARTHI03	92.36
(Herrings)	ALLYI01	2694.20		ALLYI01	69.61
	MABAI01	955.57		ARTHI02	66.22
	FLSHI02	638.33		EASTI04	65.57
	ARTHI02	636.76		RARII01	52.48
	HUCHI02	614.27		MABAI01	40.83
	RARII01	539.24		ARTHI01	31.33
	EASTI04	521.83		BRNXI02	29.50
	RARII02	353.92		FLSHI02	24.70
	LBAYI01	302.82		LBAYI02	24.31
BREVOORTIA TYRANNUS	FLSHI01	4185.43		EASTI04	67.91
(Atlantic Menhaden)	ARTHI02	585.75		ARTHI03	54.08
	HUCHI02	486.09		HUDRI03	41.44
	JAMBI01	423.10		ARTHI02	37.85
	FLSHI02	333.10		LBAYI01	24.10
	ARTHI01	163.77		HUDRI01	23.94
	HUCHI01	114.47		ALLYI01	21.75
	HARLI01	74.34		BRNXI02	21.42
	HUDRI01	52.68		HUDRI02	18.12
	EASTI03	41.74		MABAI01	10.75

*Note: See Figure 4-6 for key to location codes.

Table 4-9. Top Ten Ichthyoplankton Stations Per Each of the Top Eight Species Collected in 2001 (Continued)

Species	Location*	Eggs (Count/100m^3)		Location*	Larvae (Count/100m^3)
TAUTOGA ONITIS	JAMBI03	460.84		EASTI03	3.09
(Tautog)	HUCHI02	427.69		JAMBI01	2.64
	MILLI01	384.29		EASTI04	1.82
	EASTI04	335.11		JAMBI05	1.38
	JAMBI04	291.92		KVNKI02	1.14
	RARII01	264.62		RARII01	0.62
	UBAYI02	233.72		UBAYI01	0.60
	JAMBI01	211.56		ALLYI01	0.59
	FLSHI01	193.40		MILLI01	0.57
	MILLI02	193.19		LBAYI02	0.54
SCOPHTHALMUS AQUOSUS	RARII01	667.36		LBAYI02	45.77
(Windowpane)	JAMBI04	521.70		ARTHI01	35.57
	JAMBI03	298.57		KVNKI02	28.53
	LOBEI01	247.91		LBAYI01	23.90
	JAMBI05	167.73		RARII01	21.00
	UBAYI02	153.04		JAMBI01	18.30
	LBAYI02	113.63		KVNKI01	14.19
	JAMBI01	112.74		**GOWCI01**	13.65
	CONEI01	99.56		EASTI04	11.98
	ARTHI03	92.63		UBAYI02	11.53
ENCHELYOPUS CIMBRIUS	BRNXI01	878.60		EASTI03	4.28
(Fourbeard Rockling)	WESTI01	547.71		BRNXI02	2.21
	ALLYI01	381.64		FLSHI02	1.98
	EASTI04	297.36		EASTI04	1.82
	BRNXI02	202.03		UBAYI02	1.74
	HUCHI02	177.47		HUCHI02	1.28
	MABAI01	152.27		FLSHI01	1.05
	EASTI03	73.31		LBAYI02	0.99
	HUCHI01	37.86		ARTHI01	0.60
	UBAYI01	37.39		ALLYI01	0.59
PSEUDOPLEURONECTES AMERICANUS	UBAYI01	27.742		RARII02	510.08
(Winter Flounder)	LBAYI01	13.130		RARII01	248.86
	NOBAI01	7.762		ARTHI02	162.09
	LOBEI01	2.254		UBAYI02	157.86
	GOWCI02	0.623		ARTHI03	154.87
	ARTHI01	0.482		LBAYI02	144.27
	JAMBI04	0.462		**GOWCI01**	103.11
				LBAYI01	96.20
				UBAYI01	89.53
				HEBAI01	89.42

*Note: See Figure 4-6 for key to location codes.

the Gowanus Canal Flushing Tunnel, the Canal was among these backwaters with poor water quality and inhibited fish use for extensive periods during the year.

Of the fish species found in the Harbor, many are migratory, seasonally transient or moving daily as part of their normal behavior in pursuit of food. This characteristic of the fish community will give many species at various life stages access to the Canal. However, the Canal has very limited physical habitat diversity and is not likely to support a diverse fish community. Many species may occur in the Canal as they pass through as part of their movement patterns, but few are likely to remain in substantial numbers. Because of its limited habitat and relatively small size, the Canal will not support a large resident fish population and will be dependent upon continuing recruitment from the Harbor. Among the species expected to provide angling opportunities include; striped bass, bluefish (particularly juveniles-snappers), weakfish (in years when abundant in the Harbor) and flounders. These species will utilize pelagic and open-water prey such as anchovy and silversides, which could be seasonally abundant in the Canal.

4.7 SENSITIVE AREAS

4.7.1 CSO Policy Requirements

Federal CSO Policy requires that the long-term CSO control plan give the highest priority to controlling overflows to sensitive areas. For such areas, the CSO Policy indicates the LTCP should: (a) prohibit new or significantly increased overflows; (b) eliminate or relocate overflows that discharge to sensitive areas if physically possible, economically achievable, and as protective as additional treatment, or provide a level of treatment for remaining overflows adequate to meet standards; and (c) provide assessments in each permit term based on changes in technology, economics, or other circumstances for those locations not eliminated or relocated (USEPA, 1995a). The policy defines sensitive areas as:

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

The last item in the list was derived from the policy statement that the final determination should be the prerogative of the NPDES Permitting Authority. The Natural Resources Division of the NYSDEC was consulted during development of the assessment approach, and provided additional sensitive areas for CSO abatement prioritization based on local environmental issues (Vogel, 2005). Their response listed the following: Jamaica Bay; Bird Conservation Areas; Hudson River Park; “important tributaries” such as the Bronx River in the Bronx, and Mill, Richmond, Old Place, and Main Creeks in Staten Island; the Raritan Bay shellfish harvest area; and waterbodies targeted for regional watershed management plans (Newtown Creek and Gowanus Canal).

4.7.2 Assessment

An assessment was performed to identify any areas within Gowanus Canal that may be candidates for consideration as sensitive areas. The assessment was limited to a review of relevant regulatory designations, publicly available information accessed through Freedom of Information Act (FOIA) requests, and direct communication with the permitting authority. The following reviews the CSO Control Policy's sensitive areas specifications in further detail and their applicability to long-term control planning for Gowanus Canal (summarized in Table 4-10):

- There are no Outstanding National Resource Waters, National Marine Sanctuaries, public drinking water intakes or their designated protection areas, or shellfish beds within Gowanus Canal.

- There are no threatened or endangered species or their designated critical habitat within Gowanus Canal. Freedom of Information Act letter requests were submitted to the New York Natural Heritage Foundation and the National Marine Fisheries Service, who are responsible for documenting the occurrence of threatened or endangered marine species. No reported occurrences of threatened or endangered species were documented within the Canal.

- Gowanus Canal is not designated by the State of New York for recreational uses. There are no primary contact recreation waters such as bathing beaches in the Canal.

Table 4-10. Sensitive Area Assessment for Gowanus Canal

Designation	Present
Outstanding National Resource Waters	No
National Marine Sanctuaries	No
Threatened or Endangered Species	No
Primary Contact Recreation	No
Public Water Supply Intake	No
Public Water Supply Protected Areas	No
Shellfish Bed	No
Areas Determined By NYSDEC	Yes

In its response to the NYCDEP's request to list additional sensitive areas, the NYSDEC included Gowanus Canal as a waterbody targeted for a regional watershed management plan. Designation of the Canal as a whole does not assist in prioritizing outfalls or evaluating alternatives to addressing CSO discharges within the waterbody itself. Therefore, prioritization of outfalls within the waterbody and the selection and implementation of control alternatives can be driven by those alternatives that most reasonably attain maximum benefit to water quality throughout Gowanus Canal. In accordance with the requirements of Federal CSO Policy for sensitive areas, this waterbody/watershed assessment and planning effort evaluated the elimination and reduction through other means of discharges to the waterbody. These evaluations are presented in Section 7.

The majority of riparian areas are zoned for industrial uses, and the lower portion of Gowanus Canal extends into the Sunset Park Significant Maritime and Industrial Area (SMIA). An SMIA is a designated area in which industrial or maritime activity is encouraged, such as waterborne and airborne cargo and passenger transportation, industrial activity, and municipal and public utility services. There are six such designated areas within the City of New York, selected due to favorable zoning, marine terminal and pier infrastructure, transportation potential, and existing concentrations of water-dependent and industrial activity. These designated uses imply an absence of sensitive areas. Working waterfront uses have locational requirements that make portions of the coastal zone especially valuable as industrial areas. This most likely precludes a future designation for primary contact recreational uses in the Canal due to the potential use conflict it would represent.

5.0 Waterbody Improvement Projects

New York City is served primarily by a combined sewer system. Approximately 70 percent of the City is comprised of combined sewers totaling 4,800 miles within the five boroughs. The sewer system drains some 200,000 acres and serves a population of approximately 8 million New Yorkers. Approximately 460 outfalls are permitted to discharge during wet weather through CSOs to the receiving waters of the New York Harbor. These discharges result in localized water-quality problems such as periodically high levels of coliform bacteria, nuisance levels of floatables, depressed dissolved oxygen, and, in some cases, sediment mounds and unpleasant odors.

The City of New York is committed to its role as an environmental steward of the New York Harbor and began addressing the issue of CSO discharges in the 1950s. To date, NYCDEP has spent or committed over $2.1 billion in its city-wide CSO abatement program. As a result of this and other ongoing programs, water quality has improved dramatically over the past 30 years (NYCDEP Harbor Survey Annual Reports). Implementation of many of these solutions within the current NYCDEP 10-year capital plan will continue that trend as NYCDEP continues to address CSO-related water quality issues through its City-Wide CSO Floatables program, pump-station and collection-system improvements, and the ongoing analysis and implementation of CSO abatement solutions. The following sections present the history of NYCDEP CSO abatement and describe the current and ongoing programs in detail. Sections 5.1 through 5.6 describe city-wide programs, while Sections 5.7 through 5.10 describe programs specific to Gowanus Canal.

5.1 CITY-WIDE CSO PROGRAMS PRIOR TO 1992

Early CSO assessment programs began in the 1950s and culminated with the Spring Creek Auxiliary WPCP, a 12 MG CSO retention tank constructed on a tributary to Jamaica Bay. Completed in 1972, this project was one of the first such facilities constructed in the United States. Shortly thereafter, New York City was designated by USEPA to conduct an Area-Wide Wastewater Management Plan authorized by Section 208 of the then recently enacted CWA. This plan, completed in 1979, identified a number of urban tributary waterways in need of CSO abatement throughout the City. During the period from mid-1970s through the mid-1980s, New York City's resources were devoted to the construction of wastewater treatment plant upgrades.

In 1983, NYCDEP re-invigorated its CSO facility-planning program in accordance with NYSDEC-issued SPDES permits for its wastewater treatment plants with a project in Flushing Bay and Creek. In 1985, a City-wide CSO Assessment was undertaken which assessed the existing CSO problem and established the framework for additional facility planning. From this program, the City was divided into eight areas, which together cover the entire harbor area. Four area-wide projects were developed (East River, Jamaica Bay, Inner Harbor and Outer Harbor) and four tributary project areas were defined (Flushing Bay, Paerdegat Basin, Newtown Creek, and the Jamaica tributaries). Detailed CSO Facility Planning Projects were conducted in each of these areas in the 1980s and early 1990s and resulted in a series of detailed plans.

In 1989, NYCDEP initiated the City-Wide Floatables Study in response to a series of medical waste and floating material wash-ups and resulting bathing beach closures in New York and New Jersey in the late 1980s. This comprehensive investigation determined that medical wastes were a small component making up the spectrum of material found in metropolitan area waters and beach wash-ups, and that the likely source of the medical wastes was illegal dumping. The study also found that, aside from natural materials and wood from decaying piers and vessels, the primary component of the floatable material is street litter in surface runoff that is discharged to area waters via CSOs and storm sewers. The Floatables Control Program is discussed in Section 5.4.

5.2 CITY-WIDE CSO ABATEMENT ORDER (1992, 1996, 2005)

In 1992, NYSDEC and NYCDEP entered into the original CSO Administrative Consent Order (1992 ACO). As a goal, the 1992 ACO required NYCDEP to develop and implement a CSO abatement program to effectively address the contravention of water quality standards for coliforms, dissolved oxygen, and floatables attributable to CSOs. The 1992 ACO contained compliance schedules for the planning, design and construction of the numerous CSO projects in the eight CSO planning areas. The 1992 ACO was modified in 1996 to add a program for catch basin cleaning, construction, and repair to further control floatables.

The Flushing Bay and Paerdegat Basin CSO Retention Tanks now under construction were included in the 1992 ACO. In addition, two parallel tracks were identified for CSO planning purposes. Track 1 addressed dissolved oxygen (aquatic life protection) and coliform bacteria (recreation) issues. Track 2 addressed floatables, settleable solids and other water use impairment issues. The 1992 ACO also provided for an Interim Floatables Containment Program to be implemented consisting of a booming and skimming program in confined tributaries, skimming in the open waters of the harbor, and an inventory of street catch basins where floatable materials enter the sewer systems.

In accordance with the 1992 ACO, NYCDEP continued to implement its work for CSO abatement through the facility-planning phase into the preliminary engineering phase. Work proceeded on the planning and design of eight CSO retention tanks located on confined and highly urbanized tributaries throughout the City. The CSO retention tanks at Flushing Bay and Paerdegat Basin proceeded to final design. The Interim Floatables Containment Program was fully developed and implemented. The Corona Avenue Vortex Facility pilot project for floatables and settleable solids control was designed and implemented. The City's 130,000 catch basins were inventoried and a re-hooding program for floatables containment was implemented and substantially completed. Reconstruction and re-hooding of the remaining basins (less than 2 percent as of 2007), will be completed by 2010.

For CSOs discharging to the open waters of the Inner and Outer Harbors areas, efforts were directed to the design of sewer system improvements and wastewater treatment plant modifications to increase the capture of combined sewage for processing at the plants. For the Jamaica Tributaries, efforts focused on correction of illegal connections to the sewer system and evaluation of sewer separation as control alternatives. For Coney Island Creek, attention was directed to corrections of illegal connections and other sewer system/pumping station improvements. These efforts and the combination of the preliminary engineering design phase work at six retention tank sites resulted in changes to some of the original CSO Facility Plans included in the 1992 ACO and the development of additional CSO Facility Plans in 1999. Table 5-1 presents the status of CSO projects currently under design or construction.

Table 5-1. CSO Projects Under Design or Construction

Planning Area	Project	Design Completion	Construction Completion
Alley Creek	Outfall & Sewer System Improvements	Mar2002	Dec 2006
	CSO Retention Facility	Dec 2005	Dec 2009
Outer Harbor	Regulator Improvements – Fixed Orifices	Apr 2005	Jul 2008
	Regulator Improvements – Automation	Nov 2006	Jun 2010
	Port Richmond Throttling Facility	Aug 2005	Dec 2008
Inner Harbor	Regulator Improvements – Fixed Orifices	Sep 2002	Apr 2006
	Regulator Improvements – Automation	Nov 2006	Jun 2010
	In-Line Storage	Nov 2006	Aug 2010
Paerdegat Basin	Influent Channel	Mar 1997	Feb 2002
	Foundations and Substructures	Aug 2001	Feb 2009
	Structures and Equipment	Nov 2004	May 2011
Flushing Bay	CS4-1 Reroute & Construct Effluent Channel	Sep 1994	Jun 1996
	CS4-2 Relocate Ball fields	Sep 1994	Aug 1995
	CS4-3 Storage Tank	Sep 1996	Aug 2001
	CS4-4 Mechanical Structures	Feb 2000	Dec 2004
	CS4-5 Tide Gates	Nov 1999	Apr 2002
	CD-8 Manual Sluice Gates	May 2003	Jun 2005
Jamaica Tributaries	Meadowmere & Warnerville DWO Abatement	May 2005	Mar 2009
	Expansion of Jamaica WPCP Wet Weather Capacity	Jun 2011	Jun 2015
	Destratification Facility	Dec 2007	Nov 2010
	Laurelton & Springfield Stormwater Buildout Drainage Plan	Jan 2008	
	Regulator Automation	Nov 2006	Jun 2010
Coney Island Creek	Avenue V Pumping Station Upgrade	Jan 2005	Apr 2011
	Avenue V Force Main	Sep 2006	Jun 2012
Newtown Creek	Aeration Zone I	Dec 2004	Dec 2008
	Aeration Zone II	Jun 2010	Jun 2014
	Relief Sewer/Regulator Modification	Jun 2009	Jun 2014
	Throttling Facility	Jun 2008	Dec 2012
	CSO Storage Facility	Nov 2014	Dec 2022
Westchester Creek	Phase 1 (Influent Sewers)	Jun 2010	Jun 2015
	CSO Storage Facility		Dec 2022
Bronx River	Floatables Control	Jul 2008	Jun 2012
Hutchinson River	Phase I of Storage Facility	Jun 2010	Jun 2015
	Future Phases		Dec 2023
Jamaica Bay	Spring Creek AWPCP Upgrade	Feb 2002	Apr 2007
	26th Ward Drainage Area Sewer Cleaning & Evaluation	Jun 2007	Jun 2010
	Hendrix Creek Dredging	Jun 2007	Jun 2010
	26th Ward Wet Weather Expansion	Jun 2010	Dec 2015

NYCDEP and NYSDEC negotiated a new Consent Order that was signed January 15, 2005 that supersedes the 1992 Order and its 1996 Modifications with the intent to bring all NYCDEP CSO-related matters into compliance with the provisions of the Clean Water Act and Environmental Conservation Law. The new Order, noticed by NYSDEC in September 2004, contains requirements to evaluate and implement CSO abatement strategies on an enforceable timetable for 18 waterbodies and, ultimately, for City-wide long-term CSO control in accordance with USEPA CSO Control Policy. NYCDEP and NYSDEC also entered into a separate Memorandum of Understanding to facilitate water quality standards reviews in accordance with the CSO Control Policy.

5.3 CITY-WIDE BEST MANAGEMENT PRACTICES (BMPs)

The SPDES permits for all 14 WPCP in New York City require the NYCDEP to report annually on the progress of 14 BMPs related to CSOs. The BMPs are equivalent to the NMCs required under the USEPA National Combined Sewer Overflow policy, which were developed by the USEPA to represent best management practices that would serve as technology based CSO controls. They were intended to be "determined on a best professional judgment basis by the NPDES permitting authority" and to be best available technology based controls that could be implemented within 2 years by permittees. USEPA developed two guidance manuals that embodied the underlying intent of the NMCs (USEPA 1995b, 1995c) for permit writers and municipalities, offering suggested language for SPDES permits and programmatic controls that may accomplish the goals of the NMCs.

A list of BMPs excerpted directly from the most recent SPDES permits follows, along with brief summaries of each BMP and their respective relationships to the federal NMCs. In general, the BMPs address operation and maintenance procedures, maximum use of existing systems and facilities, and related planning efforts to maximize capture of CSO and reduce contaminants in the combined sewer system, thereby reducing water quality impacts. Through the annual reports, which were initiated in 2004 for the reporting year 2003, NYCDEP provides brief descriptions of the City-wide programs and any notable WPCP drainage area specific projects that address each BMP (NYCDEP, 2004-2008).

5.3.1 CSO Maintenance and Inspection Program

This BMP addresses NMC 1 (Proper Operations and Maintenance of Combined Sewer Systems and Combined Sewer Overflow Outfalls) and NMC 9 (Monitoring to Characterize CSO Impacts and the Efficacy of CSO Controls). Through regularly scheduled inspection of the CSOs and the performance of required repair, cleaning, and maintenance, dry weather overflows and leakage can be prevented and maximization of flow to the WPCP can be ensured. Specific components of this BMP include:

- Inspection and maintenance of CSO tide gates;
- Telemetering of regulators;
- Reporting of regulator telemetry results;
- Recording and reporting of rain events that cause dry weather overflows; and
- NYSDEC review of inspection program reports.

NYCDEP reports on the status of the City-wide program components and highlights specific maintenance projects, such as the Enhanced Beach Protection Program, where additional inspections of infrastructure in proximity to sensitive beach areas were performed. Activities related to CSO Maintenance and Inspection that have occurred over the last few years in the Gowanus Canal sewershed are summarized in Table 5-2 (NYCDEP, 2004-2008).

Table 5-2. CSO Maintenance and Inspection Activity – Gowanus Sewershed, 2004-2007

Category	Description	Location	For Year	CSO BMP Annual Report Reference*
Tide gates	Maintenance, cleaning, &/or exercising of Red Hook drainage area tide gates	Regulators RH-2, RH-18, RH-18A	2007	2008, p. 4 - 5
Tide gates	Maintenance, cleaning, &/or exercising of Owls Head drainage area tide gates	Regulators OH-CSO-2, OH-3, OH-7A	2007	2008, p. 5-6
Tide gates	Maintenance, cleaning, &/or exercising of RH drainage area tide gates	Regulators RH-2, RH-18, and RH18-A	2006	2007, p. 4
Enhanced Beach Protection Program	Daily inspection of beach sensitive regulators and pumps between the months of June and August	Four in Owls Head and six in Red Hook	2005	2006, p. 2
Enhanced Beach Protection Program	Daily inspection of beach sensitive regulators and pumps between the months of June and August	Four in Owls Head and six in Red Hook	2004	2005, p. 2
*NYCDEP submits CSO BMP Annual Reports to NYSDEC on an annual basis. Dates indicate submission year.				

5.3.2 Maximum Use of Collection System for Storage

This BMP addresses NMC 2 (Maximum Use of the Collection System for Storage) and requires the performance of cleaning and flushing to remove and prevent solids deposition within the collection system as well as an evaluation of hydraulic capacity so that regulators and weirs can be adjusted to maximize the use of system capacity for CSO storage and thereby reduce the amount of overflow. NYCDEP provides general information describing the status of City-wide SCADA, regulators, tide gates, interceptors, and collection system cleaning in the BMP Annual Report.

In the Red Hook portion of the Gowanus Canal sewershed, the final design for an inflatable dam to induce in-line storage was completed in 2007. The inflatable dam would be located in the collection system, upstream of regulator RH-20. The procurement process for the inflatable dam construction was also completed in 2007, although construction was temporarily halted at the end of the year pending resolution of design-change issues related to unanticipated subsurface conditions.

Table 5-3 summarizes interceptor-cleaning activities performed in the Gowanus sewershed over the last several years, as reported in the associated CSO BMP Annual reports (NYCDEP, 2004-2008).

Table 5-3. CSO Maintenance and Inspection Activity – Gowanus Sewershed, 2003-2007

Category	Description	Location	For Year	CSO BMP Annual Report Reference*
Interceptor Cleaning	90 cy of grit/sediment removed	Owls Head South Branch Interceptor	2007	2008 p. 140
	10 cy of grit/sediment removed	2nd Avenue Pump Station (PS)	2007	2008, p. 141
	100 cy of grit/sediment removed	Owls Head WPCP	2007	2008, p. 141
	10 cy of grit/sediment removed	Nevins Street PS	2007	2008, p. 141
	130 cy of grit/sediment removed	Gowanus PS	2007	2008, p. 141

Table 5-3. CSO Maintenance and Inspection Activity – Gowanus Sewershed, 2003-2007

Category	Description	Location	For Year	CSO BMP Annual Report Reference*
Interceptor Cleaning	44 cy of grit/sediment removed	Regulator OH-007	2006	2007, p. 124
	20 cy of grit/sediment removed	2nd Avenue PS	2006	2007, p. 125
	60 cy of grit/sediment removed	Owls Head WPCP	2006	2007, p. 125
	60 cy of grit/sediment removed	Gowanus PS	2006	2007, p. 125
	10 cy of grit/sediment removed	Nevins Street PS	2006	2007, p.125
	30 cy of grit/sediment removed	Red Hook WPCP	2006	2007, p.126
Interceptor Cleaning	242 cy of grit/sediment removed	Gowanus PS	2005	2006, p. 88
	11 cy of grit/sediment removed	Owls Head WPCP	2005	2006, p. 88
	22 cy of grit/sediment removed	Nevins Street PS	2005	2006, p. 89
	22 cy of grit/sediment removed	2nd Avenue PS	2005	2006, p. 89
Interceptor Cleaning	22 cy of grit/sediment removed	19th Street PS	2004	2005, p. 35
	77 cy of grit/sediment removed	Nevins St & 2nd Ave PSs	2004	2005, p. 35
Interceptor Cleaning	10 cy of grit/sediment removed	Red Hook WPCP	2003	2004, p. 38
	10 cy of grit/sediment removed	Gowanus PS	2003	2004, p. 38
*NYCDEP submits CSO BMP Annual Reports to NYSDEC on an annual basis. Dates indicate year of submission.				

5.3.3 Maximize Flow to WPCP

This BMP addresses NMC 4 (Maximizing Flow to the Publicly Owned Treatment Works) and reiterates the WPCP operating targets established by the SPDES permits with regard to the ability of the WPCP to receive and treat minimum flows during wet weather. The collection systems are required to deliver and the WPCPs are required to accept the following flows for the associated levels of treatment:

- Receipt of flow through the headworks of the WPCP: 2xDDWF;
- Primary treatment capacity: 2xDDWF; and
- Secondary treatment capacity: 1.5xDDWF.

The BMP also refers to the establishment of collection system control points in the system's Wet Weather Operating Plan as required in BMP #4, and requires the creation of a capital compliance schedule within six months of the NYSDEC approval of the Wet Weather Operating Plan should any physical limitations in flow delivery be detected.

In addition to describing WPCP upgrades and efforts underway to ensure appropriate flows to all 14 WPCPs, the BMP Annual Report provides analysis of the largest ten storms of the year and WPCP flow results for each of these storms. This analysis provides an indication of how much flow the WPCPs take during periods with sufficient rainfall that flows should attain twice design dry-weather flow at the WPCP. For the two WPCPs associated with the Gowanus Canal sewershed (i.e., Red Hook and Owls Head), wet-weather inflows during the top-ten storms have generally increased or remained relatively steady since 2003, as described in NYCDEP's CSO BMP Annual Reports for calendar years 2003 (p. 133) and 2007 (p.150), (NYCDEP, 2004-2008).

5.3.4 Wet-Weather Operating Plan

In order to maximize treatment during wet weather events, WWOPs are required for each WPCP drainage area. Each WWOP should be written in accordance with the NYSDEC publication entitled *Wet Weather Operations and Wet Weather Operating Plan Development for Wastewater Treatment Plants*, and should contain the following components:

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

This BMP addresses NMC 1 (Proper Operations and Maintenance of Combined Sewer Systems and Combined Sewer Overflow Outfalls) and NMC 4 (Maximizing Flow to the Publicly Owned Treatment Works). The NYCDEP provides a schedule of plan submittal dates as part of the BMP Annual Report. The Red Hook and Owls Head WPCP WWOPs were submitted in April 2005 and December 2007, respectively (CSO BMP Annual Reports for calendar year 2007, p. 152).

5.3.5 Prohibition of Dry-Weather Overflow

This BMP addresses NMC 5 (Elimination of CSOs During Dry Weather) and NMC 9 (Monitoring to Characterize CSO Impacts and the Efficacy of CSO Controls) and requires that any dry weather flow event be promptly abated and reported to NYSDEC within 24 hours. A written report must follow within 14 days and contain information per SPDES permit requirements. The status of the shoreline survey, the Dry Weather Discharge Investigation report, and a summary of the total bypasses from the treatment and collection system are provided in the BMP Annual Report.

As of December 31, 2007, the most recent shoreline survey report covering the Owls Head WPCP drainage area shoreline, among five other WPCP drainage areas, was completed and a report of the survey results was submitted to the NYSDEC in April 2008. The next shoreline survey report is due to NYSDEC in April 2013 per the SPDES permit requirement to complete a survey of at least fifty percent of the City's shoreline every five years (CSO BMP Annual Reports for calendar year 2007, p. 24).

5.3.6 Industrial Pretreatment

This BMP addresses three NMCs: No. 3 (Review and Modification of Pretreatment Requirements to Determine Whether Nondomestic Sources are Contributing to CSO Impacts); No. 7 (Pollution Prevention Programs to Reduce Contaminants in CSOs); and No. 9 (Monitoring to Characterize CSO Impacts and the Efficacy of CSO Controls). By regulating the discharges of toxic pollutants from unregulated, relocated, or new SIUs tributary to CSOs, this BMP addresses the maximization of persistent toxics treatment from industrial sources upstream of CSOs. Specific components of this BMP include:

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

The BMP Annual Report addresses the components of the industrial pretreatment BMP through a description of the City-wide program. The program has been successful, especially in the reduction of metals being discharged by industrial users of the municipal sewer system. Recent improvements to the Industrial Pretreatment Program have included a requirement in new and renewal permits that significant industrial users hold their process wastewater and non-contact cooling water to the maximum extent practicable during heavy rain events.

5.3.7 Control of Floatable and Settleable Solids

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

- Catch Basin Repair and Maintenance: This practice includes inspection and maintenance schedules to ensure proper operation of basins;
- Catch Basin Retrofitting: By upgrading basins with obsolete designs to contemporary designs with appropriate street litter capture capability, this program is intended to increase the control of floatable and settleable solids, City-wide;
- Booming, Skimming and Netting: This practice establishes the implementation of floatables containment systems within the receiving waterbody associated with applicable CSO outfalls. Requirements for system inspection, service, and maintenance are established, as well; and
- Institutional, Regulatory, and Public Education - A one-time report must be submitted examining the institutional, regulatory, and public education programs in place City-wide to reduce the generation of floatable litter. The report must also include recommendations for alternative City programs and an implementation schedule that will reduce the water quality impacts of street and toilet litter.

The annual report provides summary information regarding the status of the catch basin and booming, skimming, and netting programs City-wide, as well as updates regarding components of the institutional, regulatory, and public education programs conducted by the City.

Table 5-4. Catch Basins Reconstructed in the Vicinity of the Gowanus Canal, 2003-2007

WPCP	2003	2004	2005	2006	2007
Owls Head	215	192	173	134	116
Red Hook	61	59	49	45	42
					2007, p. 174

Table 5-5. Catch Basins Hooded in the Vicinity of the Gowanus Canal, 2003-2007

WPCP	2003	2004	2005	2006	2007
Owls Head	198	335	233	370	108
Red Hook	156	38	99	66	143
	2003, p. 57	2004, p. 54	2005, p. 121	2006, p. 155	2007, p. 172

As part of its floatables plan, the NYCDEP maintains a floatables boom near the head of Gowanus Canal. The NYCDEP has the boom inspected and serviced after significant rainstorms. Table 5-6 summarizes the quantity of floatables retrieved from the Gowanus boom from 2003 through 2007. As part of its service contract, the NYCDEP regularly maintains the floatables containment booms and netting facilities. Beyond regular maintenance inspections and minor repairs over the course of the past several years, the Gowanus boom was replaced in 2007 with a new updated boom. The new boom has a submerged, weighted skirt to help prevent floatables from escaping underneath, as described in the CSO BMP Annual Report for calendar year 2007 (p. 178).

Table 5-6. Tons of Floatable Material Retrieved From Gowanus Floatables Boom, 2003-2007

Site	2003	2004	2005	2006	2007
Gowanus Canal	5	2	3	0	3.25
Owls Head	0	0	0	0	40
	2003, p. 61	2004, p. 58	2005, p. 125	2006, p. 159	2007, p. 176

With regard to institutional, regulatory, and public education programs, the NYCDEP has conducted educational outreach at a number of Gowanus-area schools and events (see Table 5-7).

Table 5-7. NYCDEP Outreach Events at Gowanus-Area Schools and Other Events, 2005-2007

Year	In-School Events	Other Events
2007	8	18
2006	4	30
2005	1	34

5.3.8 Combined Sewer System Replacement

This BMP addresses NMC 1 (Proper Operations and Maintenance of Combined Sewer Systems and Combined Sewer Overflow Outfalls), requiring all combined sewer replacements to be approved by the New York State Department of Health (NYSDOH) and to be specified within the NYCDEP Master Plan for Sewage and Drainage. Whenever possible, separate sanitary and storm sewers should be used to replace combined sewers. The BMP Annual Report describes the general, City-wide plan and addresses specific projects occurring in the reporting year.

5.3.9 Combined Sewer/Extension

In order to minimize storm water entering the combined sewer system, this BMP requires combined sewer extensions to be accomplished using separate sewers whenever possible. If separate sewers must be extended from combined sewers, analysis must occur to ensure that the sewage system and treatment plant are able to convey and treat the increased dry weather flows with minimal impact on receiving water quality.

This BMP addresses NMC 1 (Proper Operations and Maintenance of Combined Sewer Systems and Combined Sewer Overflow Outfalls) and a brief status report is provided in each BMP Annual Report, including specific projects occurring in the reporting year.

5.3.10 Sewer Connection & Extension Prohibitions

This BMP addresses NMC 1 (Proper Operations and Maintenance of Combined Sewer Systems and Combined Sewer Overflow Outfalls) and prohibits sewer connections and extensions that would exacerbate recurrent instances of either sewer back-up or manhole overflows. Wastewater connections to the combined sewer system downstream of the last regulator or diversion chamber are also prohibited. The BMP Annual Report contains a brief status report for this BMP and provides details pertaining to chronic sewer back-up and manhole overflow notifications submitted to NYSDEC when necessary.

5.3.11 Septage and Hauled Waste

The discharge or release of septage or hauled waste upstream of a CSO (i.e., scavenger waste) is prohibited under this BMP. Scavenger wastes may only be discharged at designated manholes that never drain into a CSO, and only with a valid permit. This BMP addresses NMC 1 (Proper Operations and Maintenance of Combined Sewer Systems and Combined Sewer Overflow Outfalls). The BMP Annual Report summarizes the three scavenger waste acceptance facilities controlled by NYCDEP, all of which are downstream of CSO regulators, and the regulations governing discharge of such material at the facilities.

5.3.12 Control of Runoff

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

The BMP Annual Report refers to the NYCDEP permit regulations required of new development and sewer connections.

5.3.13 Public Notification

This BMP requires easy-to-read identification signage to be placed at or near CSO outfalls with contact information for NYCDEP to allow the public to report observed dry weather overflows. All signage information and appearance must comply with the Discharge Notification Requirements listed in the SPDES permit. This BMP also requires that a system be in place to determine the nature and duration of an overflow event, and that potential users of the receiving waters are notified of any resulting, potentially harmful conditions. The BMP does allow New York City Department of Health and Mental Hygiene (NYCDHMH) to implement and manage the notification program.

BMP # 13 addresses NMC 8 (Public Notification) as well as NMC 1 (Proper Operations and Maintenance of Combined Sewer Systems and Combined Sewer Overflow Outfalls) and NMC 9 (Monitoring to Characterize CSO Impacts and the Efficacy of CSO Controls). NYCDEP provides the status of the CSO signage program in the BMP Annual Report and lists those former CSO outfalls that no longer require signs. NYCDEP is currently developing improvements to the CSO signs to increase their visibility and to include information relative to wet-weather warnings as required by the EPA CSO Policy. In addition, descriptions of new educational signage and public education-related partnerships are described. The New York City Department of Health CSO public notification program is also summarized.

5.3.14 Annual Report

This BMP requires an annual report summarizing implementation of the BMPs, including lists of all existing documentation of implementation of the BMPs, be submitted by April 1st of each year. This BMP addresses all nine minimum controls. As of August 2008, the most recent BMP Annual Report submitted was for calendar year 2007.

5.4 CITY-WIDE CSO PLAN FOR FLOATABLES ABATEMENT

In the late 1980s, New York City initiated the City-Wide Floatables Study, a multi-year investigation of floatables in New York Harbor (HydroQual, 1993, 1995). In addition to examining floatables characteristics, this study investigated potential sources of floatables, floatables circulation and beach-deposition patterns throughout the Harbor, and potential structural and non-structural alternatives for floatables control. Findings of the study showed that the primary source of floatables (other than natural sources) in the Harbor was urban street litter carried into waterways along with rainfall runoff.

NYCDEP developed a floatables abatement plan (Floatables Plan) for the CSO areas of New York City in June 1997 (HydroQual, 1997). The Floatables Plan was updated in 2005 (HydroQual, 2005b, 2005c) to reflect the completion of some proposed action elements and the addition of a monitoring program, as well as changes appurtenant to SPDES permits and modifications of regional Waterbody/Watershed Facility Plans and CSO Facility Plans. The NYSDEC approved the updated Floatables Plan on March 17, 2006.

The objectives of the Floatables Plan are to provide substantial control of floatables discharges from CSOs throughout the City and to provide for compliance with appropriate NYSDEC and IEC requirements pertaining to floatables. The City-Wide CSO Floatables Plan consists of the following action elements:

- Monitor street litter levels City-wide and inform the Department of Sanitation of New York (DSNY) and/or the New York City Mayor's Office of Operations when changes in litter levels at or in City policies would potentially result in increased discharges of CSO floatables.
- Continue the three-year cycle to inspect catch basins City-wide for missing hoods and to replace missing hoods to prevent floatables from entering the sewer system. In addition, proceed with the retrofit, repair, or reconstruction of catch basins requiring extensive repairs or reconstruction to accommodate a hood;
- Maximize collection system storage and capacity;
- Maximize wet-weather flow capture at WPCPs;
- Capture floatables at wet-weather CSO storage/treatment facilities;
- Capture floatables at end-of-pipe and in-water facilities, including the Interim Floatables Containment Program (IFCP);
- Continue the Illegal Dumping Notification Program (IDNP) in which NYCDEP field personnel report any observed evidence of illegal shoreline dumping to the Sanitation Police section of DSNY, who have the authority to arrest dumpers who, if convicted, are responsible for proper disposal of the material;
- Engage in public outreach programs to increase public awareness of the consequences of littering and the importance of conserving water;
- As new floatables-control technologies emerge, continue to investigate their applicability, performance and cost-effectiveness in New York City;
- Provide support to NYSDEC to review and revise water quality standards to provide for achievable goals; and
- Develop a floatables-monitoring program to track floatables levels in the Harbor and inform decisions to address both short- and long-term floatables-control requirements.

Overall, implementation of the Floatables Plan is expected to control roughly 96 percent of the floatable litter generated in New York City. The Floatables Plan is a living program that will undergo various changes over time in response to ongoing assessment of the program itself, as well as changing facility plans associated with other ongoing programs. A key component of the Floatables Plan is self- assessment, including a new Floatables-Monitoring Program to evaluate the effectiveness of Plan elements and to provide for actions to address both short- and long- term floatables-control requirements (see Section 8.5.3). Evidence of increasing floatables levels that impede uses could require the addition of new floatables controls, expansion of BMPs, and modifications of Waterbody/Watershed Facility Plans and/or drainage-basin specific LTCPs, as appropriate.

5.4.1 Pilot Floatables Monitoring Program

In late 2006, work commenced to develop the Floatables-Monitoring Program to track floatables levels in New York Harbor (HydroQual, 2007a). This pilot work, which was performed to develop a monitoring procedure and an associated visual floatables rating system based on a five-point scale (very poor, poor, fair, good, very good), involved observations at a number of different sites. At each site, observations were made for up to three categories: on the shoreline, in the water near the shoreline; and in the water away from the shoreline.

Among the various pilot program sites were two locations in the Gowanus Canal area: one near the head at the Union Street Bridge (Harbor Survey station GC3), and the other near the mouth off the Columbia Street pier (Harbor Survey station G2). By August of 2007, a total of 68 observations were recorded at these two locations—all made for the water, due to the bulkheaded nature of the shoreline in these areas. Although the scores were preliminary, it is useful to note that observations at the G2 location were consistently "good" or "very good" (37 of 38 observations, or 97 percent). Observations at the GC3 location were more variable, with 21 of 30 (70 percent) recorded as "good" or "very good." Station GC3 was less likely to exhibit "good" or better scores than most of the other locations where the pilot floatables work was performed.

5.4.2 Shoreline Cleanup Pilot Program

The NYCDEP will be conducting a pilot program using Environmental Benefit Program funds to clean up shorelines at locations where floatables are known to accumulate due to CSO overflows as well as careless behaviors and illegal dumping. NYCDEP's existing floatables-collection program only addresses CSO and storm outfalls having boom and netting containment facilities. This project will address CSO and storm outfall locations that do not have containment facilities and, based upon inspection, warrant a manual cleanup effort to remove near-shore floatables and trash on an as-needed basis throughout the year. NYCDEP has identified several specific areas as examples of areas that may benefit from these efforts, such as:

- Coney Island Creek, Brooklyn
- Kaiser Park, Brooklyn
- Sheepshead Bay, Brooklyn
- Cryders Land, Queens
- Flushing Bay, Queens.
- Owls Head, Brooklyn

These cleanup efforts will consist of the following methods:

- Mechanical Cleanup: Where debris is caught up in riprap on the shoreline, a high-pressure pump will be used to spray water onto the shoreline to dislodge and flush debris and floatables from the riprap back into the water. A containment boom placed in the water around the site will allow a skimmer vessel to collect the material for proper disposal.

- Workboat-Assisted Cleanup: At a few locations where the shoreline is not readily accessible from the land side, a small work boat with an operator and two crew members will collect debris by hand or with nets and other tools. The debris will be placed onto the work boat for transport to a skimmer vessel for proper disposal.

- Manual Cleanup: At some locations, simply raking and hand cleaning will provide the most efficient clean up method. Debris will be removed and placed into plastic garbage bags or containers, then loaded onto a pick up truck for proper disposal.

DEP is currently planning to perform three cleanups each year for a four-year period at each of the above locations. Pending the outcome of this program, as well as the findings of the Floatables Monitoring Program, NYCDEP will evaluate how to proceed in the future.

5.5 CITY-WIDE USE AND STANDARDS ATTAINMENT (USA) PROJECT

In recognition of the fact that approved levels of CSO abatement in the 1992 CSO Consent Order would not always provide for the attainment of water quality standards, NYCDEP initiated the USA Project in 1999 to bring the engineering program into compliance with the regulatory requirements of the CSO Control Policy and the subsequent 2001 Guidance. The USA project was designed to follow the step-by-step process outlined in the CSO Control Policy for the development of CSO abatement projects that includes water quality analysis, facility planning, water quality standards compliance determination, water quality standards review and revision as appropriate, and public outreach. The USA Project used the USEPA Watershed Approach Framework to investigate all causes of water use impairments, not just CSOs. The goals of the USA Project were to examine desired and attainable water uses with stakeholder involvement, reconcile water quality standards with realistically attainable uses given the site specific constraints, implement the water quality standards review process, and serve as the technical basis for waterbody specific Use Attainment Evaluations (UAE), as appropriate.

The NYCDEP employed a comprehensive watershed-based approach for evaluating waterbody uses in Gowanus Canal. This watershed-based approach examined designated and beneficial uses, water quality standards, and compliance with the standards in waterbodies where these standards may not be met following completion of facility plans. The waterbody/watershed assessment integrated stakeholder and agency participation, mathematical modeling, engineering analyses, and biological assessments to evaluate impacts on aquatic life, aesthetics, recreational uses, and riparian uses in, on and adjacent to the Canal. The use evaluation followed USEPA guidance for long-term CSO control planning, TMDL development, use UAAs, and other similar assessments.

Federal UAA guidance (USEPA, 1994a) states that "Waterbody surveys and assessments conducted by the States should be sufficiently detailed to answer the following questions: 1) What are the aquatic use(s) currently being achieved in the waterbody? 2) What are the causes of any impairment of the aquatic uses? and 3) What are the aquatic use(s) that can be attained based on the physical, chemical, and biological characteristics of the waterbody?" Considerations and methods for conducting a UAA are described in USEPA guidance (USEPA, 1983 & 1986a) and other literature (Novotny, 1997). USEPA has summarized examples of UAA findings as case studies in other guidance (USEPA, 1994a). Physical, chemical and biological factors affecting use attainment were assessed in a manner consistent with the guidance and based on information gathered from previous and ongoing programs, projects, and studies that are relevant to Gowanus Canal, as described in Section 2.

The employed assessment methodology evaluated physical, chemical, and biological conditions in Gowanus Canal. Evaluations were based on data collection efforts as well as mathematical modeling comparing projections at Baseline conditions to projections reflecting implementation of various CSO abatement scenarios, such as sewer separation and 100 percent CSO abatement. Factors impeding attainment of aquatic life, recreational, and aesthetic uses consistent with the Clean Water Act were identified and analyzed. The use evaluation identified use impediments and reasonably attainable uses for the Canal.

The product of the USA Project for Gowanus Canal was to be a Water Quality Improvement Plan; however, before that Plan was finalized, the 2004 CSO Consent Order was signed, requiring an approvable Waterbody/Watershed Facility Plan for Gowanus Canal and launching the LTCP Project. The NYCDEP determined that the Gowanus Canal Water Quality Improvement Plan being developed under the USA Project would be updated under the LTCP Project as an approvable Waterbody/Watershed Facility Plan.

5.6 CITY-WIDE CSO Long-Term Control Plan (LTCP) PROJECT

In June 2004, NYCDEP authorized the LTCP Project. This work integrates all Track I and Track II CSO Facility Planning Projects and the Comprehensive City-wide Floatables Abatement Plan, incorporates on-going USA Project work in the remaining waterbodies, and develops Watershed/Waterbody Facility Plan reports and the LTCP for each waterbody area. The LTCP Project monitors and assures compliance with applicable Administrative Consent Orders. This document is a work product of the LTCP Project.

5.7 GOWANUS CANAL 201 FACILITIES PLAN (1982)

Gowanus Canal was identified during New York City's 1978 City-Wide 208 Water Quality Study as requiring additional study (Hazen and Sawyer, 1983). In April 1982, the NYCDEP applied for and received a revised 201 Facilities Plan grant for the Gowanus Pump Station that included a water quality study of Gowanus Canal and Bay, a pump station and force main study, and public participation. The goals of NYCDEP's Gowanus Canal 201 Facilities Plan (201 Facilities Plan) was to address engineering of the Gowanus Pump Station and force main and water quality problems in Gowanus Canal. Selected elements of the 201 Facilities Plan were as follows:

1. Upgrading NYCDEP's Douglas Street facilities, including the Gowanus Pump Station and tide gate chamber, power house and gate house;

2. Making basic improvements to the Canal including rehabilitation of the Bond-Lorraine Sewer, elimination of dry weather overflows, spot dredging and cleaning of the turning basins and other areas of the Canal;

3. Rehabilitating and reactivating the Gowanus Canal Flushing Tunnel, including cleaning, installing a force main to convey sewage to the Columbia Street Interceptor, and installing a new Flushing Tunnel pumping system;

4. Implementation of a two-year monitoring program to determine dissolved oxygen levels and sediment oxygen demand in the Canal following reactivation of the Flushing Tunnel; and,

5. If necessary, dredging the entire Canal to 13 feet MLW as a future action.

Mathematical modeling of Gowanus Canal was performed during planning. Implementation of the above actions was predicted to achieve dissolved oxygen concentrations of 3.0 mg/L or above in the Canal, thus meeting water quality standards of the Canal's Class SD designation.

Several elements of the 201 Facilities Plan were completed. These elements included improving operations at the Gowanus Pump Station, installing a 33-inch inner diameter (ID) high-density polyethylene (HDPE) force main through the Gowanus Canal Flushing Tunnel to convey sewage to the Columbia Street Interceptor, and eliminating dry weather overflows. However, this force main experienced repeated failures since its installation in February 1989 and is no longer operational. The Gowanus Pump Station currently pumps to the Bond-Lorraine Sewer, where it was originally designed to pump when it was first constructed.

5.8 INNER HARBOR CSO FACILITY PLAN (1993)

The Inner Harbor CSO Facility Plan (Hazen and Sawyer, 1993) focused on quantifying and assessing the impacts of CSO discharges to the lower portions of the Hudson and East Rivers, Upper New York Bay, and Gowanus Bay and Canal. The project's study area included all of the North River, Newtown Creek and Red Hook WPCP service areas, which together comprise over 160 CSOs. Field investigations and mathematical modeling were conducted for receiving waters and their watersheds. Engineering alternatives for abating CSO discharges were evaluated and recommendations were made for improving receiving water quality.

Water quality and engineering assessments concluded that the flushing and dispersive abilities of the Hudson River, East River and Upper New York Bay minimized the effects of CSOs on water quality for these areas. CSOs were not found to be a major component of water quality impairments. However, due to the dead-end configuration of Gowanus Canal and its limited flushing ability, CSOs greatly influenced water quality conditions in the Canal. In 1993, the Inner Harbor CSO Facility Plan was finalized and recommended the following system-wide actions: regulator improvements, maximizing wet weather flow to WPCPs, inducing in-line storage, reactivating the Gowanus Canal Flushing Tunnel, and dredging Gowanus Canal (Hazen and Sawyer, 1993). The plan was submitted to the NYSDEC and accepted.

The Inner Harbor CSO Facility Plan was subsequently modified by the NYCDEP and detailed in a report submitted to the NYSDEC in April 2003 (NYCDEP, 2003). The revised plan and modified schedule was approved by NYSDEC in May 2003. Additional revisions to the modified CSO facility plan were submitted to NYSDEC in February 2004. No modifications were made to elements of the plan influencing Gowanus Canal water quality. The following describes the current Inner Harbor CSO Facility Plan, its implementation schedule, projected water quality improvements and benefits, and projected compliance with water quality standards related to Gowanus Canal.

5.8.1 Facility Design and Implementation Schedule

The original Inner Harbor CSO Facility Plan was organized as a three-phase plan for open waters, along with a rehabilitation strategy for Gowanus Canal. The open waters plan included regulator improvements, new throttling facilities to maximize the wet weather flows to the WPCPs, and in-line storage to increase CSO capture. For Gowanus Canal, the plan included reactivation of the Gowanus Canal Flushing Tunnel to improve dissolved oxygen levels and dredging of the Canal to remove accumulated sediments. The basic elements of the original plan remained the same; however, details of their components were changed by the 2003 modification.

Phase I of the Inner Harbor CSO Facility Plan is addressing regulator improvements and a total of 123 regulators are being improved throughout the Inner Harbor planning area. The NYCDEP will automate regulators at 29 locations under the NYCDEP's City-Wide SCADA Project and convert 72 other regulators from mechanical to more efficient fixed orifices. The construction contract for the conversion of the 72 mechanical regulators was awarded in February of 2003 and construction is underway at the time of the writing of this report. In addition, 22 other regulators have been converted to fixed orifices under the NYSDOT Route 9A Project.

Phase II of the Inner Harbor CSO Facility Plan is for maximizing wet weather flow to WPCPs by design and construction of throttling facilities. This will maximize the use of available in-line storage, reduce CSOs, and consolidate CSO discharges to fewer locations. Throttling facilities were recommended in the original facility plan at the North River, Newtown Creek, and Red Hook WPCPs, and the Manhattan Pumping Station. Throttling facilities, consisting of independent automatic gates located upstream of WPCP forebays, were intended to reduce WPCP operational problems and maximize wet weather flows. By constructing throttling facilities, harmful effects of using existing WPCP inlet gates to control wet weather flows would be eliminated. Operating throttling facilities would enable interceptor storage capacities to be fully utilized and WPCP flows to be maximized by back-flooding the interceptor system. The Red Hook WPCP has a manually operated throttling gate that was installed during construction of the secondary processes. The modified plan includes constructing new throttling facilities at the Manhattan Pump Station and the Newtown Creek WPCP and developing a WWOP for the North River WPCP. At the time of the writing of this report, the final design of the Manhattan Pump Station throttling facility was approximately 90 percent complete, and the Newtown Creek WPCP throttling facilities were designed and the contract for its construction was awarded.

Phase III of the Inner Harbor CSO Facility Plan is for inducing in-line storage to increase CSO capture. It was originally planned to be accomplished by either raising weir elevations in diversion chambers or by installing inflatable dams within combined sewers. The original facility plan recommended weir raising due to their lower costs and maintenance. However, the plan was modified from raising weirs to installing inflatable dams due to flooding concerns. Inflatable dams, while more expensive and complicated to construct and maintain, have a built-in system that allows the dams to deflate when water levels rise beyond a pre-set level. The modified facility plan includes installation of two inflatable dams: one for Regulator B-6 in the Newtown Creek WPCP-Brooklyn service area, which will store up to 2.0 MG; and, one for Regulator R-20 in the Red Hook WPCP service area that will have the capacity to store up to 2.2 MG. The NYCDEP's Hunts Point in-line storage demonstration study and detailed hydraulic calculations of sewer system response have been reviewed by the NYCDEP Bureau of Water and Sewer Operations. In accordance with the 2005 Administrative Consent Order, final design of Phase III was initiated in July 2005 and is scheduled to be complete by November 2006.

The original and modified Inner Harbor CSO Facility Plan included three elements for rehabilitating conditions in Gowanus Canal, all of which were approved by the NYSDEC. These elements were as follows:

1. Reactivate the Gowanus Canal Flushing Tunnel to improve dissolved oxygen conditions and bring the Canal into compliance with its NYSDEC designated classification (Class SD);

2. Raise overflow weirs at two relief points along the 3rd Avenue Sewer to direct more CSO toward downstream regulators; and,

3. Dredge Gowanus Canal to historical navigation depths of 7 feet below MLW at the head end and to 12 feet below MLW at Hamilton Avenue to remove accumulated sediments.

The NYCDEP commenced construction activities in 1994 for restoring the Gowanus Canal Flushing Tunnel to operation. Approximately 1,200 cubic yards of sediment was dredged from the inlet and outlet structure of the Flushing Tunnel including a portion of the head end of the Canal. A new pumping system was installed including a specially designed seven-foot diameter propeller to pump water from Buttermilk Channel in the Upper New York Bay to the Canal at Douglass Street. The pumping system is powered by a 600 horsepower motor. The Flushing Tunnel was reactivated on March 5, 1999. The Flushing Tunnel currently conveys an average 154 MGD of Upper New York Bay water to Gowanus Canal. A detailed map of the Gowanus Canal Flushing Tunnel is shown on Figure 5-1.

The NYCDEP has continued engineering evaluations and planning activities for implementing the second Gowanus Canal element of the Inner Harbor CSO Facility Plan. To further minimize the frequency and duration of overflows to Gowanus Canal, the facility plan recommended raising two relief weirs in the 3rd Avenue Sewer. Raising the overflow weirs at these locations was projected to reduce CSO discharges to Gowanus Canal and Bay, maximize flow capacity in the sewer system, and direct more CSO to downstream regulators. However, subsequent hydraulic analyses determined that the increased flooding potential associated with raising the weirs at these two locations precludes the implementation of this alternative.

The third Gowanus Canal element of the Inner Harbor CSO Facility Plan recommended dredging the Canal. This recommendation was made in the Gowanus Canal 201 Facilities Plan in 1983 and was revised in the Inner Harbor CSO Facility Plan with updated dredge quantities. Dredging was recommended at the following locations:

1. <u>Head</u> - In addition to dredging the outlet of the Flushing Tunnel, dredging of sediment deposits from the head to a distance 500 feet downstream at a depth of 7 feet below MLW to remove accumulated sediments and to restore the Canal to navigational depths. A total of 13,000 cubic yards (yd^3) of sediment was estimated to be removed from this area.

2. <u>4th Street Basin</u> - Remove large deposits of sediment in the mouth of the basin exposed at low tide for a distance of 200 feet to a depth of 10 feet below MLW. A total of 7,600 yd^3 of sediment was estimated to be removed from this area.

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Gowanus Canal Flushing Tunnel Route

3. 11th Street Basin - A clearing operation should be conducted to improve aesthetics that could be accomplished using barges moored in the Canal. No sediment would be removed.

4. Other Areas - Remove sediment deposits just upstream of Hamilton Avenue and just downstream of the 4th Street Basin, for a total distance of approximately 950 feet, and to a depth of 12 feet below MLW to restore the navigational depth of the Canal. A total of 6,000 yd^3 of sediment was estimated to be removed from these areas.

The dredging recommendations of the Inner Harbor CSO Facility Plan amounted to a total removal of 26,600 yd^3 of sediment from multiple segments totaling about 1,700 linear feet in Gowanus Canal. The facility plan report advised that the poor conditions of bulkheads would potentially make dredging problematic; dredging sediments may remove structural support of deteriorated bulkheads and cause failures. The facility plan recommended further evaluations of this issue. Dredging the Canal was further evaluated by the NYCDEP during the USA Project. Final design and implementation of the action was deferred by the NYCDEP to coincide with planning being conducted by the USACE during its Gowanus Bay and Canal Ecosystem Restoration Feasibility Study. Coordination and partnership with the USACE enables NYCDEP to maximize not only navigational and aesthetic use improvements but also biological benefits.

5.8.2 Water Quality Improvements

The three phases of open water elements of Inner Harbor CSO Facility Plan will reduce CSOs to the Hudson and East Rivers, Upper New York Bay, and Gowanus Bay and Canal. These reductions will improve wet weather CSO capture by maximizing treatment. The major benefits of the elements will:

1. Reduce the magnitude, frequency, and duration of all CSOs that discharge to Inner Harbor receiving waters;

2. Eliminate contravention of dissolved oxygen and coliform water quality standards that are caused or contributed by CSOs in the Inner Harbor; and,

3. Reduce settleable and floatable solids from CSO discharges.

The Gowanus Canal elements of the Inner Harbor CSO Facility Plan would improve CSO capture by maximizing the use of existing facilities equivalent to the percent reductions in the open waters. An additional water quality benefit was projected by the reactivation of the Gowanus Canal Flushing Tunnel. The plan projected that reactivation of the Flushing Tunnel would achieve the same water quality benefit as more costly CSO abatement alternatives such as storage.

Reactivating the Flushing Tunnel delivers Upper New York Bay water from Buttermilk Channel to the head of Gowanus Canal. Water in Buttermilk Channel brings higher dissolved oxygen concentrations into the Canal and improves the Canal's assimilative capacity for pollutant discharges. The artificial circulation also provides a flushing action that could minimize sedimentation, particularly at the head of the Canal. Historical discharges to the Canal and poor flushing characteristics resulted in high organic-content material in the sediments of the Canal. These sediments exert an additional demand on dissolved oxygen in the Canal, impair benthic habitat, cause odors, and impede navigation. Dredging the Canal was projected to remediate these impairments. The Gowanus Canal elements of the Inner Harbor CSO Facility Plan were projected to achieve compliance with the Class SD designation for the Canal and to promote future biological communities and improve aesthetics by reducing or eliminating odors.

5.8.3 Compliance with Standards

Prior to implementation of the Inner Harbor CSO Facility Plan, water quality conditions in Gowanus Canal did not meet the numerical and narrative water quality standards of its Class SD designation all the time. The waterbody failed to meet water quality standards by exhibiting low levels of dissolved oxygen, visible floatables, and other aesthetic impairments. Reactivation of the Gowanus Canal Flushing Tunnel greatly improved water quality in the Canal. Despite problems with the flushing-system reliability and pumping rates, the Flushing Tunnel rehabilitation implemented as part of the Inner Harbor CSO Facility Plan is achieving Class SD numerical water quality standards, improving habitat conditions for the Canal's aquatic community, and improving waterbody aesthetics. The improvements in water quality that were achieved with the reactivation of the Flushing Tunnel are presented in Section 4.5.3. In summary, the data indicate that Class SD water quality standards are being met in the Canal when the Flushing Tunnel is operational.

In fulfillment of a NYSDEC permit requirement for operating the Gowanus Canal Flushing Tunnel, the NYCDEP submitted a report to the NYSDEC entitled "Final Report on Water Quality and Biological Improvements for the Reactivation of the Gowanus Canal Flushing Tunnel" (Hazen and Sawyer, 2001). The NYCDEP reported that although the benthic community in Gowanus Canal had not stabilized by the time of its monitoring after reactivation, observations of abundance and diversity of benthic species indicated that benthic habitat was improving. Plankton/nekton surveys of the Canal also indicated a presence of planktonic organisms and larval forms of other invertebrates, fish larvae and fish eggs. This was most likely due to the conveyance of Upper New York Bay water from Buttermilk Channel into the Canal; water quality in the Canal was sufficient to support the observed aquatic life.

The NYCDEP received an "Outstanding Achievement in Water Quality Improvement Award" from the Water Environment Federation (WEF) at its 2004 annual conference for reactivating the Gowanus Canal Flushing Tunnel. The WEF cited how reactivation "played a significant role in improving the condition of New York City's harbor, bays, rivers and estuaries -producing the best condition since the beginning of the 20th century. By reactivating the Gowanus Canal Flushing Tunnel, the NYCDEP has revitalized a hypoxic, severely polluted waterway, meeting NYS water quality standards, greatly reducing odors and allowing marine life to return." The WEF award is presented to a water quality improvement program that best demonstrates significant, lasting, and measurable excellence in water quality improvement or in prevention of water quality degradation in a region, basin, or waterbody.

5.9 GOWANUS FACILITIES UPGRADE FACILITY PLAN (2001)

In April 2001, the NYCDEP initiated a facility planning project for a Gowanus Facilities Upgrade. The goal of the planning project was to address operational issues that developed following implementation of the 201 Facilities Plan and the Inner Harbor CSO Facility Plan. In particular, the Gowanus Pump Station and Gowanus Canal Flushing Tunnel were not operating as intended by the two plans. Although water quality conditions in Gowanus Canal were greatly improved, an upgrade of the facilities would ensure long-term sustainability.

The 201 Facilities Plan (1982) recommended making improvements in the Gowanus Pump Station that NYCDEP implemented in the mid-1980s. New pumps were installed in the facility, and a new force main was installed within the 12-foot diameter Gowanus Canal Flushing Tunnel. Soon after installation, the force main to the Columbia Street Interceptor failed on several occasions and was abandoned in favor of the current system that again pumps to the Bond-Lorraine Sewer. The NYCDEP determined that the system was not acceptable as a permanent measure because of the continued CSOs to the Canal from the Bond-Lorraine Sewer. The 201 Facilities Plan and Inner Harbor CSO Facility Plan also recommended evaluating improvements in the Bond-Lorraine Sewer.

The Gowanus Canal Flushing Tunnel was reactivated in March 1999 with a design pumping capacity of 300 MGD from Buttermilk Channel to the Canal. Flow studies conducted by the NYCDEP revealed that actual flow rates were considerably less than the design flow of 300 MGD. Periodic system shutdowns for maintenance and repairs presently cause water quality conditions in the Canal to degrade significantly. These failures and a lack of redundancy in the Flushing Tunnel system warranted an upgrade of the system.

The following describes the NYCDEP's facility plan for its Gowanus Facilities Upgrade (Dvirka and Bartilucci, 2005), which can be summarized as two principal elements:

- Reconstruction of the Gowanus Pump Station; and
- Modernization of the Gowanus Canal Flushing Tunnel.

5.9.1 Gowanus Pump Station Reconstruction

Combined sanitary and wastewater flow from its 650-acre tributary area enters the Gowanus Pump Station via three sewers from Butler Street: one 12-foot wide by 9-foot high sewer from the west (Bond Street); one 17-foot wide by 6-foot high sewer from the east (Nevins Street); and one 7.5-foot wide by 5-foot high sewer from the east. The three tributary sewers combine at the pump station and transition to three parallel 14-foot wide by 9-foot high concrete influent conduits that discharge to the dry weather influent channel. Based on hydraulic analyses of these influent conduits, the maximum wet-weather flow rate that can be delivered to the pump station is about 650 MGD. The design capacity of the pumping station is currently 20.2 MGD. During wet weather, flows exceeding the pumping capacity of the station bypass over stop-plank weirs to discharge via outfall RH-034 to the head of Gowanus Canal.

In its previous configuration, the Gowanus Pump Station pumped flow to the Bond-Lorraine Sewer via the Butler Street force main, a 30-inch ID cast iron pipe approximately 390 feet in length (Figure 5-2) that was constructed in 1947. As discussed above, the NYCDEP made improvements to the Gowanus Pump Station per the recommendations of the 201 Facilities Plan (1982). These improvements included converting the original wet well into an influent screening chamber, converting the original dry well into a wet well, replacing the three original pumps with five submersible pumps, and redirecting the pumped flow directly to the Columbia

Street Interceptor (instead of to the Bond-Lorraine Sewer, which is hydraulically limited and discharges CSO to Gowanus Canal) via a new 33-inch ID HDPE force main running approximately one mile within the 12-foot diameter Gowanus Canal Flushing Tunnel (Figure 5-2). With this new configuration, the pump station design capacity was 20.2 MGD. The pump station improvements were completed in June 1988, and the new force main went into service in February 1989.

The new force main failed in February 1992. The NYCDEP attempted repairs, which were difficult since the force main is submerged within the Flushing Tunnel and hence required either dewatering the Tunnel or deploying a scuba crew to perform the repairs. Though the Flushing Tunnel force main was finally repaired and returned to service in 1998, it failed again shortly afterwards. Recognizing inherent flaws in the force main design that rendered continued repairs both costly and futile, the NYCDEP then abandoned that force main in favor of the original Butler Street force main connection to the Bond-Lorraine Sewer. Reconnecting the aging Butler Street force main was intended to be a temporary measure and was considered adequate only as an interim solution.

Because the 1985 pumps were designed for the hydraulic conditions associated with the mile-long, 33-inch ID HDPE force main in the Flushing Tunnel, the reactivation of the smaller and shorter Butler Street force main resulted in the pumps operating outside their optimal range, leading to severe vibrations in the Gowanus Pump Station. The NYCDEP remedied this condition with the replacement of four of the five pumps and its water level monitoring system. The new pumps and short length of the Butler Street force main in the Bond-Lorraine Sewer allowed the pump station to convey up to 28.5 MGD (more than its design capacity of 20.2 MGD). However, rather than reducing the CSOs to Gowanus Canal, this had the net effect of simply redistributing CSOs along the length of the Canal, as the Bond-Lorraine Sewer does not have sufficient capacity to convey the extra flow. As a result, no reduction in CSO occurrence or volume was realized.

To mitigate this condition, a new force main will be constructed within the existing Gowanus Canal Flushing Tunnel to replace the failed 33-inch ID HDPE force main that was abandoned in 1998. The new force main will be a 33-inch ID centrifugally cast, fiberglass reinforced, polyester (CCFRP) pipe. The pipe will be continuously encased in fiberglass reinforced concrete for ballast and protection, and will be installed along the invert of the Flushing Tunnel for 5,000 linear feet. The new force main will provide an optimum balance between combined sewer conveyance needs and Flushing Tunnel capacity as described below. To further reduce the impacts of the new force main on the Flushing Tunnel, the new force main will exit the Flushing Tunnel approximately 100 feet east of the Columbia Street Interceptor. From there, the new force main will be installed using trenchless methods for another 400 feet—under the interceptor and roughly parallel to the existing force main route—to the existing receiving manhole on the Columbia Street Interceptor (Figure 5-2). This will help alleviate a significant constriction in the Flushing Tunnel where the Columbia Street Interceptor passes through part of the Tunnel, as shown on the left side of Figure 5-3. The abandoned 33-inch ID HDPE force main will be demolished and removed.

This alignment provides an opportunity to bypass the Bond-Lorraine Sewer and connect directly to the downstream Columbia Street Interceptor with minimal impact on historic landmarks, community facilities, and mass transit. Other alternate routes evaluated for cost,

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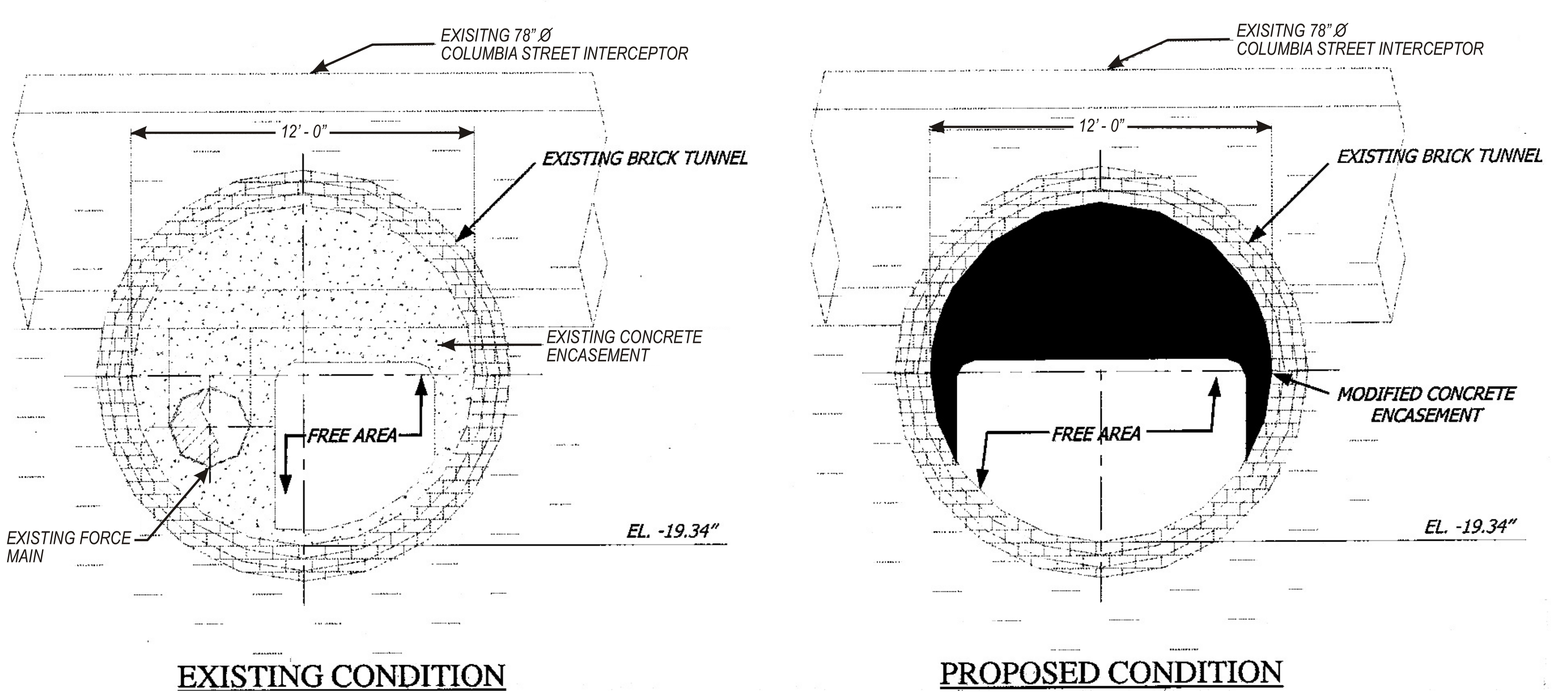
Gowanus Canal Waterbody/Watershed Facility Plan

Gowanus Pump Station Force Main Reconstruction

FIGURE 5-2



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Gowanus Canal Waterbody/Watershed Facility Plan

Flushing Tunnel Constriction at Columbia Street Interceptor

FIGURE 5-3

constructability, and environmental impacts would all require the installation of the force main within the streets of Brooklyn. These alternatives were costly, would have greater power requirements for pumping, and would have significant adverse impacts during construction. The Flushing Tunnel routing is particularly advantageous because it represents an existing means of crossing beneath both the Smith Street Subway tunnel and the Brooklyn-Queens Expressway. The disadvantage is that having the force main in the Flushing Tunnel reduces the effective conveyance capacity of the Flushing Tunnel by eight percent, although this is not considered to be prohibitive in comparison to its advantages.

The increased sewer system capacity that this new force main will provide allows for the expansion of the capacity of the Gowanus Pump Station. The firm capacity of the pump station will be increased to 30 MGD from the 1985 upgraded capacity of 20.2 MGD. The gain in capacity will be accomplished through the installation of four 140-hp submersible wastewater pumps, each with a rating point of 6,950 gpm at 55 feet total dynamic head, providing 30 MGD combined flow capacity at this rating point. Up to three pumps will be in service at any given time, with a fourth providing redundancy and allowing for pump servicing without reducing operating capacity.

Expansion of capacity beyond 30 MGD was evaluated (see Section 7.3.3) but was determined to be infeasible due to physical interferences and extenuating factors of community impact. Increasing the pumping capacity beyond 30 MGD would necessitate increasing the diameter of the force main, which runs through the Flushing Tunnel and hence negatively affects the Tunnel's flow capacity and therefore its water quality benefits. Alternate routes for the force main would create an extensive community disruption due to the construction through historic areas.

In addition to upgrading the hydraulic capacity of the Gowanus Pump Station, the CSO screening facilities will be upgraded to provide floatables control of overflows to Gowanus Canal. Though the current configuration features coarse screening of flow that enters the wet well, excess flow bypasses these screens and CSO discharges from the facility are currently not screened. The proposed improvements involve installation of a horizontally raked bar screen above the existing dry-weather influent channel to the pumping station. This screening system will be capable of screening a CSO flow rate of up to 200 MGD. This capacity exceeds the 5-minute peak CSO flow of 172 MGD calculated during the design rainfall year (with a 30 MGD pump station capacity) and hence is expected to be completely protective for that scenario. Furthermore, should an occasional storm generate more than 200 MGD, only the portion of the flow in excess of 200 MGD will discharge unscreened. Floatables already captured in such a storm will be retained rather than discharged.

5.9.2 Gowanus Canal Flushing Tunnel Modernization

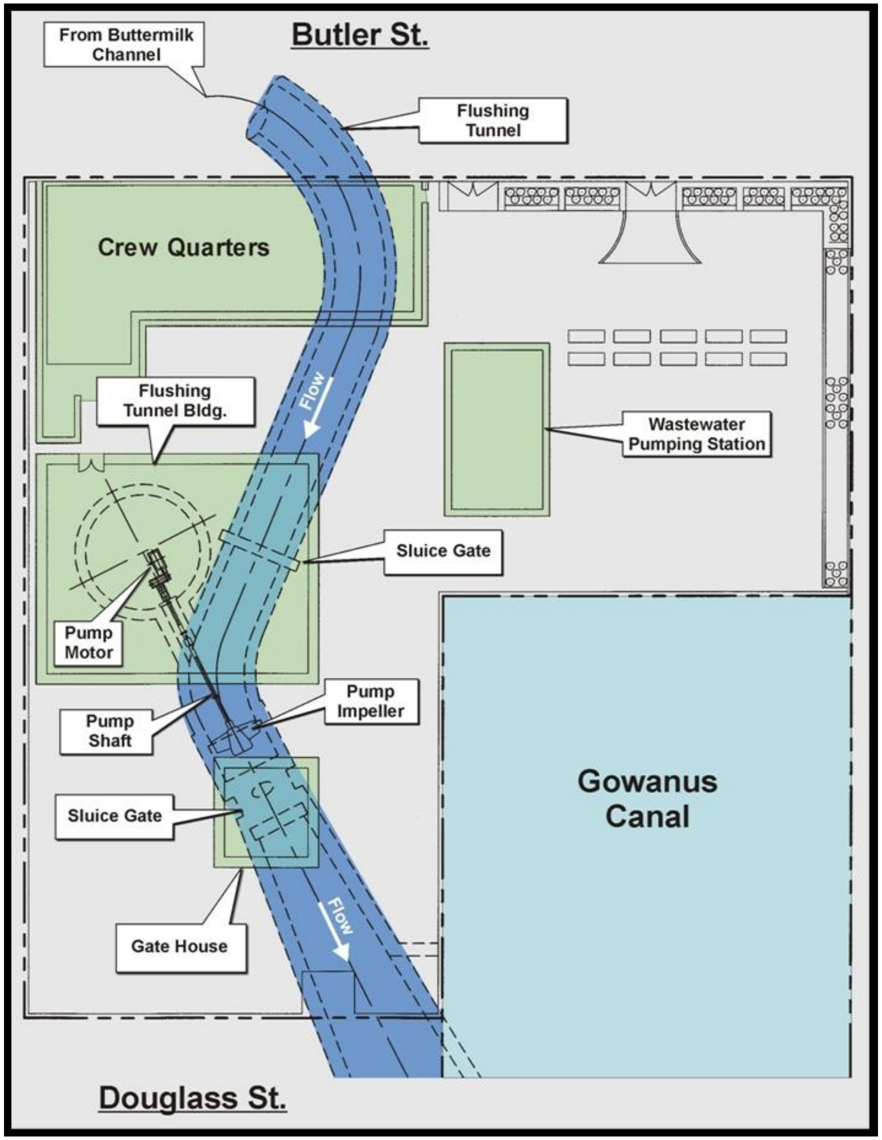
The Gowanus Canal Flushing Tunnel was originally constructed in 1911 to convey water in either direction between Gowanus Canal and Buttermilk Channel. The original flushing system consisted of a 400 horsepower (hp) motor and a 7-foot-diameter propeller that could pump 325 MGD through the approximately 6,070-foot long, 12-foot diameter brick tunnel. The system failed in the 1960s when the pumping mechanism was damaged, and remained out of service until it was successfully rehabilitated and returned to service in March 1999 as part of the Inner Harbor CSO Facility Plan. The new pumping system consisted of a 600 hp motor and a new shaft, bearings, and propeller designed to convey water at a rate of up to 300 MGD at 8 feet of total dynamic head from Buttermilk Channel to Gowanus Canal. Modeling analyses performed as part of the project had determined that continuously bringing water from Buttermilk Channel to the head of the Canal would have a greater beneficial impact than pumping in the reverse direction. The existing Flushing Tunnel facilities at the head of the Canal are shown on the left panel of Figure 5-4.

Subsequent to the Flushing Tunnel reactivation, the NYCDEP has found the current flushing system to be deficient. Based on field measurements of the existing flows, the actual capacity of the system averages about 154 MGD, only about half the design flow. The system is highly susceptible to tidal conditions, with field measurements showing peak flows of 195 MGD at high tide, and zero flow at low tides, when the system is inoperable.

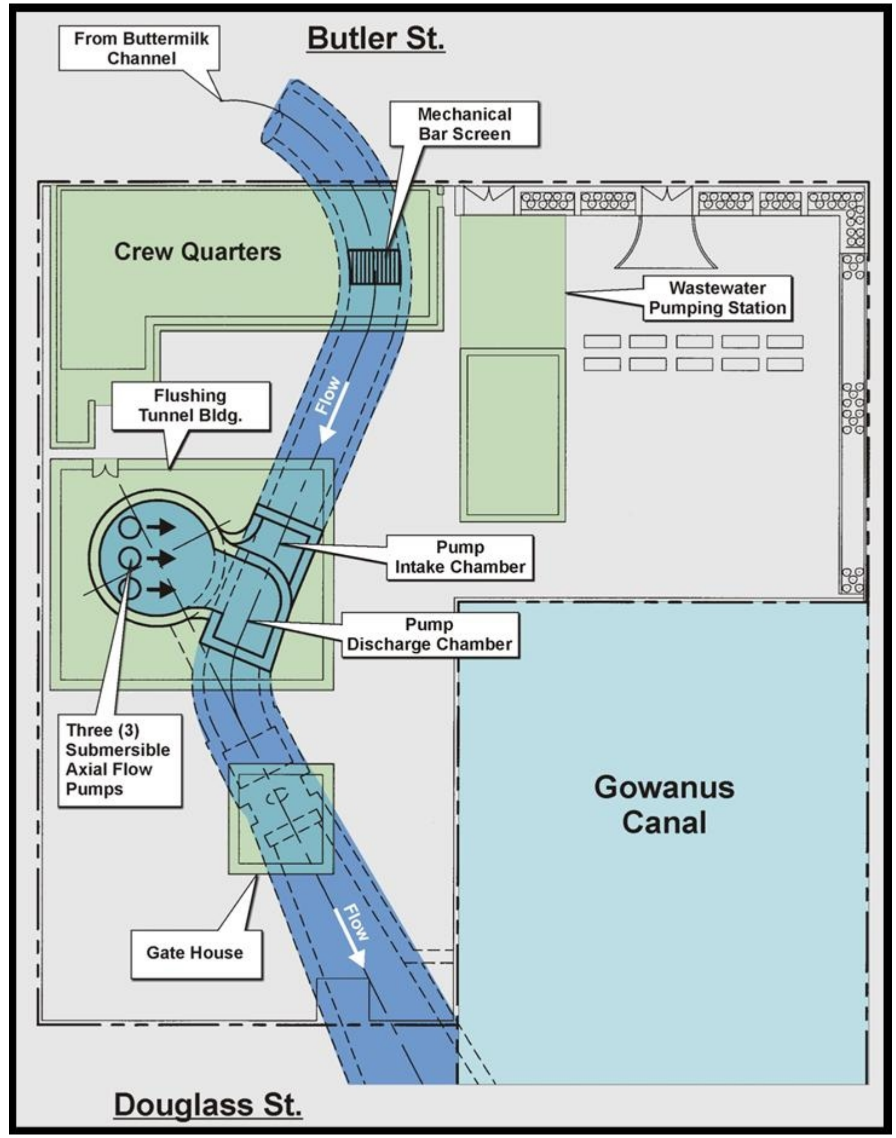
The current flushing system, shown on the left panel of Figure 5-4, is also deficient for other reasons. Critical system components are submerged and exposed to the corrosive saline water, leading to frequent maintenance and repair needs. The system also features custom-made equipment that can be costly and difficult to repair or replace. Furthermore, the lack of a backup pumping system and other system redundancy means that many maintenance and repair activities require the complete shutdown of the system. Because critical system components are submerged, maintenance or repair involves deployment of a SCUBA crew and/or dewatering a portion of the Flushing Tunnel and confined space entry. Meanwhile, the lengthy downtime required for maintenance or repair allows water quality in the Canal to deteriorate.

To address these issues, the Gowanus Canal Flushing Tunnel pumping system will be modernized to reduce downtime and improve overall operation. Evaluation of several alternative configurations revealed that vertical axial flow pumps would provide the highest capacity as well as the flexibility and redundancy lacking in the existing system for uninterrupted operation during maintenance. The proposed system, shown on the right panel of Figure 5-4, features three submersible, vertical, axial-flow pumps installed in parallel within the existing motor pit, which will serve as a wet well, and two additional pumps will be stored on site as spares that can be changed in without dewatering or system shutdowns. Each pump will have a design capacity of 69,500 gpm (100 MGD) at a head of 20 feet when operated at full speed (500 rpm), and will discharge through a 54-inch diameter concrete tube open to a common discharge chamber. Variable frequency drives will adjust the speed of the pumps in synchrony according to the available submergence at the pumps, which will be controlled according to the hydraulic draw-down in the Flushing Tunnel and the tide level at Buttermilk Channel. The proposed system consists of standard equipment for replacement and parts, and exposed system components will feature corrosion-resistant coatings.

As discussed in the previous subsection, the Columbia Street Interceptor passes through the Flushing Tunnel (Figure 5-1) and occludes the upper half of the 12-foot diameter brick tunnel (Figure 5-3). This constriction is further compounded by the existing 36-inch outer diameter HDPE Gowanus Pump Station force main (and its concrete encasement), which ties in to the interceptor at this location. Reconfiguring the Columbia Street Interceptor and/or the Flushing Tunnel was determined to be prohibitively disruptive and expensive. However, a more cost-effective option was developed. As shown on the right side of Figure 5-3, the available cross-sectional area for flow would be doubled from its current condition by rerouting the force main to exit the Flushing Tunnel approximately 100 feet east of the interceptor. This would



Existing Flushing Tunnel



Flushing Tunnel Modernization

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Gowanus Canal Flushing Tunnel Pump System Modernization

FIGURE 5-4

significantly reduce the head loss through the constriction and provide a higher hydraulic capacity to the flushing system.

Between the improvements to the pumping system and the alleviation of the tunnel constriction, the estimated average flow rate will increase by about 40 percent to about 215 MGD from 154 MGD. At high tide, the new system capacity will increase to about 252 MGD from 195 MGD. Importantly, the new system will not shut down at mean low tide conditions, when a flow rate of about 175 MGD will be maintained. In addition, the new system will have built-in redundancy and will not require shut down for most maintenance or repair work.

5.9.3 Gowanus Facilities Upgrade Implementation Schedule

The design of the Gowanus Facilities Upgrade project was underway at the time of the writing of this report. Preliminary design commenced in 2004. Final design is scheduled to be completed in October 2008. Bidding and contract awards are scheduled to follow, and contractor mobilization to begin construction is anticipated by February 2010. The project is expected to be completed and fully operational by September 2014.

5.9.4 Flushing Tunnel Operation During Construction

Construction activities associated with the Gowanus Pump Station Reconstruction and the Gowanus Canal Flushing Tunnel Modernization are intertwined. The modifications to the Flushing Tunnel pumping system and the reconstruction of the wastewater force main through the Flushing Tunnel will require the flushing system to be out of service for a period of approximately 26 months during construction. This period will include at least one summer (low dissolved oxygen) season, and without the benefit of the Flushing Tunnel, it is expected that impacts to water quality in the Canal will occur during construction.

To mitigate any impacts to Canal water quality during the Flushing Tunnel shutdown period, DEP has developed a temporary system that would operate as necessary during the Flushing Tunnel shutdown period to maintain satisfactory dissolved-oxygen levels along the entire length of the Canal. This proposed “centralized Oxygen Transfer System” (OTS) would involve the withdrawal from the Canal of 9.7 MGD (via a temporary intake from the existing outlet of the Flushing Tunnel at Douglass Street). Approximately 3,250 lbs/day of oxygen would be added to this flow using an oxygenation cone located within a facility at the foot of Douglass Street. The oxygenated flow would then be directed to the Canal via a 24-in diameter, 2,500-ft long, high density polyethylene (HDPE) pipe, discharge ports spaced at 50-ft intervals between Sackett Street and the pipe terminus just upstream of the 4th Street Turning Basin. This floating pipe would be installed roughly 10 ft from the eastern bulkhead such that it would be submerged at approximately mid-depth (and at least 2 ft below the water surface) via the use of tethers tied to concrete anchors. The discharge ports would direct oxygenated flow toward the center of the 100-ft wide Canal so that the oxygenated flow is distributed across the Canal width. With an additional discharge port located near the head of the Canal at Douglass Street, the system is expected to maintain dissolved-oxygen levels of at least 3 mg/L along the entire length of the Canal.

A Joint Permit Application has been submitted to the NYSDEC and USACE for the proposed OTS described above and includes a Field Sampling and Analysis Plan (FSAP) to monitor water quality during the system deployment. Upon acceptance of the system proposal and receipt of the permit, the NYCDEP intends to move forward with construction of this system to mitigate water-quality impacts to the Canal during construction. Additional details about the OTS system, analyses of the impacts of the system, and the FSAP are available (Dvirka & Bartilucci, July 2008b; HydroQual, August 2008).

5.10 USACE ECOSYSTEM RESTORATION

The City of New York is a non-federal local sponsor for the Gowanus Bay and Canal Ecosystem Restoration Feasibility Study being conducted by the USACE, New York District. The major focus of the study is to identify habitat restoration opportunities in Gowanus Bay and Canal including selective and careful removal of undesirable fill and *phragmites*-dominated areas on formerly high-value tidal wetland, and the restoration of tidal flow to enhance fish and wildlife habitat value and water quality function. The NYCDEP is the non-federal local sponsor of the feasibility study, and is sharing half of the cost of the study by providing funding and in-kind services (USA Project). The study includes field investigations, engineering analyses, and stakeholder involvement. USACE representatives of the feasibility study attended and participated in NYCDEP's Gowanus Canal Stakeholder Team meetings.

The feasibility study is investigating additional general restoration concepts for areas within Gowanus Bay and Canal, including recontouring the waterbody and removal of contaminated sediments, regrading shorelines to enhance tidal marshes, creating upland buffer zones, and restoring waterfront access. At the time of the writing of this report, the feasibility study was ongoing, and specific locations for improvement actions had not yet been selected. The NYCDEP intends to partner with the USACE as a non-federal local sponsor on implementing the restoration project.

5.11 NEW YORK CITY SUSTAINABILITY INITIATIVES

Sustainable stormwater management usually involves replicating the natural water balance and stormwater dynamics through the design of natural ecological processes and functions, and controlling stormwater at the source. The technologies that serve this goal are referred to as stormwater best management practices (BMPs), and include a wide range of techniques that can capture stormwater, remove urban pollutants, reduce runoff volumes and peak flows, and return stormwater to the landscape and subsurface in a manner beneficial to the environment. Low-impact development (LID) refers to the land use approach that integrates various stormwater management practices in an attempt to minimize the changes to the natural environment that the built environment has, and has alternately been referred to as Green Site Design (GSD) or more generically as simply "green solutions." Distributive by design, stormwater BMPs must be applied over a large area in order to achieve significant runoff attenuation. The generally accepted approach is to incorporate green solutions into redevelopment and new construction.

Green solutions are currently being evaluated through the NYCDEP Bureau of Environmental Planning and Assessment and the Mayor's Office of Long-Term Planning and Sustainability. Both of these groups are evaluating the BMPs, other LID techniques, and feasible implementation strategies. The Mayor's Office established the BMP Interagency Task Force to incorporate BMPs into the design and construction of projects as part of PlaNYC 2030 and is also responsible for developing a sustainable stormwater management plan per Local Law 5 passed by the City Council in the beginning of 2008. NYCDEP is substantially supporting these efforts. NYCDEP is also evaluating regulatory changes that could require BMPs for certain development, and will have a contractor on board in 2009 to construct BMP pilot projects and a New York City specific urban BMP design manual. The following subsections detail these and other stormwater management initiatives the City has recently undertaken. Although many initiatives are City-wide in nature, several initiatives explicitly identify Gowanus Canal for targeted pilot programs, and the remainder have broad implications within the Gowanus Canal watershed as the City continues to refine its policies and practices pertaining to stormwater management.

5.11.1 Jamaica Bay Watershed Protection Plan

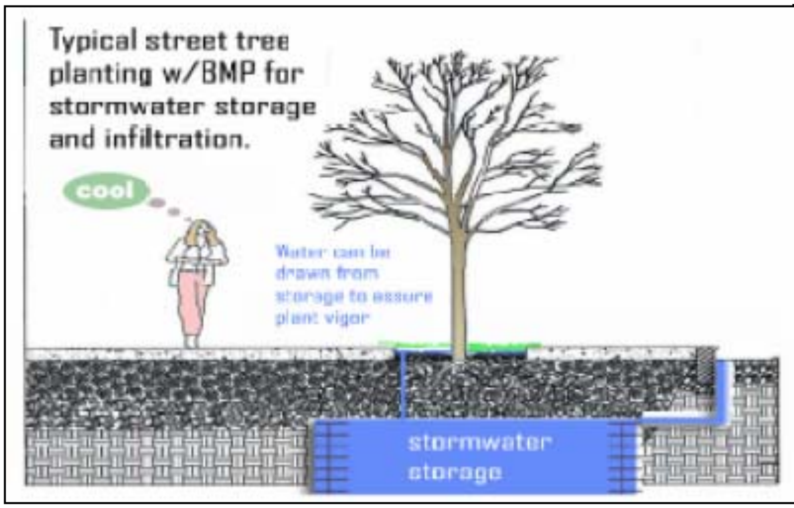
On June 30, 2005, the New York City Council passed Local Law 71 (LL 71) of 2005 to require the development of a watershed protection plan for Jamaica Bay. The legislation required NYCDEP to "assess the technical, legal, environmental and economical feasibility" of a variety of protection measures as part of the JBWPP development process, the objective of which is to restore and maintain the water quality and ecological integrity of the Bay though a comprehensive watershed approach. The Final Plan was submitted to the City Council on October 1, 2007, and annual Plan updates are expected in 2008 and 2010.

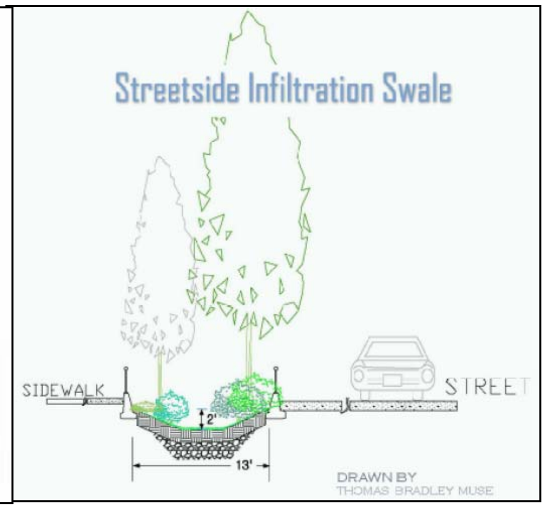
The Plan included a myriad of ecological restoration and water quality improvement strategies, and new and emerging techniques previously unaddressed, such as stream bank protection, stream buffers, other BMPs, enforcement, access and use restrictions, freshwater ponds, urban runoff management, and expansion of community use and participation. A set of recommendations for restoring and protecting desired uses of Jamaica Bay and its watershed were generated. Collectively, these pilot studies, regulatory initiatives, public outreach efforts, and technical innovations will begin to address water quality and ecological issues facing Jamaica Bay, promoting sustainability in New York City based on sound development and infrastructure practices at multiple levels. Many of the recommendations in the JBWPP are outside NYCDEP's authority or mission, and NYCDEP's support for these projects must be considered in the context of other agency mandates. The financial plan for the Bay has not been fully developed.

The first Plan update to be submitted to City Council in October 2008 will include status reports on the implementation of many strategies identified in the Plan and the status information presented below for stormwater BMPs.

5.11.2 PlaNYC 2030

On Earth Day in 2007, Mayor Bloomberg announced a comprehensive City-wide set of initiatives focused on environmental stewardship called PlaNYC 2030. By dividing the urban environment into its fundamental components (land, water, transportation, energy, and air), PlaNYC enabled New York City to identify and execute actions that would lead to a more sustainable city. In addition to the continued implementation of infrastructure upgrades and LTCP development, PlaNYC identified specific initiatives to promote BMP implementation, including the formation of an interagency BMP Task Force, pilot projects for promising BMPs, and providing incentives for green roofs. The BMP Interagency Task Force met regularly during 2007 and 2008 to discuss feasible mechanisms for distributed stormwater control through the design and construction of different agency projects within the City's right-of-way, open space, and public and private developments. The Task Force held several public meetings to receive the input of diverse stakeholders citywide. The pilot projects identified in PlaNYC (e.g., improved tree pit design and roadway vegetated swales) will be implemented by NYCDEP along with other stormwater BMP pilot projects as part of several contracts described below. Finally, the State Legislature recently approved a green roof tax abatement program (Bill Number A11226) to encourage construction and maintenance of green roofs in the City. The amount of the abatement would be $4.50 per square foot of green roof, limited to the lesser of $100,000 or the building`s tax liability for the year in which the abatement is taken. The bill will officially be written as law in Fall 2008 and with a sunset date of March 15, 2013.





5.11.3 Sustainable Stormwater Management Plan

The City Council passed Local Law 5 in 2008 requiring the Mayor's Office of Long-Term Planning and Sustainability to develop a City-wide Sustainable Stormwater Management Plan, the goals of which are to reduce stormwater volume, improve water quality, and enhance the use and enjoyment of the city's waterbodies for recreational activities. The specific requirements of the plan focus on defining what measures will be undertaken for different types of properties or areas in the city, along with a prioritization of measures, timeline and costs. A substantial public participation and public education program has obtained public input during the development of the plan. Specific requirements for signage, public notification for location and occurrence of CSOs, and other education activities are also included. The draft plan is due October 1, 2008 to the mayor, speaker of the council, and the public; the final is due December 1, 2008. The law expects a four-year review cycle, with reports every other October beginning in 2010. NYCDEP is lending substantial support to the development of the plan.

5.11.4 NYCDEP BMP Pilot Projects

NYCDEP is in the process of selecting a contractor for an upcoming NYCDEP BMP contract, anticipated to start in the beginning of 2009. NYCDEP has made substantial progress advancing the RFP; it has selected a contractor and completed contract negotiations. A significant portion of the contract includes multiple stormwater BMP pilot projects that will be used to evaluate the efficacy of each BMP, maintenance needs, schedules, and uncertainties associated New York City-specific climate and site conditions (local geology, cold weather limitations, construction costs, maintenance requirements, etc.). The results of these pilots will be used to guide future development practices, and design manual development and watershed planning analyses aspects of the project. The specific tasks in the RFP included:

- Three locations in the Bronx at which stormwater BMP retrofits for open space and other land uses will be evaluated;
- New York City Housing Authority (NYCHA) complexes will test the ability to redirect runoff to existing pervious surfaces and encourage on-site stormwater infiltration;
- A porous pavement pilot to investigate different types of porous pavement and potential maintenance issues associated with the use of porous pavement;
- Two locations in southeast Queens along North and South Conduit Avenues that will be used to quantify the benefits of tree plantings and other BMPs for stormwater management;
- Two 10,000 square-foot, publicly owned rooftops will be retrofitted with blue roofs to evaluate retrofitting existing structures;
- The distribution of 1,000 55-gallon capacity rain barrels to gauge public acceptance of and interest in this technology, with focused distribution in the Jamaica Bay watershed (250 of which were distributed during the spring and summer of 2007).

NYCDEP submitted a Nitrogen Consent Judgment Environmental Benefit Project (EBP) Plan to NYSDEC in January 2007 that proposed a Jamaica Bay stormwater pilot study. This project would use Judgment EBP funds to conduct a three year pilot study program to implement and monitor several stormwater treatment technologies and volume reduction stormwater BMPs for potential application within the Jamaica Bay watershed. The goals of Jamaica Bay Watershed Stormwater Pilot Project include documenting the quality of New York City stormwater and refining the specific capture rates and treatment efficiencies that may be expected locally. Once this information has been gathered, it will be used to develop an effective Green Site Design stormwater strategy.

The project is expected to cost approximately $1.5 million and will include infiltration swales for street-side and parking lot applications, parking lot curb water capture systems, enhanced tree pits, and a commercial green roof installation. The EBP would be conducted through an innovative collaborative effort between NYCDEP and the Gaia Institute. NYCDEP will shortly enter into a Memorandum of Agreement (MOA) with the Gaia Institute to complete the pilot study. The Gaia Institute is a 501(c)3 not-for-profit corporation located on City Island in the Bronx, that explores how human activities can be attenuated to increase ecological productivity, biodiversity, environmental quality, and economic well being. The terms of the agreement remain subject to negotiation; however, payment would be made only after NYSDEC has reviewed and approved invoices, at which time written approval would be sent to the New York State Environmental Facilities Corporation (NYSEFC) to release payment.

NYCDEP also submitted an EBP Plan for NYSDEC approval in March 2008 that is expected to partially mitigate the impacts of stormwater and CSO discharges in the New York Harbor Estuary through stormwater BMP implementation. Practices such as bioinfiltration swales, enlarged street tree pits with underground water storage, constructed wetlands, and others would be evaluated. The CSO EBP Plan proposes pilots in the Bronx, Flushing, and Gowanus watersheds. Gowanus Canal was selected as one of the representative watersheds within which to further evaluate BMP performance based on its particular characteristics.

NYCDEP intends to establish a Request for Grant (RFG) program that will enable local stakeholder groups to submit proposals for effective stormwater management projects that meet the objectives of capturing and treatment of stormwater (e.g., reduction of stormwater entering sewer system) within the watersheds covered by the EBP Plan. The RFG process will be structured to allow for a variety of proposals for both small and larger groups. A total of $1,450,000 was requested for projects within the Gowanus Canal watershed: three grants with a maximum award of $450,000 each, and five smaller projects with a maximum value of $20,000 each. The procedure will be to recommend reimbursement from the New York State Environmental Facilities Corporation (NYSEFC) directly to the grant applicants. To help expedite these projects, it is anticipated that NYCDEP will follow the procedures similar to that of the Nitrogen Consent Order EBP program, and that a Memorandum of Understanding (MOU) will be developed between NYCDEP and the individual grant applicants.

The Gowanus watershed field survey analyses are anticipated to be completed by the end of 2008, at which time NYCDEP will provide detailed information to NYSDEC for review and comment prior to the start of the RFG process. Once NYCDEP and NYSDEC agree on eligibility grant guidelines (expected by the end of January 2009), NYCDEP will perform public outreach to encourage environmental groups to submit grant proposals that meet the criteria agreed upon. Certain submission requirements, including the submittal of designs at least 120 days ahead of starting any work and the three-year minimum monitoring duration extend the schedule out to 2015 before final results can be expected.

5.11.5 Other NYCDEP BMP Initiatives

A BMP Design Manual will be developed that offers specific guidance for designing and constructing BMPs in New York City's site-specific conditions and regulatory environment. The BMP Design Manual will identify specifically how to design and install effective BMPs in New York City, addressing different land use and building classifications, soil and bedrock geology, local climate conditions, and the regulatory environment. The manual will include the pilot and demonstration projects as examples and is anticipated to have an online, interactive access portal that can be used to tailor a stormwater control to the type of soil, depth to seasonal high water table and bedrock, site topography, and location of foundation, utilities and other underground features unique to a given site.

Another noteworthy component of the RFP is the development of watershed plans for up to four watersheds including the Gowanus Canal that will be based on a comprehensive water quality and ecological approach. These watershed plans will identify BMP, restoration, and other low-impact/decentralized strategies for addressing multiple water quality and ecosystem goals.

NYCDEP has also worked closely with the City Planning Commissioner (CPC) and Department of City Planning (DCP) to review proposed rezonings in areas adjacent to the Canal including the proposed rezoning and development at 363-365 Bond Street bounded by the Canal, and Carroll and Second Streets. The rezoning proposes to change the current zoning from predominately manufacturing districts to a Special Mixed-Use District. The proposed development includes the construction of 447 new dwelling units on approximately 3 acres and a 0.7-acre publicly-accessible waterfront open space along the Canal. NYCDEP has provided comments and discussed stormwater and water conservation measures with DCP to address existing infrastructure and water quality concerns in the Gowanus Canal drainage area. DCP expects to certify the Uniform Land Use Review Procedure (ULURP) application for 363-365 Bond Street which includes a conceptual BMP plan to manage and treat on-site and street discharges entering the Gowanus Canal in September 2008. DCP is also studying a larger area-wide rezoning for a 25 block area surrounding the head end of the Gowanus Canal that would also effectively change the area from manufacturing zoning districts to multi-use zoning districts. Both rezonings are also being reviewed to reflect and ensure consistency with NYCDEP's proposed Gowanus Facilities Upgrade, as described previously in Section 5.

5.11.6 BMP Code Review Task Force

A detailed review of New York City's existing codes and regulations is being performed in an attempt to identify potential code revisions that could be recommended to promote BMP implementation. NYCDEP convened various staff from different bureaus and offices within the agency—Bureau of Environmental Planning and Analysis, Bureau of Water and Sewer Operations, Legal Office and Office of Strategic Projects—and other City agencies—Department of Buildings, Law Department and Mayor's Office of Long-Term Planning and Sustainability—to conduct the review. The Task Force will identify opportunities for revisions that would encourage BMP installation based on a review of BMP regulation and practices in other urban municipalities such as Portland, Philadelphia, Chicago, and Seattle.

6.0 Public Participation and Agency Interaction

One of the nine elements of a long-term control plan is a public participation and agency interaction process that actively involves the affected public and regulators in decision-making to select long-term CSO controls. Guidance states that establishing early communication with both the public and regulatory agencies is an important first step in the long-term planning approach and crucial to the success of a CSO control program (USEPA, 1995a). The NYCDEP is committed to involving the public and regulators early in the planning process by describing the scope and goals of its facility planning projects and continuing public involvement during its development, evaluation, and selection of plan elements.

The CSO Control Policy emphasizes that state water quality standards authorities, permitting authorities, USEPA regional offices and permittees should meet early and frequently throughout the long-term planning process. It also describes several issues involving regulatory agencies that could affect the development of the long-term control plan, including the review and appropriate revision of water quality standards and agreement on the data, analyses, monitoring, and modeling necessary to support the development of the long-term control plan. A Harbor-Wide Government Steering Committee was therefore convened by the NYCDEP consisting of city, state, interstate, and federal stakeholders representing regulatory, planning, and public concerns in the New York Harbor watershed.

The NYCDEP has formed local and city-wide citizen advisory committees, has involved other municipal officials, local community government representatives, permitting agencies, and the general public in its planning process. Public meetings are conducted to present technical information and obtain input from interested individuals and organizations. Potential CSO alternatives, costs (to the NYCDEP and to the public via water usage rates) and benefits are discussed before completing engineering evaluations. Comments are sought regarding the selection of a recommended plan. This process was been executed by the NYCDEP during the Inner and Outer Harbor CSO Facility Planning Projects. The NYCDEP regularly met with its Citizens Advisory Committee on Water Quality to discuss the goals, progress and findings of its ongoing planning projects such as the waterbody/watershed assessment of Gowanus Canal. A local stakeholder team was specifically convened by the NYCDEP to participate in the waterbody/watershed assessment of Gowanus Canal.

The following section describes the formation and activities of the NYCDEP's Harbor-Wide Government Steering Committee, its Citizens Advisory Committee on Water Quality, and its Gowanus Canal Waterbody/Watershed Stakeholder Team that represented the NYCDEP's public participation and agency interaction components of its waterbody/watershed assessment of Gowanus Canal.

6.1 HARBOR-WIDE GOVERNMENT STEERING COMMITTEE

The NYCDEP convened a Harbor-Wide Government Steering Committee whose members include representatives of USEPA Region 2, the NYSDEC, other New York City agencies with regulatory responsibility for city land use (Department of Parks and Recreation, City Planning), the USACE, the National Park Service, and local and regional citizen environmental advocacy groups. The Harbor-Wide Government Steering Committee assured overall program coordination and integration of management planning and implementation activities by holding quarterly meetings, exploring regulatory issues, prioritizing planning and goals, developing strategies, reviewing and approving assessment-related work plans and coordinating actions. The Citizens Advisory Committee on Water Quality (CAC), which reviews and comments on NYCDEP water quality improvement programs, is represented on the Steering Committee and separately monitors and comments on the progress of CSO projects, among other NYCDEP activities.

Federal government members of the Steering Committee Harbor-Wide Government Steering Committee included representatives of the USEPA, USACE and the National Park Service. USEPA Region 2 was represented by its Deputy Director and its Water Quality Standards Coordinator. The USACE was represented by its Chief of the Technical Support Section, Planning Division, New York District. The National Park Service member was a representative of its Division of Natural Resources at the Gateway National Recreational Area.

Interstate interests were represented by the Executive Director and Chief Engineer of the IEC. The IEC is a joint agency of the States of New York, New Jersey, and Connecticut. The IEC was established in 1936 under a compact between New York and New Jersey and approval by Congress. The State of Connecticut joined the IEC in 1941. The mandates of the IEC are governed by the Tri-State Compact, Statutes and the IEC’s Water Quality Regulations. The IEC’s responsibilities and programs include activities in areas such as air pollution, resource recovery facilities and toxics; however, the IEC's continuing emphasis is on water quality, an area in which the IEC is a regulatory and enforcement agency. The IEC's area of jurisdiction includes the waters abutting all five boroughs of New York City.

The State of New York was represented by the central and regional offices of the NYSDEC. The NYSDEC’s Central Office in Albany was represented by its Associate Director of the Division of Water, the Director of the Bureau of Water Permits in the Division of Water, the Director of the Bureau of Water Assessment and Management Branch of the Division of Water, and the Director of the Bureau of Water Compliance in the Division of Water. The Region II office of the NYSDEC was represented by the Regional Engineer for the Region II Water Division.

Several departments of The City of New York were represented on the Harbor-Wide Government Steering Committee. The Deputy Commissioner of the Bureau of Environmental Engineering and its Director of Planning and Capital Budget represented the NYCDEP. The Department of City Planning was represented by its Director of Waterfront/Open Space. The New York City Department of Parks and Recreation was represented by the Chief of its Natural Resources Group.

Two members of the Harbor-Wide Government Steering Committee were the co-chairs of the NYCDEP’s Citizens Advisory Committee on Water Quality. The members were themselves representatives of public interests groups. One member was a General Counsel of Environmental Defense at the New York Headquarters. The second member represented the Real Estate Board of New York.

A Waterbody Work Plan (HydroQual, 2001a) describing the methodology was developed by the USA Project, reviewed and approved by the Harbor-Wide Government Steering Committee, and implemented to conduct the assessment of Gowanus Canal. On September 26, 2003, the Harbor-Wide Government Steering Committee was fully briefed on the ongoing waterbody/watershed assessment of Gowanus Canal and preliminary analyses. Watershed and waterbody characteristics, water quality conditions, designated and current uses, related regulatory issues, water quality improvement projects, priority waterbody/watershed problems and opportunities, field investigations, mathematical modeling approaches, public participation, and coordination with USACE ecosystem restoration feasibility studies.

The Harbor-Wide Government Steering Committee approved the NYCDEP's waterbody/ watershed assessment approach during the September 26, 2003 meeting. It recommended that NYCDEP investigate cost-effective engineering alternatives that improve water quality conditions above that attained by the Inner Harbor CSO Facility Plan and achieve removal of Gowanus Canal from the State of New York's 303(d) list, to pursue ecosystem restoration actions with USACE, and to coordinate use attainment evaluations with the NYSDEC. Representatives of the NYSDEC reported that its agency was awaiting the results of the NYCDEP's waterbody/watershed assessment before completing the 303(d) evaluation.

6.2 WATER QUALITY CITIZENS ADVISORY COMMITTEE

The NYCDEP's CAC, which reviews and comments on the NYCDEP's water quality improvement program, is represented on the Harbor-Wide Government Steering Committee and separately monitors and comments on NYCDEP's progress. The CAC represents the interests of New York City agencies, borough offices, real estate interests, and non-governmental environmental advocacy groups. The NYCDEP supported and regularly informed the CAC on all of its ongoing planning projects and programs related to water quality in New York Harbor waterbodies. In turn, the CAC commented on NYCDEP's activities and facilitated dissemination of information back to the organizations and constituencies it represents.

Recognizing the magnitude and complexity of planning, implementation and regulatory issues being addressed by the NYCDEP in its water quality facility planning projects, the CAC was a proponent of conducting waterbody/watershed assessments of CSO waterbodies. Prior to and after initiation of the NYCDEP's USA Project, the CAC was regularly informed of the goals and strategy of the NYCDEP's waterbody/watershed assessment methodology. The CAC was informed of the approach and schedule of the waterbody/watershed assessments such as that of Gowanus Canal, and was regularly briefed on the assessment findings for Paerdegat Basin and the Bronx River. It was also briefed on the preliminary components of waterbody/watershed facility plans for Paerdegat Basin. Though the CAC itself was not briefed on specific assessment activities of Gowanus Canal, several members of the CAC participated in discussions of Gowanus Canal as members of the Harbor-Wide Government Steering Committee.

6.3 PUBLIC OPINION SURVEY

The NYCDEP conducted a telephone survey in order to assess and measure the use of waterbodies in New York City, and obtain feedback from New York City residents about their attitudes towards the water resources in their community and elsewhere. Surveys addressed city-wide issues as well as those for local waterbodies. Primary and secondary waterbody survey results (dependent on residential location within watersheds) were analyzed discreetly and summarized to provide additional insight public into waterbody uses and goals in addition to those identified via the public participation process described above.

Survey interviews were conducted using Computer Assisted Telephone Interviews (CATI) among residents of the five New York City boroughs that were 18 years of age or older. Residents were asked about specific waterways depending on their zip code. A total of 7,424 interviews with New York City residents were conducted during these telephone surveys and a total of 8,031 primary waterway responses were recorded. Questionnaire development involved a pre-test prior to the full field application of the survey to ensure that the survey covered all relevant issues and it was presented in a way that would be clear to respondents. The pre-test was conducted via a series of five focus groups representing residents of each of the five New York City boroughs. Final presentation of results involved editing, cleaning, and weighting collected data. The weights were applied to the data to correct for unequal probability of household selection due to households with more than one telephone number, and different numbers of individuals available to be interviewed in different households. Post-stratification weighting was also applied for each waterbody to balance the sample data to 2000 U.S. Census population data that takes into account household composition, age, gender, and race/ethnicity. The survey data then was projected to actual population counts from the 2000 U.S. Census so that areas could easily be combined to yield an appropriate weighted sample for all five boroughs of New York City.

The telephone survey interviewed 300 Gowanus Canal watershed residents from June through September 2003. The survey was analyzed to quantify the extent of current uses of the Canal's waters or riparian areas, and record interest in utilizing the waterbody and riparian areas. Elements of the survey focused on awareness of the Canal; uses of the waterbody and riparian areas; recreational activities involving these areas and how enjoyable these activities were; reasons why residents might not partake in recreational activities in or around the Canal; overall perceptions of New York City waterbodies; and what improvements have been recognized or are desired. A copy of a presentation of the survey results is provided in Appendix C.

6.3.1 Gowanus Canal Awareness

Approximately 67 percent of Gowanus Canal area residents that participated in the survey were aware of the Canal but only 11 percent could identify Gowanus Canal as their primary waterbody without any prompting or aid in their response. The local awareness was only slightly higher than the overall awareness of primary waterbodies for all New York City residents who participated in the survey. Most of the area residents identified the East River or the Hudson River as the waterway closest to their home. Coney Island Beach and Gowanus Canal ranked last but equal in distribution.

6.3.2 Water and Riparian Uses

Approximately 21 percent of Gowanus Canal area residents that participated in the survey visit waterbodies in their community or elsewhere in New York City on a regular basis and 41 percent occasionally visit waterbodies. The remaining percentage of residents rarely visit or never visit waterbodies. In general, Gowanus Canal area residents visit the Canal less frequently than other New York City residents. Only 16 percent of area residents have visited

Gowanus Canal at some point, and 12 percent have done so in the prior 12 months. Those who have visited the Canal within the prior 12 months responded that they visit the Canal an average of 13 times per year but the median number of visits was only four visits per year. Amongst those area residents who are aware of Gowanus Canal but have never visited the Canal, 45 percent responded that there was no particular reason for not visiting the Canal, 25 percent responded that they do not visit the Canal because of waterbody conditions and 21 percent responded that it was because of riparian conditions. The most common reason cited that waterbody conditions have discouraged visiting Gowanus Canal is odors, followed by pollution, and lastly, trash in the water or dirty appearance of the water. Additionally, area residents surveyed responded that trash and unclean conditions of riparian areas have also discouraged visiting the Canal.

The number of are residents that have participated in waterbody-related activities at Gowanus Canal represents 20 percent of those who have ever visited the Canal and only three percent of the total area residents surveyed. The most common response indicated that fishing at Gowanus Canal is the preferred activity amongst those who have ever visited the Canal. The second most common response was on-water activities such as boating, canoeing, kayaking and sailing. In-water activities were the least popular, with only jet skiing reported by any respondents (approximately 1 percent of respondents who have visited the Canal). No respondents reported swimming, wading, or surfing in Canal waters. Among the respondents who have never participated in water activities while visiting Gowanus Canal, 20 percent responded that there was no particular reason for not engaging in water activities, but 18 percent responded that pollution was the reason for not participating in water activities and 12 percent responded that garbage in or on the water and the dirty appearance of the water was their main reason for not participating.

Riparian-based activities appear to be more popular than in-water activities for Gowanus Canal. Forty-two percent of area residents who have visited Gowanus Canal, and 7 percent of all residents surveyed, responded that they had participated in activities in riparian areas of Gowanus Canal. In comparison to all New York City residents surveyed, riparian activities at Gowanus Canal is a slightly less popular activity than at other primary waterways in New York City. The compilation of Gowanus Canal area responses suggest that sports are the most-favored land-based activity occurring at or nearby the Canal. The second most likely activity was reported as walking or strolling along riparian areas. Seven to eight percent of visitors also reported having engaged in games at these areas or simply visited to view the water. Eating and dining was the least-frequent activity occurring along Gowanus Canal.

6.3.3 Improvements to Gowanus Canal

Almost one half of Gowanus Canal area residents responded that they have noticed improvements in New York City waterways in the past five years, although only seven percent noticed improvements in Gowanus Canal specifically. This response is generally consistent with other New York City residents interviewed during the telephone survey. Water quality, appearance, and color were the most frequently mentioned improvements by respondents. Although other improvements also cited were cleaner and better waterways and improved availability of park benches.

Gowanus Canal area residents who were aware of the Canal as their primary waterbody mostly agreed that, if funds were available, they would like to see further improvements to the Canal (41 percent). In general, this response was in agreement with and slightly stronger than other New York City residents (38 percent). Within the group of residents that identified a desire for Gowanus Canal improvements, 34 percent felt that the improvements were extremely important and 30 percent felt that improvements were somewhat important. Additionally, it should be noted that 29 percent of the residents that responded that improvements were needed for Gowanus Canal, were not sure how strongly they felt about the improvements. Only a small percentage of the residents did not care much about or did not care at all for the identified improvements. Among those who specifically expressed a desire for water quality, appearance, and odor improvements, more than half (53 percent) felt these improvements were extremely important and 39 percent felt it was somewhat important.

Additionally, among area residents who felt that waterbody improvements were extremely important, 47 percent responded that they would be willing to pay a range of $10 to $25 a year for that improvement, but 15 percent responded that they would not be willing to pay anything for the desired improvement. In general, 39 percent of the New York City residents with similar attitudes towards improvements to their primary waterbody responded that they would be willing to pay for those improvements, and 22 percent responded that they would not be willing to pay for anything.

Finally, of area residents who felt that water quality improvements in particular were extremely important, 49 percent responded that they would be willing to pay a range of $10 to $25 a year for that improvement, but 17 percent responded that they would not be willing to pay for the improvement. For New York City residents desiring water quality improvements in their primary waterway, 41 percent responded that they would be willing to pay for those improvements, and 22 percent responded that they would not be willing to pay for anything.

6.4 WATERBODY/WATERSHED STAKEHOLDER TEAM

Public participation is a component of each step in the long-term control planning process described in USEPA guidance. It is a recommended element of system characterization, development and evaluation of alternatives for CSO controls, and selection and implementation of a long-term plan. The NYCDEP convened a local waterbody/watershed stakeholder team for the assessment of Gowanus Canal that represented local residents, businesses, non-governmental organizations, community government, and riparian and waterbody users. The stakeholder team was specifically included in identifying existing conditions and goals for aquatic life, recreation and aesthetic uses. This section describes NYCDEP's efforts under the USA project in convening the stakeholder team, its public representation, and its participation in the waterbody/watershed assessment of Gowanus Canal. Section 6.6 describes additional NYCDEP meetings.

6.4.1 Convening the Stakeholder Team

A local waterbody/watershed stakeholder team was convened specifically for Gowanus Canal by the NYCDEP. In order to create a representative and inclusive Stakeholder Team, the NYCDEP reached out to the local Community Board and to other organizations interested in the Canal. The resulting Stakeholder Team consisted of local government representatives, organizations, residents, and waterbody users. The stakeholder team was recruited through outreach meetings at the local community board and other neighborhood organizations. The Stakeholder Team met periodically throughout 2003 and 2004 during the waterbody/watershed assessment.

The initial outreach for identifying Stakeholder Team members was through the Brooklyn Community Board 6, which encompasses the watershed and Gowanus Canal itself. New York City's community boards provide the first point of contact for public notification and participation for plans and activities of city agencies, including the NYCDEP. The community boards play an advisory role in zoning and other land use issues, in community planning, in the municipal budget process, and in the coordination of municipal services. New York City is divided into 59 Community Districts and each district has an appointed Board of up to 50 unsalaried community members. Gowanus Canal and over 95 percent of its watershed fall within the boundaries of Brooklyn Community Board 6; this community board was therefore selected for the initial solicitation of potential participants for the Stakeholder Team. A presentation of the USA Project and its waterbody/watershed assessment goals was made during a full-board meeting of Brooklyn Community Board 6 on October 7, 2002.

The NYCDEP gave several presentations regarding the USA Project and its waterbody/watershed assessment goals to other organizations for soliciting members of the Stakeholder Team. On August 13, 2002, the NYCDEP met with the Gowanus Canal Community Development Corporation (GCCDC), an organization that promotes waterfront access to the Canal. On October 1, 2002 the NYCDEP also met with the Brooklyn Borough President's Gowanus Canal Task Force, a coordinating body related to the administration of a government grant to GCCDC for local Gowanus Canal planning.

In each of these outreach meetings, the presentation included an overview of the scope, goals and organization of the NYCDEP's USA Project, a brief description of the geography and water quality issues of Gowanus Canal, and an explanation of the nature of the participation requested of potential Stakeholder Team members. As was stated at these meetings, the project sought stakeholder team members with direct involvement or experience of the Gowanus Canal, either as individuals or as representatives of organizations, who would be available for four to six working meetings over the course of twelve to eighteen months.

The above-described presentations were followed up by telephone calls and letters to obtain a full response from Community Board 6. Through this response, and the individual responses of attendees at other presentations, 30 members were identified for the Stakeholder Team.

The Stakeholder Team met in the evening at a local meeting location, Mary Star of the Sea home at 41 First Street, Brooklyn, New York, on five separate occasions through the course of the planning project. These five meetings are broadly summarized below within the categories of long-term control planning efforts. At different times, members of the Stakeholder Team identified the need for outreach meetings supplementary to the standard team meetings. On October 10, 2003, Stakeholder Team members from the South Brooklyn Local Development Corporation organized a daytime meeting with more than a dozen local area business owners to solicit their participation and to inform the NYCDEP of ongoing maritime and industrial uses of Gowanus Canal and its surrounding district.

6.4.2 System Characterization

The first Gowanus Canal Waterbody/Watershed Stakeholder Team meeting was held on April 29, 2003. After a general introduction, members of the Stakeholder Team were each prompted to express their areas of interest, concern and involvement with Gowanus Canal and its district. Taken together, this yielded an initial statement of aspirations of the Canal in terms of recreational use, aquatic habitat, and land use. A waterbody fact sheet and summary of water quality issues was distributed and discussed. The waterbody/watershed assessment methodology and schedule was explained, and the Stakeholder Team was engaged in an initial discussion of land use and riparian issues.

The second Stakeholder Team meeting occurred on June 3, 2003. NYCDEP presented the current status of facility planning for Gowanus Canal. Initial water quality field data was presented. Draft land use and water use characterizations were presented, reviewed by the Stakeholder Team, and amended with their comments.

The third Stakeholder Team meeting was held on August 12, 2003. A list of waterbody and riparian problems and impairments were presented for review and comment. The larger context of land use and riparian planning was reviewed through a draft list and map of planned and proposed beneficial use projects. This led into a more detailed and interactive discussion of current waterbody uses and goals. The Stakeholder Team strongly supported the concept of improved shoreline access to Gowanus Canal and endorsed the current use and potential expansion of recreational boating on the Canal, along with the water quality to support secondary contact recreation. There was consensus on a goal of making the water as clean as possible to support aquatic life and to allow safe contact by recreational users. The Stakeholder Team strongly supported the "mixed use" of the waterbody, feeling that recreational boating could grow and coexist with maritime barge traffic that was expected to continue. While the Stakeholder Team wanted the water to be as clean as possible, the majority of members did not believe that swimming was a desired or practical use for the Canal, in light of the restrictions of the Canal width, the bulkheaded shorelines, and the recreational and maritime boat traffic that was considered appropriate and desirable for the Canal.

6.4.3 Development/Evaluation of Alternatives

The fourth Stakeholder Team meeting on October 14, 2003 reported the comments and use information obtained from the October 10, 2003 meeting with local business owners, and provided an update of area projects and activities that was further refined through member comments. The project team reported more detailed analysis of the components of the sub-watersheds of the Gowanus Canal drainage area, and prompted a discussion of the study methodology and the manner in which the water quality modeling accounted for public (City) and private (State-regulated) outfalls and their effects. The meeting revisited and finalized the discussion of waterbody goals from the third meeting.

A discussion of ways to improve water quality was held during the fourth Stakeholder Team meeting. Water quality and CSO control goals were discussed for Gowanus Canal. The types of control alternatives generally available to meet CSO control goals and those realistically available for Gowanus Canal were reviewed. The costs and benefits of specific alternatives for

Gowanus Canal were preliminarily described. Finally, the process of evaluating and comparing various alternatives for CSO controls were also reviewed. In return, members of the Stakeholder Team recommended investigating green roofs as a long-term strategy for diminishing future CSO events while avoiding the costs of building new infrastructure. The NYCDEP reported that best management practices, such as green roofs, are CSO abatement alternatives have been and continue to be evaluated by the NYCDEP and in some cases, are being planned for pilot testing by the NYCDEP in other locations.

6.4.4 Selection of the Waterbody/Watershed Facility Plan (WWFP)

The fifth and final Stakeholder Team meeting was held on April 20, 2004. There was a final review with the Stakeholder Team of updates and corrections on the illustrative mapping of land use and riparian issues. A presentation of a preliminary waterbody/watershed facility plan commenced with a review of data, the methodology of water quality modeling, and findings. The NYCDEP described the components of use impairments and the findings of cost-benefit analyses that resulted in the selection of engineering alternatives. Projected waterbody use attainment and implementation schedules were reviewed and discussed.

The meeting concluded with summary comments by the Stakeholder Team that were recorded in the meeting's notes. The Stakeholder Team was solicited for submission of comments in addition to those expressed during the meeting but none were received.

As shown in the following sections, an Administrative Consent Order between the NYSDEC and the NYCDEP was subsequently adopted that led to additional Waterbody/Watershed analyses and ultimately resulted in a slightly modified Waterbody/Watershed Facility Plan versus what had been presented previously. As described in Section 6.6 below, NYCDEP conducted additional public meetings, including an additional meeting with the Gowanus Stakeholder Team, to update the public with respect to the Waterbody/Watershed Facility Plan.

6.5 ADMINISTRATIVE CONSENT ORDER

The Administrative Consent Order was published for public comments on September 8, 2004, as part of the overall responsiveness effort on behalf of NYSDEC. The public comment period, originally limited to 30 days, was extended twice to November 15, 2004, to allow for additional commentary. Comments were received from public agencies, elected officials, private and non-profit organizations, and private individuals. In total, NYSDEC received in excess of 600 official comments via letter, facsimile, or email during the comment period. All comments received were carefully reviewed and evaluated, then categorized by thematic elements deemed similar in nature by NYSDEC. Each set of similar comments received a specific, focused response. Many of the comments received, although differing in detail, contained thematic elements similar in nature regarding NYSDEC and NYCDEP efforts toward CSO abatement, water quality issues, standards, and regulatory requirements.

None of the comments received changed the terms of the Order, but the volume of commentary was interpreted by NYSDEC to indicate that "NYC citizenry places CSO abatement as a high ongoing priority" (NYSDEC, 2005). The terms of the Order offer numerous opportunities for public participation and input for future CSO abatement measures and regulatory decisions, such as the requirement to comply with federal CSO policy with regard to public participation during LTCP development.

6.6 ADDITIONAL OUTREACH MEETINGS WITH THE PUBLIC

On April 27, 2006, NYCDEP participated in a community meeting that offered a public forum on the issue of CSO in Gowanus Canal. This meeting, organized by State Senator Velmanette Montgomery and co-sponsored by NYCDEP, NYSDEC, and USACE, was attended by other government policymakers such as Congresswoman Nydia Velazquez, Congressman Major Owens, Senator Martin Connor, Assemblywoman Joan Millman, Assemblyman Felix Ortiz, and City Councilmembers Sara Gonzalez and Bill DeBlasio. Other participants included representatives from federal (USACE, USEPA), state (NYSDEC), local (Brooklyn Community Board 6) and other (Gowanus Canal Community Development Corporation, Friends and Residents of the Greater Gowanus, Urban Divers Estuary, and United Puerto Rican Organization of Sunset Park) groups. James Mueller, NYCDEP, provided a presentation on the City's latest plans to address the CSO Consent Order in Gowanus Canal and fielded questions posed at the forum.

On July 25, 2006, the NYCDEP conducted an additional meeting with the public. This meeting represented the sixth time that NYCDEP met specifically with Gowanus Canal stakeholder groups initially identified and convened during the USA Study. NYCDEP representatives reviewed the status of the long-term control planning process in the context of the requirements of the federal CSO Control Policy and the CSO Consent Order, and informed the group that NYCDEP planned to submit to NYSDEC for approval a Waterbody/Watershed Facility Plan for Gowanus Canal in August 2006 and a Long-Term Control Plan by January 2008, and that NYCDEP sought public questions and comments on the Waterbody/Watershed Facility Plan that was being presented. The NYCDEP also presented a detailed description of the development of the proposed Gowanus Canal Waterbody/Watershed Facility, including other evaluated alternatives as well as the implementation schedule associated with the selected alternatives. Approximately 25 members of the public—including representatives of several stakeholder groups, elected officials, and private citizens—attended the meeting, provided comments, and asked a variety of questions pertaining to the development of the Waterbody/Watershed Facility Plan. The NYCDEP responded to each of the questions and requested that the group provide any additional comments on the Waterbody/Watershed Facility Plan. The NYCDEP provided hard copies of the presentation to all attendees and posted an electronic copy on a special website available to the stakeholders. Minutes from this meeting are presented in Appendix G.

6.7 SPDES PERMITTING AUTHORITY

Any facilities built as a part of this Waterbody/Watershed Facility Plan or water quality standards revision would be subject to the modifications of the Red Hook and Owls Head WPCP SPDES permits and as such would be subject to a formal public review process.

Following NYSDEC review of the Gowanus Canal Waterbody/Watershed Facility Plan and the subsequent Gowanus Canal Long Term Control Plan, the NYCDEP or the NYSDEC will solicit additional public comment through public notice and a public meeting.

6.8 NEW YORK STATE PUBLIC NOTIFICATION

In accordance with the NYSDEC public notification requirements, DEP posted in the Environmental News Bulletin (ENB) a notice of a meeting held jointly between DEP and DEC to provide the public with updates on the Gowanus WB/WSFP process and a forum in which to ask questions and provide feedback. This meeting was held on Tuesday, February 12, 2008 at 6:30 p.m. at P.S. 58, located at 330 Smith Street at Carroll Street in Brooklyn. A copy of the powerpoint presentations shown at this meeting, along with a summary of questions and DEP's responses, is provided in Appendix H.

7.0 Evaluation of Alternatives

As described in Section 4.5, Gowanus Canal currently appears on the NYSDEC "Section 303(d) List of Impaired Waters" for low dissolved oxygen associated with CSO and other urban inputs. The CSO Consent Order requires NYCDEP to complete an approvable Waterbody/Watershed Facility Plan for Gowanus Canal by June 2007. Although a Waterbody/Watershed Facility Plan does not necessarily require consistency with federal CSO Policy for CSO Long Term Control Plans, it is NYCDEP's intention that this Waterbody/Watershed Facility Plan satisfy the requirements of a CSO LTCP.

As previously discussed in Section 5, the NYCDEP has been engaged for many years in water-quality improvement projects and CSO facility planning for the Gowanus Canal waterbody and watershed. The Waterbody/Watershed Facility Plan developed herein builds upon these projects, some of which preceded the current CSO Policy, but nevertheless were consistent with many aspects of the Policy. Aspects of the Inner Harbor Facility Plan (1993), which was approved by NYSDEC, have already been implemented and are being improved upon with subsequent projects such as the Gowanus Facilities Upgrade (2001) and the USA Study, which was in the process of developing a Water Quality Improvement Plan for Gowanus Canal when the CSO Consent Order was signed in 2004 and in turn led to the current CSO LTCP project, of which this document is a product.

This section presents analyses performed to evaluate alternatives for CSO control. These analyses were performed in accordance with federal CSO LTCP guidance and hence satisfy the requirements associated with LTCP development. Section 7.1 summarizes aspects of the regulatory framework for the evaluation of alternatives. Section 7.2 identifies and provides an initial screening of various CSO control alternatives. Section 7.3 describes alternatives investigated during development of the Gowanus Canal Water Quality Improvement Plan. Section 7.4 presents an array of feasible alternatives representing a range of CSO abatement scenarios up to and including 100 percent CSO capture that were specifically evaluated with modeling analyses. Section 7.5 presents a performance versus cost analysis of the feasible alternatives based on projected CSO volumes and frequencies. Section 7.6 describes the model-projected water-quality and use benefits of the evaluated alternatives, and Section 7.7 provides a compliance-attainability analysis based on the modeled projections. Section 7.8 provides an analysis of the remaining factors affecting dissolved oxygen in the Canal after implementation of the Water Quality Improvement Plan. Section 7.9 presents an analysis of CSO transfer and water-quality impacts of the Plan on other waterbodies.

7.1 REGULATORY FRAMEWORK FOR EVALUATION OF ALTERNATIVES

The evaluation of alternatives to address CSO discharges and water quality problems in a particular waterbody involves regulatory considerations that are in addition to those presented in Section 1. The following subsections present a summary of these considerations.

7.1.1 Water-Quality Objectives

As previously described in Sections 1.2.3 and 4.5, Gowanus Canal appears on the NYSDEC "Section 303(d) List of Impaired Waters" due to "dissolved oxygen/oxygen demand" from "urban/storm/CSO" inputs. The NYSDEC has designated Gowanus Canal as a Class SD waterbody subject to a minimum dissolved oxygen concentration of 3.0 mg/L. Therefore, attainment of never-less-than 3.0 mg/L dissolved oxygen is a mandated water-quality objective for Gowanus Canal. Because Class SD waterbodies do not support recreational uses, no bacteria criteria apply in Gowanus Canal. Compliance with NYSDEC narrative water-quality standards for aesthetics – including floatables, sediment mounds and associated odors – is another mandated water-quality objective for Gowanus Canal.

7.1.2 Range of Alternatives

The CSO Consent Order (Section 1.2.5) requires NYCDEP to complete an approvable Waterbody/Watershed Facility Plan for Gowanus Canal by June 2007. Although a Waterbody/Watershed Facility Plan does not necessarily require consistency with federal CSO Policy for CSO LTCPs (Section 1.2.2), it is NYCDEP's intention that this Waterbody/Watershed Facility Plan satisfy the requirements of a CSO LTCP.

The federal CSO Policy calls for LTCPs to consider a number of factors when evaluating CSO control alternatives, as described in Sections II.C.4 and II.C.5 of the Policy (40 CFR 122 [FRL-4732-7]). USEPA expects the analysis of alternatives to be sufficient to make a reasonable assessment of the expected performance and the cost of the alternatives. With regard to performance, USEPA expects the LTCP to "consider a reasonable range of alternatives" in the selection process. The LTCP should consider four or more alternatives, providing a range of control above the existing condition and extending to full elimination of CSOs, as measured in terms of CSO frequency or CSO capture.

7.1.3 "Presumption" and "Demonstration" Approaches

Whether a particular alternative provides sufficient control can be determined in two different ways. In the "Presumption Approach," alternatives that meet any of a number of discharge-based criteria may be "presumed" to provide sufficient CSO control as to meet the water-quality based requirements of the CWA. These discharge-based criteria, which are applicable for an entire combined-sewer system (CSS; e.g., a WPCP drainage area) and not necessarily the drainage area of a particular waterbody, include:

i. no more than an average of four overflow events per year, provided that the permitting authority may allow up to two additional overflow events per year. For the purpose of this criterion, an overflow event is one or more overflows from a CSS as the result of a precipitation event that does not receive a minimum treatment specified below;
ii. the elimination or the capture for treatment of no less than 85 percent by volume of the combined sewage collected in the CSS during precipitation events on a system-wide annual average basis; or

iii. the elimination or removal of no less than the mass of the pollutants […] for the volumes that would be eliminated or captured for treatment under item ii. above.

Combined sewer flows remaining after implementation of the Nine Minimum Controls and within the criteria specified at II.C.4.a.i or ii, should receive a minimum of:

- Primary clarification (Removal of floatables and settleable solids may be achieved by any combination of treatment technologies or methods that are shown to be equivalent to primary clarification.);
- Solids and floatables disposal; and
- Disinfection of effluent, if necessary, to meet WQS, protect designated uses and protect human health, including removal of harmful disinfection chemical residuals, where necessary.

In the "Demonstration Approach," alternatives providing sufficient CSO control are those that, through modeling and/or other analyses, are expected to provide sufficient CSO control as to meet the water-quality based requirements of the CWA. The criteria associated with the Demonstration Approach are:

i. the planned control program is adequate to meet WQS and protect designated uses, unless WQS or uses cannot be met as a result of natural background conditions or pollution sources other than CSOs;
ii. the CSO discharges remaining after implementation of the planned control program will not preclude the attainment of WQS or the receiving waters' designated uses or contribute to their impairment. Where WQS and designated uses are not met in part because of natural background conditions or pollution sources other than CSOs, a total maximum daily load, including a wasteload allocation and a load allocation, or other means should be used to apportion pollutant loads;
iii. the planned control program will provide the maximum pollution reduction benefits reasonably attainable; and
iv. the planned control program is designed to allow cost effective expansion or cost effective retrofitting if additional controls are subsequently determined to be necessary to meet WQS or designated uses.

7.1.4 Cost/Performance Consideration

USEPA expects the permittee to use the costs associated with each of these alternatives to demonstrate the relationships among a comprehensive set of reasonable control alternatives that correspond to the different ranges specified in Section II.C.4. This should include an analysis to determine where the increment of pollution reduction achieved in the receiving water diminishes compared to the increased costs. This analysis, often known as "knee of the curve," should be among the considerations used to help guide selection of controls.

7.1.5 Consideration of Non-CSO Inputs

Load sources other than CSOs were included in the receiving water modeling to assess water-quality conditions. These other inputs consist primarily of stormwater and water entering the Canal via the Flushing Tunnel (from Buttermilk Channel) and via tidal exchange with

Gowanus Bay. Other sources of pollutants of concern were found to be insignificant, and pollutant-reduction alternatives involved CSO reduction as well as increased throughput from the Flushing Tunnel.

7.1.6 Consideration of Other Parameters

Other parameters such as existing waterbody uses and stakeholder goals for waterbody use were taken into account when determining the necessary level of CSO control. Other parameters considered as part of the evaluations of alternatives for Gowanus Canal include the following:

- Waterbody Use: As discussed in Section 2.2.5, Gowanus Canal is entirely within the coastal zone boundary, and its downstream reaches have been designated a Significant Maritime and Industrial Area (SMIA) through the Waterfront Revitalization Program (WRP), which promotes public investment to improve transportation access and maritime and industrial operations. This designation likely precludes future designation for primary contact recreational uses in the waterbody due to the potential use conflict it would represent.

- Aquatic Life Uses: Aquatic life in Gowanus Canal was characterized under the USA project and is described in detail in Section 4.

- Sensitive Areas: As discussed in Section 4, the NYSDEC, as the permitting authority, has not designated Gowanus Canal as a sensitive area. There are no areas within the Canal that satisfy the CSO Control Policy criteria for sensitive areas. Therefore, prioritization of goals, selection of control alternatives, and scheduled implementation of these alternatives can be given to those alternatives that most reasonably attain the maximum benefit to water quality throughout the Canal.

- Stakeholder Goals: As discussed in Section 6, stakeholder goals for the waterbody include balancing existing commercial/industrial maritime uses with secondary-contact recreational uses, and improving pathogen levels in the Canal to support these recreational uses. There was consensus on a goal of making the water as clean as possible to support aquatic life. Finally, since planned projects for riparian zones will increase access to the Canal, improved aesthetic conditions are desired, including the removal of sediment mounds, odors, oil slicks, and floatables.

7.2 IDENTIFICATION OF ALTERNATIVE CSO CONTROL TECHNOLOGIES

A wide range of CSO control technologies was considered for application to New York City's Combined Sewer System (CSS). The technologies are grouped into the following general categories:

- Source Control
- Inflow Control
- Sewer System Optimization
- Green Solutions
- Sewer Separation

- Storage
- Treatment
- Receiving Water Improvement
- Floatables Control

Each technology is described below along with a discussion of the suitability of implementing it as a control technology for Gowanus Canal. Table 7-1 lists the various CSO control technologies typically included within each of the general categories. Information is provided regarding implementation and operational factors that should be considered when evaluating the control technologies for a given locale. The table also indicates the general effectiveness of each control technology for four performance criteria including CSO volume reduction, bacteria reduction, floatables capture, and suspended solids reduction. It should be noted that a technology receiving "low" or "none" for some performance parameters does not preclude that technology from being considered for Gowanus Canal. There are other areas where the control technology could be effective, such as improving dissolved oxygen in the waterbody, or the technology could be utilized in conjunction with another control technology. In some instances, technologies with a low or medium impact in a performance area could be effective when implemented in conjunction with another technology.

Table 7-1. Assessment of CSO Control Technologies

CSO Control Technology	Performance				Implementation and Operational Factors
	CSO Volume	Bacteria	Floatables	Suspended Solids	
Source Control					
Public Education	None	Low	Med.	Low	Cannot reduce the volume, frequency or duration of CSO overflows.
Street Sweeping	None	Low	Med.	Med.	Effective at floatables removal, cost-intensive O&M. Ineffective at reducing CSO volume, bacteria and very fine particulate pollution.
Construction Site Erosion Control	None	Low	Low	Med.	Reduces sewer sediment loading, enforcement required. Contractor pays for controls.
Catch Basin Cleaning	None	Very Low	Med.	Low	Labor intensive, requires specialized equipment.
Industrial Pretreatment	Low	Low	Low	Low	There is limited industrial activity in and out of combined sewer area.
Inflow Control					
Storm Water Detention	Med.	Med.	Med.	Med.	Requires large area in congested urban environment, potential siting difficulties and public opposition, construction would be disruptive to affected areas, increased O&M.
Street Storage of Storm Water	Med.	Med.	Med.	Med.	Potential flooding and freezing problems, public opposition, low operational cost.
Water Conservation	Low	Low	Low	Low	Potentially reduces dry weather flow making room for CSO, ancillary benefit is reduced water consumption
Inflow/Infiltration Control	Low	Low	Low	Low	Infiltration usually lower volume than inflow, infiltration can be difficult to control

Table 7-1. Assessment of CSO Control Technologies

CSO Control Technology	Performance				Implementation and Operational Factors
	CSO Volume	Bacteria	Floatables	Suspended Solids	
Green Solutions					
Bioretention	Med.	Med.	Med.	Med.	Site specific, requires widespread application across city to be effective, potential to be cost intensive in some areas.
Dry Wells	Med.	Med.	Low	Med.	Site specific, low cost, good BMP for residential areas, requires interaction with homeowners and businesses, widespread participation required to be effective.
Filter Strips	Med.	Med.	Low	Med.	Site specific, low cost, good BMP for parking lots, requires interaction with private owners in residential areas, requires widespread application across city to be effective.
Vegetated Buffers	Med.	Med.	Med.	Med.	Site specific, low cost, good BMP for parking lots, requires interaction with homeowners in residential areas, requires widespread application across city to be effective.
Level Spreader	Low	Low	Low	Med.	Site specific, must be used in conjunction with other Green Solution techniques, low cost.
Grassed Swales	Med.	Med.	Low	Med.	Site specific, requires widespread application across city to be effective, potential to be cost-intensive in some areas.
Rain Barrels	Low	Low	Low	Low	Good BMP for residential areas, minimal capture of total runoff volume, requires barrel coverage to inhibit mosquitoes, low cost, requires interaction with home and business owners.
Cisterns	Med.	Med.	Low	Med.	Site specific, requires widespread application across city to be effective, potential to be cost-intensive in some areas.
Infiltration Trenches/Catch Basins	Med.	Med.	Med.	Med.	Site specific, low cost, good BMP for residential areas, widespread participation required to be effective.
Rooftop Greening	Med.	Low	Low	Med.	Site specific, cost intensive, non-intrusive construction, other beneficial effects to city, requires widespread application to be effective, requires interaction with all property owners.
Increased Tree Cover	Low	Low	None	Low	Site specific, low cost, little capture of stormwater runoff, other beneficial effects to city.
Permeable Pavements	Med.	Med.	Low	Med.	Site specific, cost intensive, subject to clogging, increased O&M costs, labor intensive.
Sewer System Optimization					
Optimize Existing System	Med.	Med.	Med.	Med.	Low cost relative to large scale structural BMPs, limited by existing system volume and dry weather flow dam elevations.
Real Time Control	Med.	Med.	Med.	Med.	Highly automated system, increased O&M, increased potential for sewer backups.
Sewer Separation					
Complete Separation	High	Med.	Low	Low	Disruptive to affected areas, cost intensive, potential for increased stormwater pollutant loads, requires homeowner participation.
Partial Separation	High	Med.	Low	Low	Disruptive to affected areas, cost intensive, potential for increased stormwater pollutant loads.
Rain Leader Disconnection	Med.	Med.	Low	Low	Low cost, requires home and business owner participation, potential for increased storm water pollutant loads.

Table 7-1. Assessment of CSO Control Technologies

CSO Control Technology	Performance				Implementation and Operational Factors
	CSO Volume	Bacteria	Floatables	Suspended Solids	
Storage					
Closed Concrete Tanks	High	High	High	High	Requires large space, disruptive to affected area, cost intensive, aesthetically acceptable.
Storage Pipelines/Conduits	High	High	High	High	Disruptive to affected areas, potentially expensive in congested urban areas, aesthetically acceptable, provides storage and conveyance.
Tunnels	High	High	High	High	Non-disruptive, requires little area at ground level, capital intensive, provides storage and conveyance, pump station required to lift stored flow out of tunnel.
Treatment					
Screening/ Netting Systems	None	None	High	None	Controls only floatables.
Primary Sedimentation(1)	Low	Med.	High	Med.	Limited space at WPCP, difficult to site in urban areas.
Vortex Separator (includes Swirl Concentrators)	None	Low	High	Low	Variable pollutant removal performance. Depending on available head, may require foul sewer flows to be pumped to the WPCP and other flow controls with increased O&M.
High Rate Physical/Chemical Treatment[1]	None	Med.	High	High	Limited space at WPCP, requires construction of extensive new conveyance conduits, high O&M costs.
Disinfection	None	High	None	None	Cost Intensive/Increased O&M.
Expansion of WPCP	High	High	High	High	Limited by space at WPCP, increased O&M.
Receiving Water Improvement					
Outfall Relocation	High	High	High	High	Relocates discharge to different area, requires the construction of extensive new conveyance conduits.
In-stream Aeration	None	None	None	None	High O&M, only effective for increasing DO, limited effective area.
Maintenance Dredging	None	None	None	None	Removes deposited solids after build-up occurs.
Solids and Floatables Controls					
Netting Systems	None	None	High	None	Easy to implement, potential negative aesthetic impact
Containment Booms	None	None	High	None	Simple to install, difficult to clean, negative aesthetic impact
Skimming Vessels	None	None	High	None	Easy to implement but limited to navigable waters
Manual Bar Screens	None	None	High	None	Prone to clogging, requires manual maintenance
Weir Mounted Screens	None	None	High	None	Relatively low maintenance, requires suitable physical configuration, must bring power to site
Fixed baffles	None	None	High	None	Low maintenance, easy to install, requires proper hydraulic configuration
Floating Baffles	None	None	High	None	Moving parts make them susceptible to failure
Catch Basin Modifications/Hooding	None	None	High	None	Requires suitable catch basin configuration and increases maintenance efforts

(1) Process includes pretreatment screening and disinfection

7.2.1 Source Control

To control pollutants at their source, management practices can be applied where pollutants accumulate. Source management practices are described below:

- Public Education – Public education programs can be aimed at reducing (1) littering by the public and the potential for litter to be discharged to receiving waters during CSO events and (2) illegal dumping of contaminants in the sewer system that could be discharged to receiving waters during rain events. Public education programs cannot reduce the volume, frequency or duration of CSO overflows, but can help improve CSO quality by reducing floatable debris in particular. Public education and information is an integral part of any LTCP. Public Education is also an ongoing activity within NYCDEP as described in the report New York City Floatable Litter Reduction: Institutional, Regulatory and Public Education Programs, (HydroQual, 2005a).

- Street Sweeping – The major objectives of municipal street cleaning are to enhance the aesthetic appearance of streets by periodically removing the surface accumulation of litter, debris, dust and dirt, and to prevent these pollutants from entering storm or combined sewers. Common methods of street cleaning are manual, mechanical and vacuum sweepers, and street flushing. Studies on the effect of street sweeping on the reduction of floatables and pollutants in runoff have been conducted. New York City found that street cleaning can be effective in removing floatables (HydroQual, 1995). The Department of Sanitation of New York City employs a regular street sweeping program and an aggressive enforcement program targeting property owners to minimize the amount of litter on their sidewalks. These programs are described in New York City's City-Wide Comprehensive CSO Floatables Plan (HydroQual, 2005b).

  Studies, funded by the National Urban Renewal Program (NURP) during the late 1970s to the early 1980s, reported that street sweeping was generally ineffective at removing pollutants and improving the quality of urban runoff (MWCOG, 1983 and USEPA, 1983). The principal reason for this is that mechanical sweepers, employed at the time, cannot pick up the finer particles (diameter < 60 microns). Studies have shown that these fine particles contain a majority of the target pollutants on city streets that are washed into sewer systems (Sutherland, 1995). In the early 1990s new vacuum-assisted sweeper technology was introduced that can pick up the finer particles along city streets. A recent study showed that these vacuum-assisted sweepers have a 70 percent pickup efficiency for particles less than 60 microns (Sutherland, 1995).

  Street sweeping only affects the pollutant concentration in the runoff component of combined sewer flows. Thus, a street sweeping program is ineffective at reducing the volume and frequency of CSO events. Furthermore, the total area accessible to sweepers is limited. Areas such as sidewalks, traffic islands, and congested street parking areas cannot be cleaned using this method.

  Although a street sweeping program employing high efficiency sweepers could reduce the concentrations of some pollutants in CSOs, bacteriological pollution originates primarily from the sanitary component of sewer flows. Thus, minimal reductions in fecal coliform and *E. coli* concentrations of CSOs would be expected.

- Construction Site Erosion Control – Construction site erosion control involves management practices aimed at controlling the washing of sediment and silt from disturbed land associated with construction activity. Erosion control has the potential to reduce solids concentrations in CSOs and reduce sewer cleanout O&M costs.

- Catch Basin Cleaning – The major objective of catch basin cleaning is to reduce conveyance of solids and floatables to the combined sewer system by regularly removing accumulated catch basin deposits. Methods to clean catch basins include manual, bucket, and vacuum removal. Cleaning catch basins can only remove an average of 1-2 percent of the BOD_5 produced by a combined sewer watershed (USEPA, 1978). As a result catch basins cannot be considered an effective pollution control alternative for BOD removal. While catch basins can be effective in reducing floatables in combined sewers, catch basin cleaning does not necessarily increase floatables retention in the catch basin.

  As described in its City-Wide Comprehensive CSO Floatables Plan (HydroQual, 2005b), New York City has an aggressive catch basin hooding program to contain floatables within catch basins and remove the material through catch basin cleaning.

- Industrial Pretreatment – Industrial pretreatment programs are geared toward reducing potential contaminants in CSO by controlling industrial discharges to the sewer system. NYCDEP has an industrial pretreatment program as described in Section 3.5.5.

As noted in the previous descriptions of the source control technologies, the City already has myriad source-control programs in place. Public education and dissemination of information are ongoing NYCDEP activities. The City's CEQR program addresses construction site erosion control. The City's City-Wide Comprehensive CSO Floatables Plan features both street sweeping and catch basin cleaning as source-control elements. Finally, the City's successful industrial pretreatment program has been in place since January 1987. Therefore, source controls are already being effectively implemented to a satisfactory level.

7.2.2 Inflow Control

Inflow control involves eliminating or retarding storm water inflow to the combined sewer system, lowering the magnitude of the peak flow through the system, and thereby reducing overflows. Methods for inflow control are described below:

- Storm Water Detention – Storm water detention utilizes a surface storage basin or facility to capture storm water before it enters the combined sewer system. Typically, a flow restriction device is added to the catch basin to effectively block storm water from entering the basin. The storm water is then diverted along natural or man-made drainage routes to a surface storage basin or "pond-like" facility where evaporation and/or natural soil percolation eventually empties the basin. Such systems are applicable for smaller land areas, typically up to 75 acres, and are more suitable for non-urban areas. Such a system is not considered viable for a highly congested urban area such as New York City. Storm water blocked from entering catch basins would be routed along streets to the detention pond which would be built in the urban environment. Extensive public education and testing is required to build support for this control and to address public concerns such as potential unsafe travel conditions, flood damage, and damage to roadways.

- Street Storage of Storm Water – Street storage of storm water utilizes the City's streets to temporarily store storm water on the road surface. Typically, the catch basin is modified to include a flow restriction device. This device limits the rate at which surface runoff enters the combined sewer system. The excess storm water is retained on the roadway entering the catch basin at a controlled rate. Street storage can effectively reduce inflow during peak periods and can decrease CSO volume. It also can promote street flooding and must be carefully evaluated and planned to ensure that unsafe travel conditions and damage to roadways do not occur. For these reasons, street storage of storm water is not considered a viable CSO control technology in New York City.

- Water Conservation, Infiltration/Inflow (I/I) Reduction - Water conservation and infiltration control are both geared toward reducing the dry weather flow in the system, thereby allowing the system to accommodate more CSO. Water conservation includes measures such as installing low flow fixtures, public education to reduce wasted water, leak detection and correction, and other programs. The City of New York has an on-going water conservation and public education program. The NYCDEP's ongoing efforts to save water include: installing home meters to encourage conservation; use of sonar equipment to survey all water piping for leaks; replacement of approximately 70 miles of old water supply pipe a year; and equipping fire hydrants with special locking devices. These programs in conjunction with other on-going water conservation programs have resulted in the reduction of water consumption by approximately 200 MG per day over a 12 year period.

  Infiltration is ground water that enters the collection system through leaking pipe joints, cracked pipes, manholes, and other similar sources. Excessive amounts of infiltration can take up hydraulic capacity in the collection system. In contrast, inflow in the form of surface drainage is intended to enter the CSS. For combined sewer communities, sources of inflow that might be controlled include leaking or missing tide gates and inflow in the separate sanitary system located upstream of the CSS. New York City has achieved significant reductions in wastewater flow through its existing water conservation program.

- Green Solutions/Low Impact Development – For the purposes of this Waterbody/Watershed Facility Plan, "green solutions" encompasses a range of techniques that includes stormwater best management practices (BMPs) and low-impact development (LID) as well as source-control technologies. The goal of green solutions is to mimic predevelopment site hydrology to store, infiltrate, evaporate, and detain runoff to reduce both the volume of stormwater generated by a site and its peak overflow rate. Green solutions are promising, and their potential benefits extend beyond stormwater management to include habitat restoration, heat island mitigation, and urban aesthetics.

There are several complicating factors to implementing green solutions in a City-wide, programmatic way. Prior to NYCDEP's Jamaica Bay Watershed Protection Plan (October 2007), few studies had been conducted for applying green solutions to ultra-urban areas such as New York City, where lack of available space, existing infrastructure and land acquisition issues tend to counterbalance the environmental benefits of implementation. As a result, many uncertainties associated with BMPs remain, including cost of BMP installations in New York City, operation and maintenance requirements and related costs, and seasonal variations in BMP performance. In addition, it will be necessary to obtain input and acceptance by numerous City agencies, including the Department of Parks and Recreation, the Department of Transportation, and the Department of Buildings. Further, because many of these technologies are distributed in nature (i.e., constructed within individual properties), time is required to achieve the penetration rate necessary for enough of these source-control measures to be in place to have an impact on stormwater inflows to the combined sewers. NYCDEP is undertaking a number of BMP pilot projects to determine the efficacy and applicability of each BMP, identify maintenance needs and schedules, address other uncertainties associated with the performance of BMPs under New York City-specific climate and site conditions and share these pilot results and findings with other City agencies and the Mayor's Office.

Because of these complicating factors, green solutions are not retained as alternatives to be included in the Waterbody/Watershed Facility Plan subject to the enforcement under the CSO Consent Order. However, green solutions will continue to undergo the rigorous level of evaluation necessary for programmatic implementation by the City of New York through parallel planning efforts as described in detail in Section 5. NYCDEP will provide updates on these evaluations and will incorporate the most promising technologies into the CSO program where possible, cost effective, and environmentally beneficial. Any solution satisfying these criteria would be included through a future modification when the Waterbody/Watershed Facility Plan is converted to a Drainage Basin Specific LTCP or in the subsequent City-Wide LTCP.

7.2.3 Sewer System Optimization

This CSO control technology involves making the best use of existing facilities to limit overflows. The techniques are described below:

- Optimize Existing System – This approach involves evaluating the current standard operating procedures for facilities such as pump stations, control gates, inflatable dams, and treatment facilities to determine if improved operating procedures can be developed to provide benefit in terms of CSO control.

  As described in Section 5, previous and ongoing NYCDEP projects routinely consider alternatives to operating procedures to optimize the existing system. The operating procedures are satisfactorily implemented under the existing system. Elevated static weir heights, opportunities for inflatable dams and/or control gates, and similar alternatives have been eliminated from further consideration in light of the unacceptably high risk that these alternatives would pose to flooding in the community. However, as the Gowanus Facilities Upgrade project is implemented and the existing system changes, NYCDEP will continue to look for new opportunities to optimize the system.

- Real Time Control (RTC) – RTC is any response – manual or automatic – made in response to changes in the sewer system condition. For example, sewer level and flow data can be measured in "real time" at key points in the sewer system and transferred to a control device such as a central computer where decisions are made to operate control components (such as gates, pump stations or inflatable dams) to maximize use of the existing sewer system and to limit overflows. Data monitoring need not be centralized; local dynamic controls can be used to control regulators to prevent localized flooding. However, system wide dynamic controls are typically used to implement control objectives such as maximizing flow to the WPCP or transferring flows from one portion of the CSS to another to fully utilize the system. Predictive control, which incorporates use of weather forecast data is also possible, but is complex and requires sophisticated operational capabilities. RTC can reduce CSO volumes where in-system storage capacity is available. In-system storage is a method of using excess sewer capacity by containing combined sewage within a sewer and releasing it to the WPCP after a storm event when capacity for treatment becomes available. Methods of equipping sewers for in-system storage include inflatable dams, mechanical gates and increased overflow weir elevations. RTC is being developed in other cities such as Louisville, Kentucky; Cleveland, Ohio; and Quebec, Canada. Refer to Figure 7-1 for a diagram of an example inflatable dam system.

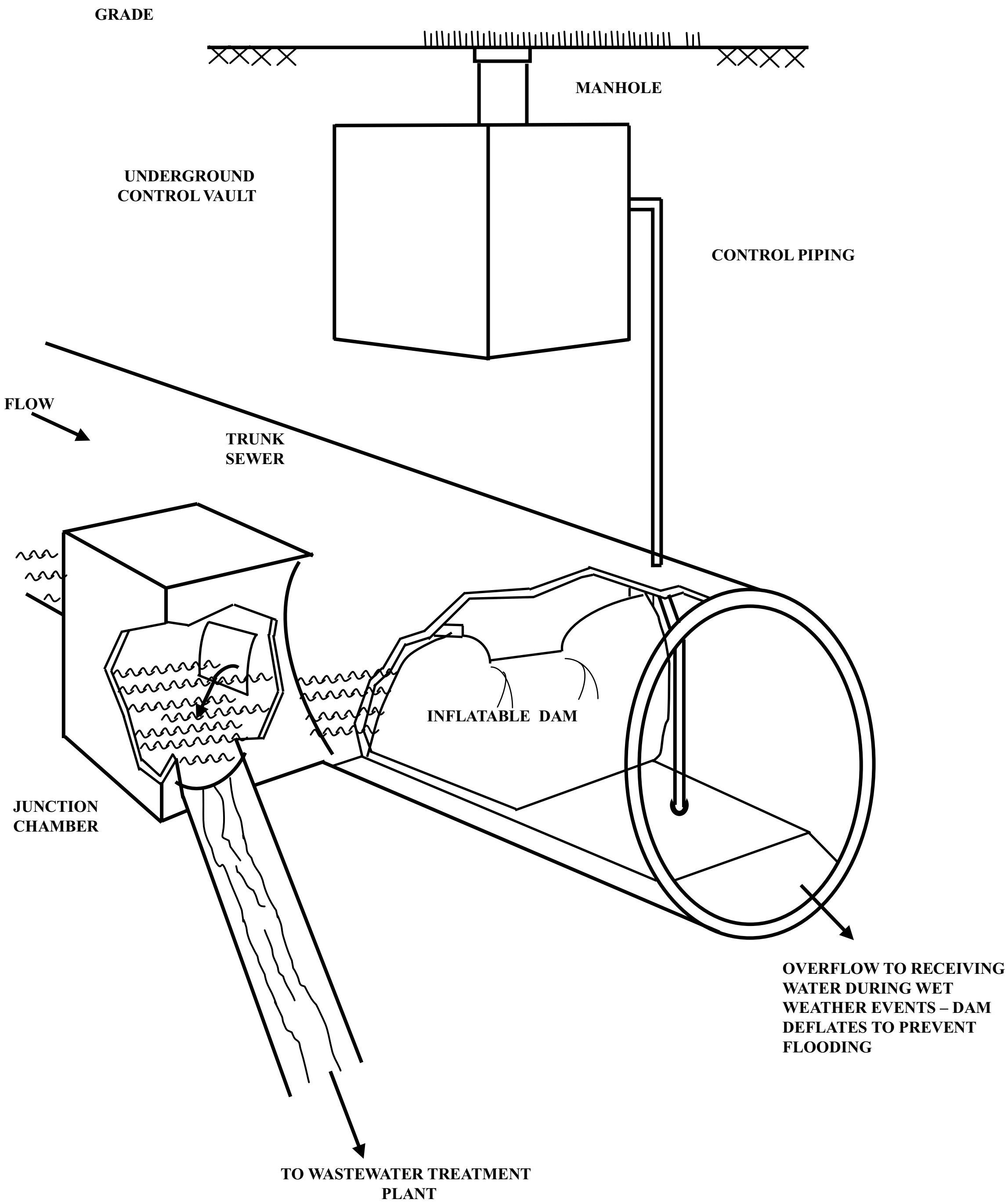
  New York City has conducted an extensive pilot study of the use of inflatable dams (O'Brien & Gere, 2004) within the City's combined sewers. The results of this study have led to the use of inflatable dams and RTC to control them at two locations (Metcalf Avenue and Lafayette Avenue) in the Bronx.

  Widespread application of inflatable dams and RTC is limited in NYC as it does not provide for storage of large enough volumes of combined sewage, in areas where tributary water quality is degraded, to provide adequate improvements in water quality. This is the case in the Gowanus Canal sewershed, where the lack of any significant available in-line storage capacity limits RTC's ability to reduce CSO volume without causing sewer backups.

7.2.4 Sewer Separation

Sewer separation is the conversion of a combined sewer system into a system of separate sanitary sewers and storm sewers. This alternative prevents sanitary wastewater from being discharged to receiving waters. However, when combined sewers are separated, storm sewer discharges to the receiving waters will increase since storm water will no longer be captured and treated in the combined sewer system. Loading of some pollutants, such as floatables, would increase with sewer separation because concentrations of these pollutants are higher in storm water than in sanitary sewage. In addition, this alternative involves substantial excavation that would exacerbate street disruption problems within the City.

Varying degrees of sewer separation could be achieved as described below and illustrated in Figure 7-2:



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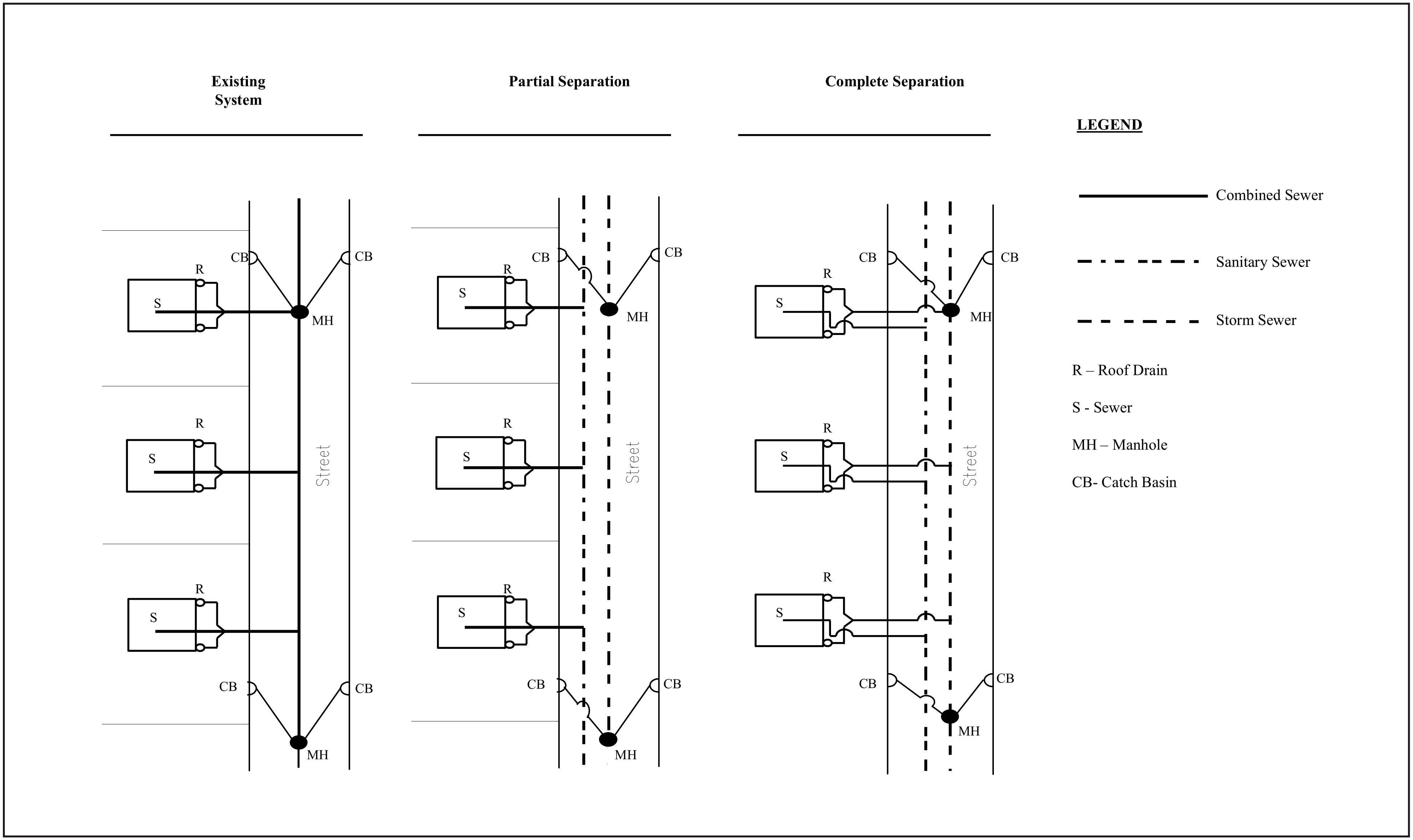
Inflatable Dam System

FIGURE 7-1



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Sewer Separation Alternatives

FIGURE 7-2

- Rain Leader (Gutters and Downspouts) Disconnection – Rain leaders are disconnected from the combined sewer system with storm runoff diverted elsewhere. Depending on the locale, leaders may be run to a dry well, vegetation bed, a lawn, a storm sewer or the street. Unfortunately, in areas such as the Gowanus Canal watershed, lack of substantial pervious areas (lawns, etc.) severely limits the ability to disperse the storm runoff into the ground. As a result, this scheme contributes to nuisance flooding and potentially to wet foundations and basements, and is also against existing building codes established for health and safety reasons. Furthermore, this scheme may only briefly delay runoff from entering the combined sewer systems through catch basins.

- Partial Separation – Combined sewers are separated in the streets only, or other public rights-of way. This is accomplished by constructing either a new sanitary wastewater system or a new storm water system.

- Complete Separation – In addition to separation of sewers in the streets, storm water runoff from private residences or buildings (i.e. rooftops and parking lots) is also separated. Complete separation is almost impossible to attain in New York City since it requires re-plumbing of apartment buildings, office buildings and commercial buildings where roof drains are interconnected to the sanitary plumbing inside the building.

As indicated above, partial or complete separation requires construction of a new, stormwater-only conduit to the waterbody. This element would require widespread excavation and lengthy timeframes to implement broadly across the Gowanus Canal drainage area. The associated street disruption and, in many portions of the area, fragile historical buildings would make it infeasible in much of the area. However, in other areas that are adjacent to the waterbody, particularly those undergoing new development projects, partial separation through construction of high level storm sewers (HLSS) is a potentially feasible alternative that is featured in the New York City Mayor's "PlaNYC 2030" initiative, issued in December 2006. As such, while partial separation will not be retained as an alternative for this Waterbody/Watershed Facility Plan, NYCDEP will continue to promote and support opportunities for local partial separation through the construction of HLSS as new development continues into the future.

7.2.5 Storage

The objective of retention facilities (also referred to as off-line storage) is to reduce overflows by capturing combined sewage in excess of WPCP capacity during wet weather for controlled release into wastewater treatment facilities after the storm. Retention facilities can provide a relatively constant flow into the treatment plant and thus reduce the size of treatment facilities required. Retention facilities have had considerable use and are well documented. Retention facilities may be located at overflow points or near dry weather or wet weather treatment facilities. A major factor determining the feasibility of using retention facilities is land availability. Operation and maintenance costs are generally small, typically requiring only collection and disposal cost for residual sludge solids, unless inlet or outlet pumping is required. Many demonstration projects have included storage of peak storm water flows, including those in Richmond, Virginia; Chippewa Falls, Wisconsin; Boston, Massachusetts; Milwaukee, Wisconsin; and Columbus, Ohio.

The following are types of CSO retention facilities:

- Closed Concrete Tanks – Closed concrete tanks are similar to open tanks except that the tanks are covered and include many mechanical facilities to minimize their aesthetic and environmental impact. Closed concrete tanks typically include odor control systems, washdown/solids removal systems, and access for cleaning and maintenance. Closed concrete tanks have been constructed below grade such that the overlying surface can be used for parks, playgrounds, parking or other light public uses.

- Storage Pipelines/Conduits – Large diameter pipelines or conduits can provide significant storage in addition to the ability to convey flow. The pipelines are fitted with some type of discharge control to allow flow to be stored within the pipeline during wet weather. After the rain event, the contents of the pipeline are allowed to flow by gravity along its length. A pipeline has the advantage of requiring a relatively small right-of-way for construction. The primary disadvantage is that it takes a relatively large diameter pipeline or cast-in-place conduit to provide the volume required to accommodate large periodic CSO flows requiring a greater construction effort than a pipeline used only for conveyance. For large CSO areas, pipeline size requirements may be so large that construction of a tunnel is more feasible.

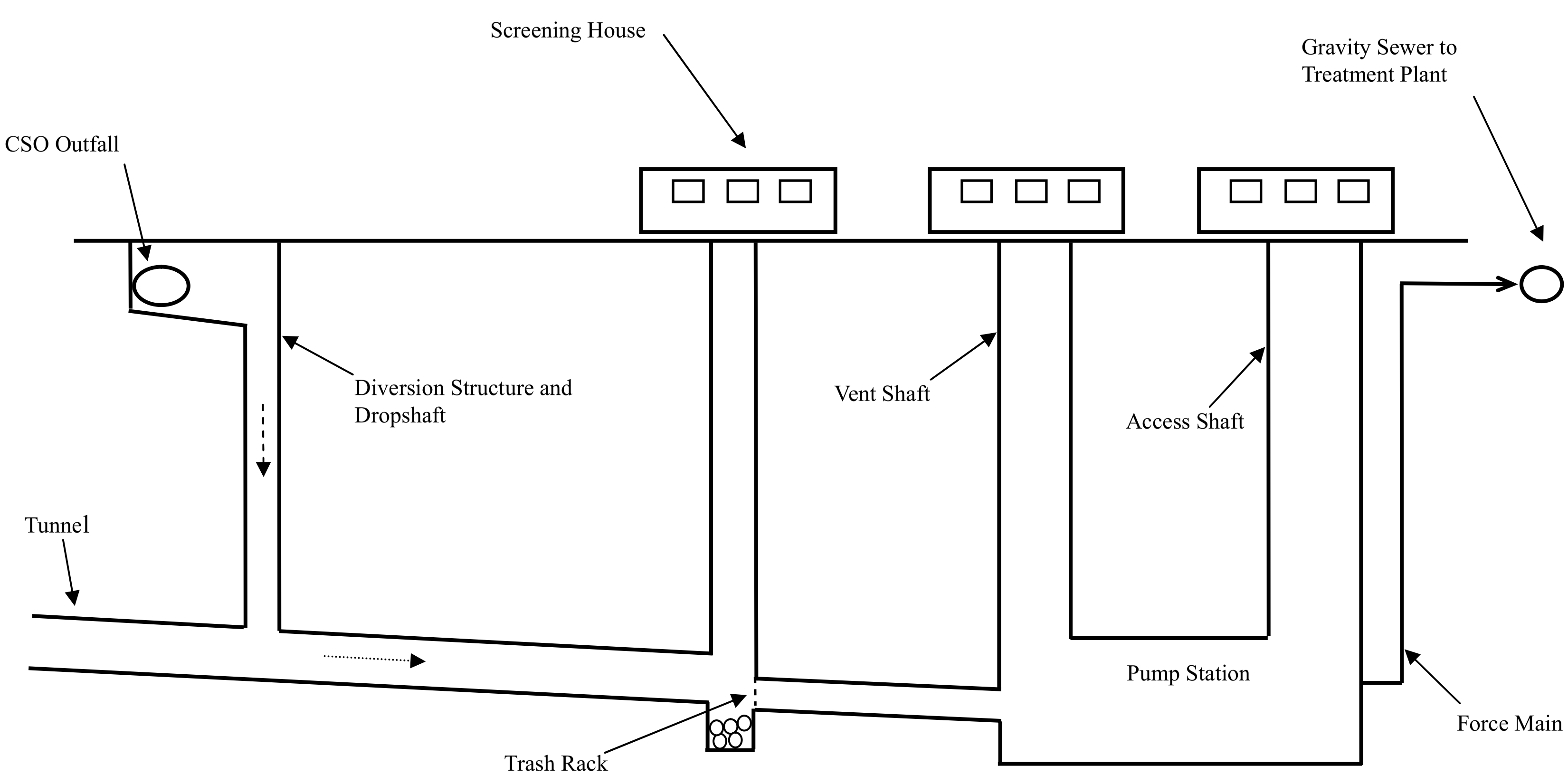
- Tunnels – Tunnels are similar to storage pipelines in that they can provide both significant storage volume and conveyance capacity. Tunnels have the advantage of causing minimal surface disruption and of requiring little right-of-way for construction. Excavation to construct the tunnel is carried out deep beneath the city and therefore would not impact traffic. The ability to construct tunnels at a reasonable cost depends on the geology. Tunnels have been used in many CSO control plans including Chicago, Illinois; Rochester, New York; Cleveland, Ohio; Richmond, Virginia; and Toronto, Canada, among others. A schematic diagram of a typical storage tunnel system is shown in Figure 7-3. The storage tunnel stores flow and then conveys it to a dewatering station where floatables are removed at a screening house and then flows are lifted for conveyance to the WPCP.

CSO retention facilities have been successfully utilized in various locations, including New York City. In light of their operational history, each of the three retention facility types listed above will be retained for further consideration.

7.2.6 Treatment

Treatment alternatives include technologies intended to separate solids and/or floatables from the combined sewage flow, disinfect for pathogens treatment, or provide secondary treatment for some portion of the combined flow. The following are types of treatment technologies:

- Screening – The major objective of screening is to provide high rate solids/liquid separation for combined sewer floatables and debris thereby preventing floatables from entering receiving waters. The following categories of screens are applicable to CSO outfall applications:



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Storage Tunnel Schematic

FIGURE 7-3

- Trash Racks and Manually Cleaned Bar Racks – Trash racks are intended to remove large objects from overflow and have a clear spacing between approximately 1.5 to 3.0 inches. Manually cleaned bar racks are similar and have clear spacings between 1.0 to 2.0 inches. Both screens must be either manually raked and the screenings allowed to drain before disposal, or cleaned with a Vactor truck.

- Netting Systems – Netting Systems are intended to remove floatables and debris at CSO outfalls. A system of disposable mesh bags is installed in either a floating structure at the end of the outfall or in an underground chamber on the land side of the outfall. Nets and captured debris must be periodically removed using a boom truck and disposed of in a landfill.

- Mechanically Cleaned Bar Screens – Mechanically cleaned bar screens typically have clear spacing between 0.25 and 1.0 inches. Bars are mounted 0 to 39 degrees from the vertical and rake mechanisms periodically remove material trapped on the bar screen. Facilities are typically located in a building to house collected screenings that must be collected after a CSO event and then transported to a landfill.

- Fine Screens – Fine screens in CSO facilities typically follow bar screens and have openings between 0.010 and 0.5 inches. Flow is passed through the openings and solids are retained on the surface. Screens can be in the shape of a rotary drum or linear horizontal or vertical screens. Proprietary screens such as ROMAG have been specifically designed for wet weather applications. These screens retain solids on the dry weather side of the system so they can be conveyed to the wastewater treatment plant with the sanitary wastewater thereby minimizing the need for manual collection of screenings.

Manually cleaned screens for CSO control at remote locations have not been widely applied due to the need to clean screens, and the potential to cause flooding if screens blind. Mechanically cleaned screens have had much greater application at CSO facilities. Due to the widely varying nature of CSO flow rates, even mechanically cleaned screens are subject to blinding under certain conditions. In addition, the screening must be housed in a building to address aesthetic concerns and may require odor facilities as well. Fine screens have had more limited application for CSOs in the United States. ROMAG reports that over 250 fine screens have been installed in Europe and several screens have been installed in the United States (USEPA, 1999a).

- Primary Sedimentation – The objective of sedimentation is to produce a clarified effluent by gravitational settling of the suspended particles that are heavier than water. It is one of the most common and well-established unit operations for wastewater treatment. Sedimentation tanks also provide storage capacity, and disinfection can occur concurrently in the same tank. It is also very adaptable to chemical additives, such as lime, alum, ferric chloride, and polymers, which provide higher suspended solids and BOD removal. Many CSO control demonstration projects have included sedimentation. These include Dallas, Texas; Saginaw, Michigan; and Mt. Clements, Michigan (USEPA, 1978). Studies on existing storm water basins indicate suspended solids removals of 15 to 89 percent; BOD_5 removals of 10 to 52 percent (USEPA, 1978, Fair and Geyer, 1965, Ferrara and Witkowski, 1983, Oliver and Gigoropolulos, 1981).

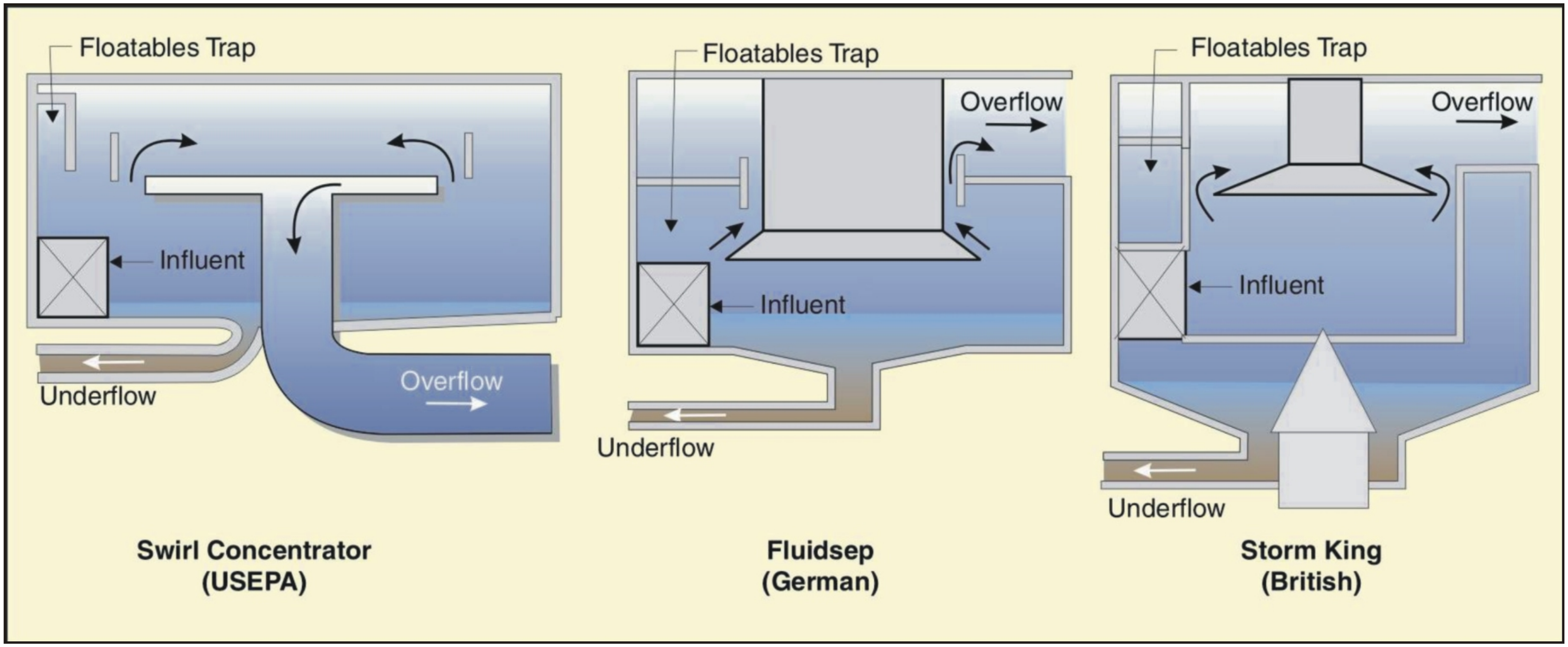
The NYCDEP's WPCPs are designed to accept their respective 2×DDWF for primary treatment during wet weather events. As such, NYC already controls a significant portion of combined sewage through the use of this technology.

- Vortex Separation – Vortex separation technologies currently marketed include: USEPA Swirl Concentrator, Storm King Hydrodynamic Separator of British design, and the FluidSep vortex separator of German design. Although each of the three is configured somewhat differently, the operation of each unit and the mechanisms for solids separation are similar. Flow enters the unit tangentially and is directed around the perimeter of a cylinder, creating a swirling, vortex pattern. The swirling action causes solids to move to the outside wall and fall toward the bottom, where the solids concentrated flow is conveyed through a sewer line to the WPCP. The overflow is discharged over a weir at the top of the unit. Various baffle arrangements capture floatables that are subsequently carried out in the underflow. Principal attributes of the vortex separator are the ability to treat high flows in a very small footprint, and a lack of mechanical components and moving parts, thereby reducing operation and maintenance.

  Vortex separators have been operated in a number of cities, including Decatur, Illinois; Columbus, Georgia; Syracuse, New York; West Roxbury, Massachusetts; Rochester, New York; Lancaster, Pennsylvania; Indianapolis, Indiana; and Toronto, Ontario, Canada. Vortex separator prototypes have achieved suspended solids removals of 12 to 86 percent in Lancaster, Pennsylvania; 18 to 55 percent in Syracuse, New York; and 6 to 36 percent in West Roxbury, Massachusetts. BOD_5 removals from 29 to 79 percent have been achieved with the swirl concentrator prototype in Syracuse New York (Alquier, 1982).

  New York City evaluated the performance of three swirl/vortex technologies at a full-scale test facility (133 mgd each) at the Corona Avenue Vortex Facility (see Figure 7-4). The purpose of the test was to demonstrate the effectiveness of the vortex technology for control of CSO pollutants, primarily floatables, oil and grease, settleable solids and total suspended solids. The two-year testing program, initiated in late 1999, evaluated the floatables-removal performance of the facility for a total of 22 wet weather events. Overall, the results indicated that the vortex units provided an average floatables removal of approximately 60 percent during the tested events. Based on the results of the testing, NYCDEP concluded that widespread application of the vortex technology is not effective for control of settleable solids and was not a cost effective way to control floatables. As such, the application of this technology will be limited and other methods to control floatable discharges into receiving waters will need to be assessed.

  Also, the performance of vortex separators has been found to be inconsistent in other demonstrations. A pilot study in Richmond, Virginia showed that the performance of two vortex separators was irregular and ranged from <0 percent to 26 percent with an average removal efficiency of about 6 percent (Greeley and Hansen, 1995). The performance of vortex separators is also a strong function of influent TSS concentrations. A high average influent TSS concentration will yield a higher percent removal. As a



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Schematic Diagrams of the Three Vortex Technologies Tested at CAVF

FIGURE 7-4

result, if influent CSO is very dilute with storm water, the overall TSS removal will be low. Suspended solids removal in the beginning of a storm may be better if there is a pronounced first flush period with high solids concentrations (City of Indianapolis, 1996). Removal effectiveness is also a function of the hydraulic loading rate with better performance observed at lower loading rates. Furthermore, one of the advantages of vortex separation – the lack of required moving parts – requires sufficient driving head.

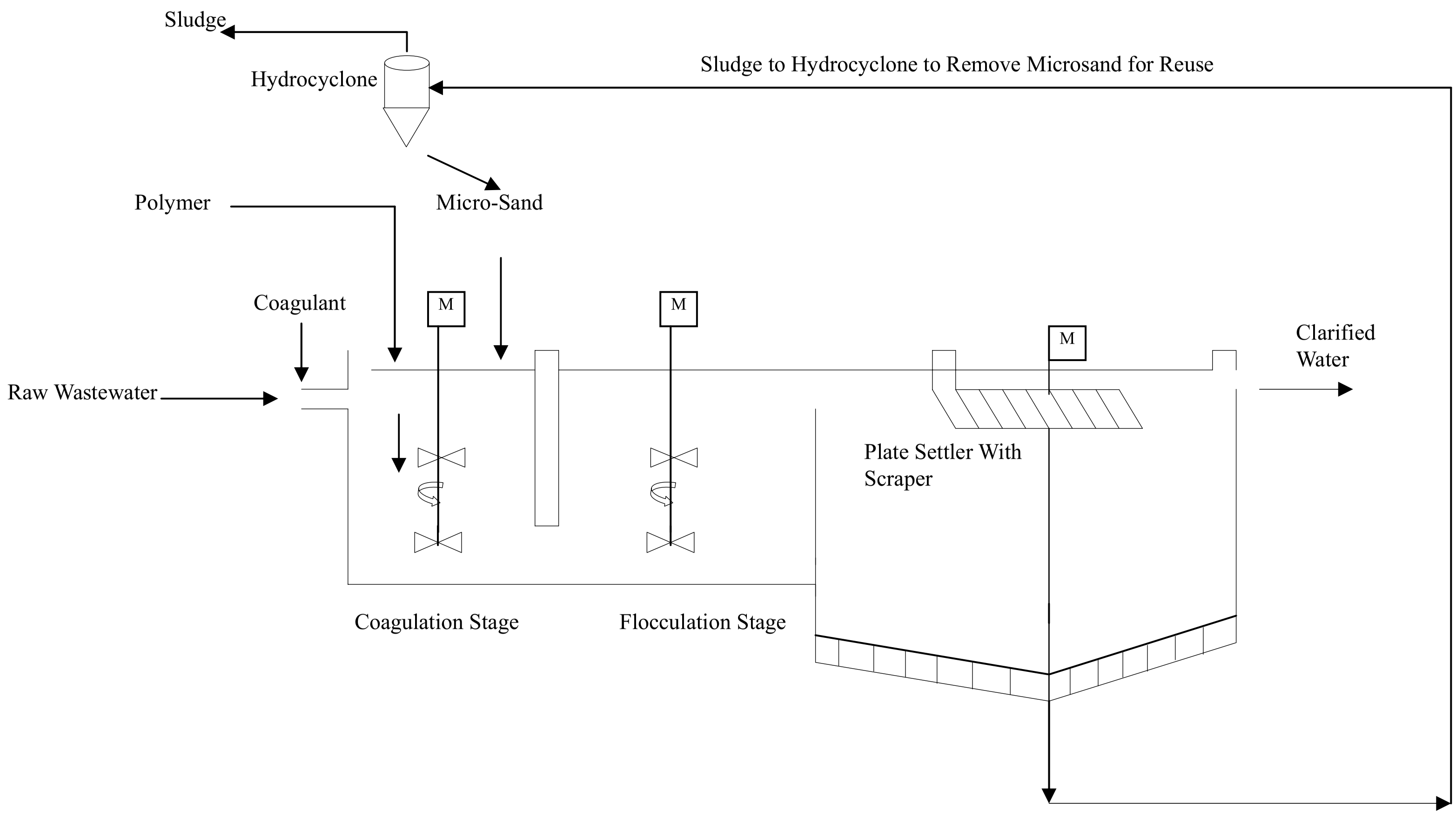
Based on the poor results of the testing at the Corona Vortex Facility (NYCDEP, 2003b; HydroQual, 2005e), and the general lack of available head, vortex separators have been removed from further consideration in New York City.

- High Rate Physical Chemical Treatment (HRPCT) – High rate physical/chemical treatment is a traditional gravity settling process enhanced with flocculation and settling aids to increase loading rates and improve performance. The pretreatment requirements for high rate treatment are screening and degritting, identical to that required prior to primary sedimentation. The first stage of HRPCT is coagulant addition, where ferric chloride, alum or a similar coagulant is added and rapidly mixed into solution. Degritting may be incorporated into the coagulation stage with a larger tank designed for gravity settling of grit material. The coagulation stage is followed by a flocculation stage where polymer is added and mixed to form floc particles that will settle in the following stage. Also in this stage recycled sludge or micro sand from the settling stage is added back in to improve the flocculation process. Finally, the wastewater enters the gravity settling stage that is enhanced by lamella tubes or plates. Disinfection, which is not part of the HRPCT process, typically is completed after treatment to the HRPCT effluent. Sludge is collected at the bottom of the clarifier and either pumped back to the flocculation stage or wasted periodically when sludge blanket depths become too high. The two principal manufacturers of HRPCT processes are Infilco Degremont Incorporated, which manufacturers the DensaDeg™ process, and Kruger, Inc., which manufactures the Actiflo™ process. Each is described in more detail below:

  - IDI DensaDeg™ – Infilco Degremont offers the DensaDeg 2D and 4D processes, both of which require screening upstream. The 2D process requires upstream grit removal as well, but the 4D process integrates grit removal into the coagulation stage. Otherwise the 2D and 4D processes are identical.

    DensaDeg performance varies with surface overflow rate and chemical dosages, but in general removal rates of 80 – 95 percent for TSS and 30 – 60 percent for BOD can be expected. Phosphorous and nitrogen are also removable with this process, although the removal efficiencies are dependent on the solubility of these compounds present in the wastewater. Removal efficiencies are also dependent on start-up time. Typically the DensaDeg process takes about 30 minutes before optimum removal rates are achieved to allow for the build-up of sludge solids.

  - Kruger Actiflo™ – The US Filter Actiflo process is different from the DensaDeg process in that fine sand is used to ballast the sludge solids. As a result, the solids settle faster, but specialized equipment must be incorporated in the system to accommodate the handling sand throughout the system. Figure 7-5 shows the components of a typical Actiflo system.



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Kruger Actiflo HRPCT

FIGURE 7-5

The Actiflo process does require screening upstream. Grit removal is recommended, but since the system uses microsand as ballast in the process, the presence of grit is tolerable in the system. If grit removal does not precede the process, the tanks must be flushed of accumulated grit every few months to a year, depending on the accumulation of grit and system run times.

Actiflo performance varies with surface overflow rate and chemical dosages, but in general removal rates of 80 – 95 percent for TSS and 30 – 60 percent for BOD are typical. Phosphorous and nitrogen are also removable with this process, although the removal efficiencies are dependent on the solubility of these compounds present in the wastewater. Phosphorous removal is typically between 60 – 90 percent, and nitrogen removal is typically between 15 – 35 percent. Removal efficiencies are also dependent on start-up time. Typically the Actiflo process takes about 15 minutes before optimum removal rates are achieved.

Pilot testing of HRPCT was performed at the 26th Ward WPCP in Brooklyn, and consisted of evaluating equipment from three leading HRPCT manufacturers from May through August 1999. The three leading processes tested during the pilot test were the Ballasted Floc Reactor^{TM} from Microsep/US Filter, the Actiflo^{TM} from Kruger, and the Densadeg 4D^{TM} from Infilco Degremont. Pilot testing suggested good to excellent performance on all units, often in excess of 80 percent for TSS and 50 percent for BOD_5.

- Disinfection – The major objective of disinfection is to control the discharge of pathogenic microorganisms in receiving waters. As described in Sections 1 and 4, disinfection of CSO is not required for Gowanus Canal, a Class SD waterbody.

  Disinfection of combined sewer overflow is included as part of many CSO treatment facilities, including those in Washington, D.C.; Boston, Massachusetts; Rochester, New York; and Syracuse, New York. The disinfection methods considered for use in combined sewer overflow treatment are chlorine gas, calcium or sodium hypochlorite, chloride dioxide, peracetic acid, ozone, ultraviolet radiation, and electron beam irradiation (USEPA, 1999b and 1999c). The chemicals are all oxidizing agents that are corrosive to equipment and in concentrated forms are highly toxic to both microorganisms and people. Each is described below.

  - Chlorine gas – Chlorine gas is extremely effective and relatively inexpensive. However, it is extremely toxic and its use and transportation must be monitored or controlled to protect the public. Chlorine gas is a respiratory irritant and in high concentrations can be deadly. Therefore, it is not well suited to populous or potentially non-secure areas.

  - Calcium or Sodium Hypochlorite – Hypochlorite systems are common in wastewater treatment installations. For years, large, densely populated metropolitan areas have employed hypochlorite systems in lieu of chlorine gas for safety reasons. The hypochlorite system uses sodium hypochlorite in a liquid form much like household bleach and is similarly effective as chlorine gas although more expensive. It can be delivered in tank trucks and stored in aboveground tanks. The solution's shelf life, (a function of its initial strength, temperature, pH, light, exposure, and the presence of metallic or organic impurities) is relatively short.

- Chlorine Dioxide – Chlorine dioxide is an extremely unstable and explosive gas and any means of transport is potentially very hazardous. Therefore, it must be generated on site. The overall system is relatively complex to operate and maintain compared to more conventional chlorination.

- Ozone – Ozone is a strong oxidizer and must be applied to CSO as a gas. Due to the instability of ozone, it must also be generated on site. The principle advantage of ozone is that there is no trace residual chlorine remaining in the treated effluent. Disadvantages associated with ozone use as a disinfectant is that it is relatively expensive, with the cost of the ozone generation equipment being the primary capital cost item. Operating costs can be very high depending on power costs, since ozonation is a power intensive system. Ozonation is also relatively complex to operate and maintain compared to chlorination. Ozone is not considered practical for CSO applications because it must be generated on site in an intermittent fashion in response to variable and fluctuating CSO flow rates.

- UV Disinfection – UV disinfection uses light with wavelengths between 40 and 400 nanometers for disinfection. Light of the correct wavelength can penetrate cells of pathogenic organisms, structurally altering DNA and preventing cell function. As with ozone, the principle advantage of UV disinfection is that no trace chlorine residual remains in the treated effluent. However, because UV light must penetrate the water to be effective, the TSS level of CSOs can affect the disinfection ability. As such, to be effective UV must be preceded by thorough separation of solids from the combined sewage. Pretreatment by sedimentation, high-rate sedimentation, and/or filtration maybe required to reduce suspended solids concentrations to less than 20 to 40 mg/l or so depending on the water quality goals.

Disinfection reduces potential public health impacts from CSOs but needs to be used in conjunction with other technologies. In order to protect aquatic life in the receiving waters, dechlorination facilities would need to be installed whenever chlorination is used as a disinfectant. Dechlorination would be accomplished by injection of sodium bisulfite in the flow stream before discharge of treated CSO flow to waterways. Dechlorination with sodium bisulfite is rapid; hence no contact chamber is required. However, even with the addition of dechlorination, the NYCDEP believes that there could be a residual chlorine concentration of 1 mg/L from a CSO disinfection facility.

- Expansion of WPCP Treatment –The NYCDEP developed WWOPs for the Red Hook and Owls Head WPCPs (see Appendix A) per NYSDEC requirements. NYSDEC approved these WWOPs, which provided recommendations for maximizing treatment of flow during wet weather events. The reports outlined three primary objectives in maximizing treatment for wet-weather flows: (1) maximize plant wet-weather inflows to prevent overflows from the collection system regulators and provide primary treatment and disinfection to up to 2xDDWF; (2) provide secondary treatment for wet-weather flows up to 1.5xDDWF to maximize pollutant removal during wet-weather events; and (3) maintain reasonably high effluent quality during wet weather while allowing for a subsequent, stable recovery to dry-weather operations. With this WWOP implemented, NYCDEP is implementing this alternative to a satisfactory level.

7.2.7 Receiving Water Improvement

Receiving waters can also be treated directly with various technologies that improve water quality. Below are described the different treatment options that could aid in improving water quality in conjunction with CSO control measures:

- Outfall Relocation – Outfall relocation involves moving the combined sewer outfall to another location. For example, an outfall may be relocated away from a sensitive area to prevent negative impacts to that area.

- Aeration – Aeration improves the dissolved oxygen content of the river by adding air directly to the waterbody ("in-stream aeration"). Air could possibly be added in large enough volumes to increase dissolved oxygen in the waterbody to meet the ambient water quality standards. However, shallow water-column depths and soft substrates can limit the effectiveness and applicability of in-stream aeration. Furthermore, depending on the amount of air that would be required to be transferred into the water column, the facilities necessary and the delivery systems could be extensive and impractical. An alternative would be to deliver a lower volume of air and control short term anoxic conditions that may result from intermittent wet weather overflows. NYCDEP has investigated in-stream aeration as a method of meeting dissolved oxygen standards and will be conducting pilot tested this technology within Newtown Creek over the next few years.

- Flushing Water – The addition of flushing water at the head end of dead end waterbodies improves circulation, purging pollutant-laden water from the water body while bringing in cleaner water with higher dissolved oxygen. The Gowanus Canal Flushing Tunnel, which was initially completed in 1911, is an existing example of this technology.

- Maintenance Dredging - Maintenance dredging technology is essentially the dredging of settled CSO solids from the bottom of waterbodies on an interim basis. The settled solids would be dredged from the receiving waterbody as needed to prevent use impairments such as access by recreational boater/kyackers and/or abate nuisance conditions such as odors. The concept would be to conduct dredging periodically or routinely to prevent the use impairment/nuisance conditions from occurring. Dredging would be conducted as an alternative to structural CSO controls such as storage. Bottom water conditions between dredging operations would likely not comply with dissolved oxygen standards and bottom habitat would degrade following each dredging.

  This technology allows CSO settleable solids to exit the sewer system and settle in the waterbody generally immediately downstream of the outfall, but without regular or periodic dredging, such mounds can extend a thousand feet or more. The settled solids usually combine with leaves and accumulate into a "CSO" mound. This CSO mound would then be dredged and removed from the water environment. The assumption is that dredging would occur prior to the CSO mound creating an impairment or nuisance condition. Generally, it is envisioned that maintenance dredging would be preformed prior to a CSO mound building to an elevation that it becomes exposed at low tide or mean lower low tide. The extent and depth of dredging would depend on the rate of accretion, or build-up of settleable solids, and preferred years between dredging.

The technology could be considered similar to the DSNY practice of dredging their marine transfer station barge slips. Every 5 to 10 years DSNY must conduct dredging of the barge slips at the stations because sediments accumulate and prevent the use of the barge slip. DSNY has investigated methods to prevent the accumulation of solids but decided that the routine or periodic dredging technology is the most cost-effective approach. This concept could potentially be applied to certain CSO sediment accumulation conditions.

Dredging can be accomplished by a number of acceptable methods. Methods of dredging generally fall into either floating mechanical or hydraulic techniques, with a variety of variants for both of these techniques. The actual method of dredging selected would depend on the physical characteristics (grain size, viscosity, etc.) of the materials that require removal, the extent of entrained pollutants (metals, etc), and local water currents, depth and width of waterbody and other conditions such as bridges that could interfere with dredge movements. It is likely that CSO sediments would require removal with a closed bucket mechanical dredge or an auger/suction-head hydraulic dredge. Removal techniques, however, would be site specific.

After removal of CSO sediments, the material would likely be placed onto a barge for transport away from the site. On-site dewatering may be considered as well. Sediments would then be off-loaded from the barge and shipped by land methods to a landfill that accepts New York Harbor sediments. Recently, harbor sediments have been shipped to a landfill in Virginia for final disposal.

7.2.8 Solids and Floatables Control

Technologies that provide solids and floatables control do not reduce the frequency or magnitude of CSO overflows, but can reduce the presence of aesthetically objectionable items such as plastic, paper, polystyrene and sanitary "toilet litter" matter, etc. These technologies include both end-of-pipe technologies such as netting and screens, as well as BMPs such as catch basin modifications and street cleaning which could be implemented upstream of outfalls in the drainage area. Each of these technologies is summarized below:

- Netting Devices **-** Netting devices can be used to separate floatables from CSOs by passing the flow through a set of netted bags. Floatables are retained in the bags, and the bags are periodically removed for disposal. Netting systems can be located in-water at the end of the pipe, or can be placed in-line to remove the floatables before discharge to the receiving waters. NYCDEP has installed a floating end of pipe netting system at CSO TI-023 located in Little Bay.

- Containment Booms - Containment booms are specially fabricated floatation structures with suspended curtains designed to capture buoyant materials. They are typically anchored to a shoreline structure and to the bottom of the receiving water. After a rain event, collected materials can be removed using either a skimmer vessel or a land-based vacuum truck. A 2-year pilot study of containment booms was conducted by New York

City in Jamaica Bay. An assessment of the effectiveness indicated that the containment booms provided a retention efficiency of approximately 75 percent.

As part of its Interim Floatables Containment Program (IFCP), NYCDEP currently operates floatables booms at various locations city-wide, including at the entrance to the Gowanus Canal Flushing Tunnel (to prevent entrainment of floatables into the Tunnel) and near the head of Gowanus Canal (to retain CSO floatables discharged from upstream CSOs). Figure 7-6 presents a photograph of the floatables boom near the head of Gowanus Canal.

- Skimmer Vessels – Skimmer vessels remove materials floating within a few inches of the water surface and are being used in various cities, including New York. The vessels range in size from less than 30 feet to more than 100 feet long. They can be equipped with moving screens on a conveyor belt system to separate floatables from the water or with nets that can be lowered into the water to collect the materials. Skimmer vessels are typically effective in areas where currents are relatively slow-moving and can also be employed in open-water areas where slicks from floatables form due to tidal and meteorological conditions. New York City currently operates skimmer vessels to service containment boom sites and to conduct open-water operations.

- Bar Screens - Manually Cleaned **-** Manually cleaned bar screens can be located within in-line CSO chambers or at the point of outfall to capture floatables. The configuration of the screen would be similar to that found in the influent channels of small wastewater pumping stations or treatment facilities. Retained materials must be manually raked and removed from the sites after every storm. For multiple CSOs, this would result in very high maintenance requirements. Previous experience with manually cleaned screens in CSO applications has shown these units to have a propensity for clogging. In Louisville, Kentucky, "self-cleaning" screens of various designs became clogged with leaves and organic material shortly after installation in CSO locations.

- Weir-Mounted Screens - Mechanically Cleaned - Horizontal mechanical screens are weir-mounted mechanically cleaned screens driven by electric motors or hydraulic power packs. The rake mechanism is triggered by a float switch in the influent channel and returns the screened materials to the interceptor sewer. Various screen configurations and bar openings are available depending on the manufacturer. Horizontal screens can be installed in new overflow weir chambers or retrofitted into existing structures if adequate space is available. Electric power service must be brought to each site.

- Baffles Mounted in Regulator

    - Fixed Underflow Baffles - Underflow baffles consist of a transverse baffle mounted in front of and typically perpendicular to the overflow pipe. During a storm event, the baffle prevents the discharge of floatables by blocking their path to the overflow pipe. As the storm subsides, the floatables are conveyed to downstream facilities by the dry weather flow in the interceptor sewer. The applicability and effectiveness of the baffle depends on the configuration and hydraulic conditions at the regulator structure. Baffles are being used in CSO applications in several locations including

Floatables Containment Boom in Gowanus Canal (Looking North Toward Head of Canal)

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Boston, Massachusetts and Louisville, Kentucky. However, the typical regular structures in New York City are not amenable to fixed baffle retrofits.

- Floating Underflow Baffles - A variation on the fixed underflow baffle is the floating underflow baffle developed in Germany and marketed under the name HydroSwitch by Gabriel, Novac & Associates, Inc. The floating baffle is mounted within a regulator chamber sized to provide floatables storage during wet weather events. All floatables trapped behind the floating baffle are directed to the WWTP through the dry weather flow pipe. By allowing the baffle to float, a greater range of hydraulic conditions can be accommodated. This technology has not yet been demonstrated in the United States; however, there are operating units in Germany.

- Hinged Baffle With Bending Weir – This system incorporates two technologies, the hinged baffle and the bending weir to retain floatables in regulators during storm events. During a storm event, the hinged baffle provides floatables retention while the bending weir increases flow to the plant. After a storm event, retained floatables drop into the regulator channel and then into the sewer interceptor to be removed at the treatment plant. During large storm events that exceed the capacity of the regulator, more flow backs up behind the baffle. To prevent flooding, the hinged baffle opens to allow more flow to pass through the regulator. The bending weir provides additional storage of storm water and floatables within the regulator during storm events by raising the overflow weir elevation. Similar to the hinged baffle, the bending weir also helps to prevent flooding during large storm events by opening and allowing additional combined sewage to overflow the weir. The bending weir allows an increasing volume of combined sewage to overflow the weir as the water level inside the regulators rise. The major benefit of the system is that it includes a built-in mechanical emergency release mechanism. This feature eliminates the need for the construction of an emergency bypass that many other in-line CSO control technologies require. In addition, the system has no utility requirements and is associated with low O&M costs.

- Catch Basin Modifications - Catch basin modifications consist of various devices to prevent floatables from entering the CSS. Inlet grates and closed curb pieces reduce the amount of street litter and debris that enters the catch basin. Catch basin modifications such as hoods, submerged outlets, and vortex valves, alter the outlet pipe conditions and keep floatables from entering the CSS. Catch basin hoods are similar to the underflow baffle concept described previously for installation in regulator chambers. These devices also provide a water seal for containing sewer gas. The success of a catch basin modification program is dependent on having catch basins with sumps deep enough to accommodate hood-type devices. A potential disadvantage of catch basin outlet modifications and other insert-type devices is the fact that retained materials could clog the outlet if cleaning is not performed frequently enough. This could result in backup of storm flows and increased street flooding. New York City has moved forward with a program to hood all of its catch basins.

- Best Management Practices (BMPs) – BMPs such as street cleaning and public education have the potential to reduce solids and floatables in CSO. These are described in the beginning of this section under "source controls."

Table 7-2 provides a comparison of the floatables control technologies discussed above in terms of implementation effort, required maintenance, effectiveness and relative cost. For implementation effort and required maintenance, technologies that require little to low effort are preferable to those requiring moderate or high effort. When considering effectiveness, a technology is preferable if the rating is high.

Table 7-2. Comparison of Solids and Floatables Control Technologies

Technology	Implementation Effort	Required Maintenance	Effectiveness	Relative Capital Cost
Public Education	Moderate	High	Variable	Moderate
Street Cleaning	Low	High	Moderate	Moderate
Catch Basin Modifications	Low	Moderate	Moderate	Low
Weir-Mounted Screens	Low	Moderate	High	Moderate
Screen with Backwash	High	Low	High	High
Fixed Baffles	Low	Low	Moderate	Low
Floating Baffles	High	Low	Moderate	Moderate
Bar Screens - Manual	Low	High	Moderate	Low
In-Line Netting	High	Moderate	High	High
End-of-Pipe Netting	Moderate	Moderate	High	Moderate
Containment Booms	Moderate	Moderate	Moderate	Moderate

7.2.9 Initial Screening of CSO Control Technologies

Table 7-3 presents a tabular summary of the results of the initial technology screening discussed in the previous sections. Technologies that will advance to the alternatives development screening are noted under the column entitled “Retain for Consideration”. These technologies have proven experience and have the potential for producing some level of CSO control.

Other technologies were considered as having a positive effect on CSOs but either could only be implemented to a certain degree or could only provide a specific benefit level and, thusly, would have a variable effect on CSO overflow. For instance, NYCDEP has implemented a water conservation program which, to date, has been largely effective. This program, which will be maintained in the future, directly affects dry weather flow since it pertains to water usage patterns. As such, technologies included in this category provide some level of CSO control but in-of-themselves do not provide the level of control sought by this program.

Technologies included under the heading “Consider Combining with Other Control Technologies” are those that would be more effective if combined with another control or would provide an added benefit if coupled with another control technology.

The last classification is for those technologies that did not advance through the initial screening process. In the case of technologies such as infiltration/inflow, the NYCDEP has implemented a program in accordance with federal and state laws that has effectively reduced I/I. Inclusion of this control technology in the CSO control program would not provide further tangible benefits. Other technologies like complete sewer separation are simply not feasible in an urban area as extensively built-out as New York City.

Table 7-3. Initial Screening of CSO Control Technologies

CSO Control Technology	Retain for Consideration	Being Implemented	Consider Combining with Other Control Technologies	Eliminate from Further Consideration
Source Control				
Public Education		X		
Street Sweeping		X		
Construction Site Erosion Control		X		
Catch Basin Cleaning		X		
Industrial Pretreatment		X		
Inflow Control				
Storm Water Detention				X
Street Storage of Storm Water				X
Water Conservation		X		
Infiltration/Inflow Reduction				X
Green Solutions – See Section 5		X		
Sewer System Optimization				
Optimize Existing System	X			
Real Time Control				X
Sewer Separation				
Complete Separation				X
Partial Separation				X
Rain Leader Disconnection				X
Storage				
Closed Concrete Tanks	X			
Storage Pipelines/Conduits	X			
Tunnels	X			
Treatment				
Screening	X			
Primary Sedimentation		X		
Vortex Separator				X
High Rate Physical Chemical Treatment	X			
Disinfection				X
Expansion of WPCP		X		
Receiving Water Improvement				
Outfall Relocation	X			
In-stream Aeration	X			
Maintenance Dredging	X			
Solids and Floatable Controls				
Netting Systems	X			

Table 7-3. Initial Screening of CSO Control Technologies

CSO Control Technology	Retain for Consideration	Being Implemented	Consider Combining with Other Control Technologies	Eliminate from Further Consideration
Containment Booms		X		
Skimming	X			
Manual Bar Screens				X
Weir Mounted Screens	X			
Fixed baffles				X
Floating Baffles				X
Catch Basin Modifications		X		

The technologies successively moving through the preliminary screening process will be formed into alternatives that will be further screened in subsequent subsections of this section.

7.3 WATER QUALITY IMPROVEMENT PLANNING

As described in Section 5, NYCDEP initiated facilities planning to improve water quality in Gowanus Canal well before the establishment of the CSO Control Policy. The Inner Harbor CSO Facility Plan (1993) established several measures that were implemented to improve water quality, and the Gowanus Facilities Upgrade Facilities Plan (2001-ongoing) is in the process of implementing additional measures to reach those water-quality objectives. In 1999, NYCDEP initiated the Use and Standards Attainment (USA) project to involve stakeholders and the public to determine desirable uses of the waterbody, to examine water quality and realistically attainable uses given site-specific constraints, and initiate the process to review water-quality standards, and to serve as the technical basis for waterbody-specific Use Attainment Evaluations (UAE), as appropriate. The product of the USA project for Gowanus Canal was to be a Water Quality Improvement Plan. However, before that plan was finalized, the 2004 CSO Consent Order was signed, requiring an approvable Waterbody/Watershed Facility Plan for Gowanus Canal and launching the CSO Long Term Control Plan (LTCP) project.

The following describes control alternatives that NYCDEP investigated under the USA project to develop the Gowanus Canal Water Quality Improvement Plan, which is summarized in Section 7.3.9. Section 7.4 presents how the results of these investigations were used herein to develop a Waterbody/Watershed Facility Plan for Gowanus Canal.

7.3.1 Optimizing Sewer System with Retrofits and Sewer-System Adjustments

Optimizing Sewer System with Retrofits and Sewer System Adjustments

The Inner Harbor CSO Facility Plan recommended investigating raising overflow weirs at relief points along the Third Avenue and Bond-Lorraine Sewers to direct more CSO away from Gowanus Canal and toward downstream regulators in the Owls Head and Red Hook WPCP service areas, respectively. Engineering analyses were performed to further evaluate these recommendations and to determine whether adjustments could be made in other locations to reduce CSOs. Based on a preliminary screening of all outfalls to Gowanus Canal, cost-performance analyses were performed for weir adjustments at RH-035, RH-031, and OH-007. In each case, the benefits of raising weirs were either minimal or outweighed by the increased likelihood of sewer backups into basements.

Outfall RH-035 is a relief of the Bond-Lorraine Sewer that discharges at a point about halfway between the Gowanus Pump Station and Hamilton Avenue. Modeling analyses show that, with flow from the Gowanus Pump Station routed through the Flushing Tunnel force main, raising the weir 12 inches at RH-035 would produce an insignificant reduction of CSO to Gowanus Canal. Although raising the weir 12 inches could significantly reduce overflows *with the Gowanus Pump Station flow routed to the Bond-Lorraine Sewer,* the Gowanus Facilities Upgrade project is underway to remove the flow from the Bond-Lorraine Sewer. Furthermore, storing flow in the relatively shallow Bond-Lorraine Sewer would likely pose an increased risk of sewer backups into basements. Therefore, raising the weir at RH-035 was dismissed.

Outfall RH-031 is a relief of the Bond-Lorraine Sewer that discharges at Hamilton Avenue. Modeling analyses indicate that closing RH-031 would double overflows upstream at RH-035 and would increase the potential to flood basements in the low-lying areas of the drainage area. Raising the weir at RH-031 would produce similar results to a lesser degree. Although either action would slightly reduce CSO discharges to Gowanus Canal as a whole, the discharges to upstream areas of the Canal would increase, thereby increasing the negative impact on the Canal.

Outfall OH-007 is located on the eastern side of the Canal near the 4th Street turning basin. This outfall relieves flow from a looped sewer network serving the upper reaches of the Owls Head WPCP service area. Several relief weir adjustments were evaluated; however, modifications of the Second Avenue Pump Station and downstream sewers would be required in tandem with these alternatives in order to convey additional wet-weather flow in the Third Avenue Sewer. These required modifications add complexity and cost that are not justifiable since the result is simply the relocation of a small discharge volume downstream, and the action is therefore not recommended.

7.3.2 Maximizing WPCP Treatment

The CSO Control Policy encourages municipalities to consider maximizing treatment for CSO control as part of a long-term control plan (USEPA, 1995a). The use of WPCP capacity is presented in the CSO Control Policy within three general contexts:

- As a minimum control, maximizing flow to the WPCP to ensure that optimum use is made of existing treatment capacity;
- Expanding existing treatment facilities rather than constructing separate facilities for CSO control; and,
- Maximizing use of the primary treatment portion of a WPCP and bypassing secondary treatment in certain circumstances.

NYCDEP maximized WPCP treatment as determined and required by the NYSDEC in its operating permits and the appurtenant WWOPs for the Red Hook and Owls Head WPCPs, which require that flows of up to 2xDDWF receive primary treatment and up to 1.5xDDWF receive secondary treatment. The use of this capacity can reduce the volume and load of CSO discharges to local receiving waters; however, Gowanus Canal is located at the far upstream reaches of the drainage area served by these WPCPs and is not significantly impacted by increased inflow capacities at the WPCPs.

7.3.3 Increasing Pump Station Capacities

The Gowanus Canal watershed is currently serviced by several pump stations, including the Nevins Street, Gowanus, and Hamilton Avenue pump stations in the Red Hook WPCP service area, and the Second Avenue and 19th Street pump stations in the Owls Head WPCP service area (see Figure 3-6). The Gowanus, Nevins Street, and Second Avenue pump stations were evaluated for expanding capacity and the associated benefits. In addition, several combinations of upgrading the stations were also evaluated.

Nevins Street Pump Station

The Nevins Street Pump Station is located on Nevins Street between Sackett and Degraw Streets. It has a capacity of 2.2 MGD and currently receives a total sanitary (dry-weather) flow of 0.54 MGD from regulators R-22, R-23, R-24, and R-25. The Nevins Street Pump Station force main conveys combined sewage to a major trunk sewer of the Gowanus Pump Station. Therefore, if the pump station capacity is increased, the additional flow conveyed to the Gowanus Pump Station may be discharged at that location (RH-034) instead of outfalls RH-033, RH-036, RH-037, and RH-038, all of which are near RH-034. A cost-performance analysis was performed for increasing the Nevins Street Pump Station capacity to 4, 6, 8 and 10 MGD. Based on the latest available costing information (O'Brien & Gere, 2006), estimated Probable Total Project Costs[1] (PTPCs) for these expansions ranged from $9.4 million (expansion to 4 MGD) to $24.7 million (expansion to 10 MGD). In all cases, the projected CSO discharge to the Canal was not significantly reduced and there would be virtually no water quality benefit. Therefore, increasing the capacity of the Nevins Street Pump Station was rejected as not being effective.

Second Avenue Pump Station

The Second Avenue Pump Station is located at Second Avenue and 5th Street. It has a capacity of 1.0 MGD and currently receives a sanitary flow of 0.6 MGD during dry weather. The Second Avenue Pump Station force main conveys combined sewage to a major trunk sewer on Third Avenue that becomes a part of the Owls Head WPCP interceptor system. This trunk sewer has limited capacity and wet weather flows are also re-regulated by additional inline regulators downstream. Therefore, if the pump station capacity is increased, the Third Avenue sewer would have to be enlarged but combined sewage may still be discharged downstream to Gowanus Bay and Upper New York Bay. Based on the latest available costing information

[1] PTPCs represent the realistic total of all hard costs, soft costs, and ancillary costs associated with a particular CSO abatement technology per the definitions provided in O'Brien & Gere, April 2006. All PTPCs shown in this report are adjusted to June 2008 dollars (ENR CCI = 12519.75).

(O'Brien & Gere, 2006) a cost-performance analysis was performed for increasing the capacity to 4, 6, and 10 MGD with PTPCs ranging from $13.2 million (expansion to 4 MGD) to $27.0 million (expansion to 10 MGD). The projected reduction of total CSO upstream of Hamilton Avenue decreased by only five percent and there would be very little water quality benefit. As a result of this analysis, increasing the capacity of the Second Avenue Pump Station was rejected.

Gowanus Pump Station

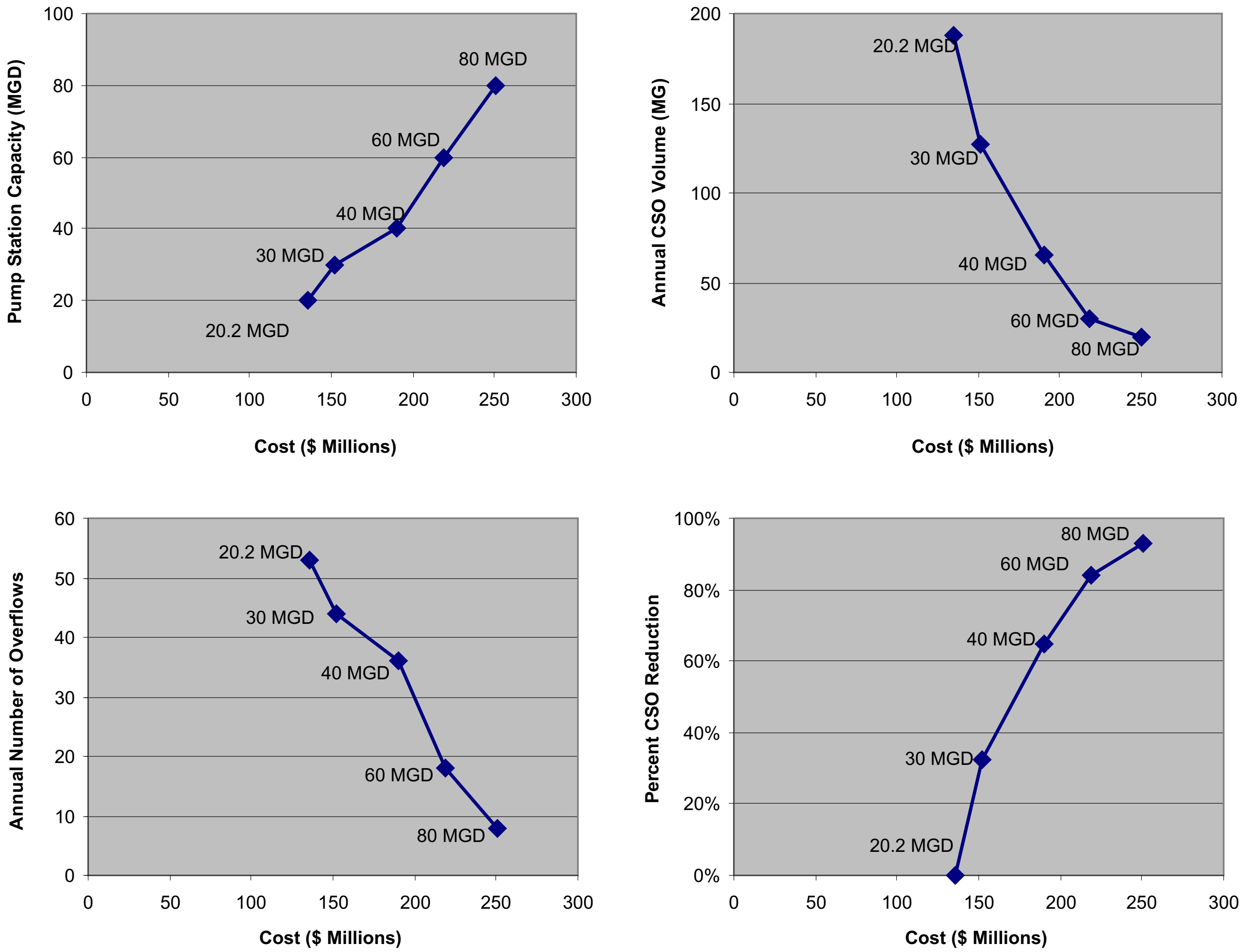
The Gowanus Pump Station is located at the head of Gowanus Canal, at Butler Street between Bond Street and Nevins Street. As shown in Tables 3-11 and 3-13, CSO discharges from this pump station via outfall RH-034 dominate the wet-weather flow and landside pollutant loadings to Gowanus Canal.

As described in Section 5.9.1, the Gowanus Facilities Upgrade project evaluated alternatives to improve the Gowanus Pump Station to reduce CSO discharges to Gowanus Canal. The evaluated alternatives included increasing the pump station capacity from 20.0 MGD (twice its design dry-weather flow) to 80 MGD. Figure 7-7 presents a series of performance vs. cost curves for increasing pumping capacity. The panel at the upper left indicates that pumping-capacity expansion costs increase linearly between 20.2 and 80 MGD. Similarly, the lower left panel indicates that the cost associated with reducing CSO frequency is also relatively linear. However, the panels on the right, which describe the CSO volume-reduction costs, demonstrate a "knee" at the 30 MGD capacity. This indicates an increase in the marginal cost relative to the gained benefit. Other considerations also indicated that the 30 MGD capacity was optimal. For example, expanding the capacity beyond 30 MGD would leave inadequate space for the existing tide gate chamber and installation of CSO screening facilities. Furthermore, increasing the pumping rate required a larger-diameter force main, which would in turn diminish the available conveyance capacity for the Flushing Tunnel through which the force main would be routed. A force main with a capacity of 40 MGD or more could not be accommodated within the Flushing Tunnel. Installation of a new force main outside of the Flushing Tunnel was determined to be unacceptably disruptive to the community, as well as prohibitively expensive. Finally, receiving water modeling indicated that water quality benefits were limited. The CSO volume reduction associated with the 30 MGD pumping capacity provided virtually the same water quality benefits as higher CSO reductions (as demonstrated later in this section). Therefore, increasing the capacity of the Gowanus Pump Station to 30 MGD was selected as an element of the Gowanus Facilities Upgrade Facility Plan. Based on the engineer's cost estimate[2] (Dvirka and Bartilucci, 2008a), the estimated PTPC, adjusted to June 2008, of the Gowanus Pump Station upgrade is $151.7 million, or $139.0 million, exclusive of costs associated with CSO floatables screening (see Section 7.3.5).

7.3.4 Improving the Gowanus Canal Flushing Tunnel

As described in Section 5.9.2, the Gowanus Flushing Tunnel has experienced repeated operational and maintenance difficulties since its reactivation in 1999. In addition, pumping

[2] The engineer's cost estimate of $88.7 million reflects 2007 Q1 dollars, with markups for contractor mobilization (13%), field and home office (17%), profit (10%), payment performance bonds and insurance (3%), construction contingency (10%), change order allowance (10%), design contingency (8%), and escalation to midpoint (3.2 years at 8.5%).



Estimated PTPC, June 2008 dollars
Original Costs taken from Dvirka & Bartilluci, Nov 30, 2005 for
Wastewater pumping system expansion
wastewater force main and tunnel work
service building and site facilities
CSO screening system

New York City
Department of Environmental Protection

Cost -Performance Curves for Expanding Gowanus Pump Station Capacity

system deficiencies and obstructions within the Flushing Tunnel itself limit the average flushing rate to about 154 MGD, roughly half the design capacity of 300 MGD.

The Gowanus Facilities Upgrade project considered replacing the existing pumping system with a similar system. Although relatively inexpensive, this option was dismissed because it would not provide pump redundancy needed to prevent system shut downs for maintenance, and because this it would not improve access to critical system components now requiring system shut down and confined space entry for onsite repairs. Horizontal axial flow pumps were also evaluated, but were rejected due to the need for extensive construction required to install these pumps, the prolonged construction period, capacity limitations, and required non-standard features.

The selected design for the Flushing Tunnel pumping system involved replacement of the existing system with vertical axial pumps. Although this design does involve extensive construction and electrical work, the vertical axial flow pumps will allow for maximum submergence of the pumps and will therefore maximize pumping capacity. The multiple-pump system will also provide the redundancy needed to prevent shutting down the system for maintenance and will be easier to retrofit than the other alternatives. It will also include a mechanical screening system that will further reduce floatable pollution in Gowanus Canal.

The flushing capacity of the Flushing Tunnel is also reduced because of a constriction in the Tunnel itself. As shown on Figure 5-3, the Columbia Street Interceptor was built in such a way that it passes through the Flushing Tunnel and occludes the upper half of the Tunnel. At the same location, the existing Gowanus Pump Station force main blocks another quarter of the Tunnel's flow area. Analyses of ways to alleviate the constriction determined that, while rerouting of either the Columbia Avenue Interceptor or the Flushing Tunnel was not feasible, it was feasible to reroute the force main so that it exits the Tunnel about 100 feet upstream of the interceptor. This doubles the area available for flow.

Between the improvements to the pumping system and the alleviation of the tunnel constriction, the estimated average flow rate will increase by about 40 percent to about 215 MGD from 154 MGD. At high tide, the new system capacity will increase to about 252 MGD from 195 MGD. Importantly, the new system will maintain a minimum flow rate of about 175 MGD instead of shutting down at low tide. Finally, the new system will have built-in redundancy and will not require shut down for most maintenance or repair work. Based on the engineer's cost estimate[3,4] (Dvirka and Bartilucci, 2008a), the estimated PTPC of this work is $83.2 million (June 2008 dollars).

7.3.5 Enhancing Floatables Control

As described in Section 5.9.1, the Gowanus Facilities Upgrade project includes the addition of CSO floatables screening at the Gowanus Pump Station (RH-034, the largest CSO discharging to the Canal). The Gowanus Pump Station currently has no ability to control

[3] The engineer's cost estimate of $53.1 million reflects conditions in note 4.
[4] 2007 Q1 dollars, with markups for contractor mobilization (13%), field and home office (17%), profit (10%), payment performance bonds and insurance (3%), construction contingency (10%), change order allowance (10%), design contingency (8%), and escalation to midpoint (3.2 years at 8.5%).

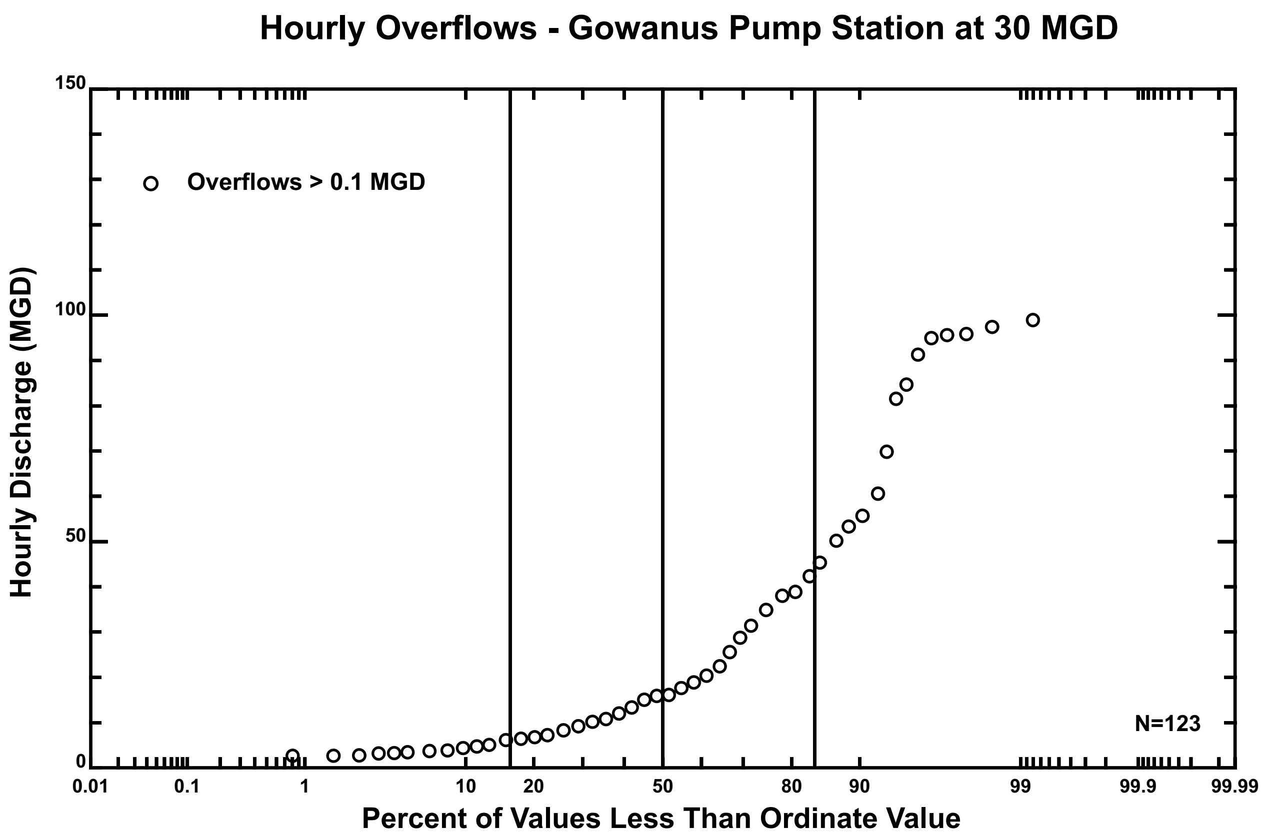
floatables discharges. An evaluation of floatables screening technologies was included in the planning for the Gowanus Facilities Upgrade Facility Plan project. A hydraulic analysis of the sewer system and pump station identified that the peak wet-weather flow that could potentially be conveyed to the pump station from upstream sewers is approximately 650 MGD. Taking into account an increased pump station capacity of 30 MGD, and the storms that occur in the design (typical) precipitation year, the maximum *hourly* CSO discharge rate at the Gowanus Pump Station (RH-034) is projected to be approximately 100 MGD. Figure 7-8 presents a probability distribution of the calculated hourly (non-zero) CSO discharge rates for the design (typical) precipitation year. Recognizing that discharge rates can be higher for periods shorter than one hour, a flow rate of 200 MGD was selected for floatables screening capacity. The portion of flow above 200 MGD will be discharged without screening.

During the Gowanus Facilities Upgrade Project, floatables screening technologies evaluated for application at the Gowanus Pump Station included vertically and horizontally raked automatic bar screens and inline netting systems. As indicated above, the required peak working capacity of the screening system was 200 MGD. To avoid surcharging the sewer system upstream of the pump station during severe wet-weather events, a diversion chamber equipped with a self-cleaning system was considered a necessity. Given the flow requirement, the existing layout of the facility, and the recommended clear open spacing requirements (0.5 to 1.0 inches), horizontally raked bar screens were recommended. Such a system would allow the portion of flow beyond the 200 MGD capacity to pass unscreened directly to Gowanus Canal via an adjustable weir—while maintaining floatables capture on the first 200 MGD. Based on the engineer's cost estimate[5] (Dvirka and Bartilucci, 2008a), the estimated PTPC of this work is $12.8 million (June 2008 dollars).

In order to further improve aesthetic conditions related to floatables, additional floatables controls were herein considered for the remaining CSO discharges to the Canal. Recognizing that floatables controls such as street sweeping and catch basin hooding is already implemented over the entire watershed, the cost-benefits of additional controls were maximized by first considering outfall OH-007, which represents over half of the remaining CSO discharge to the Canal with the Gowanus Facilities Upgrade Project elements in place. Floatables from the remaining, minor CSO locations are addressed later in this subsection.

Owls Head outfall OH-007 was evaluated for installation of floatables controls. Discharges from this outfall originate with flows that exceeds the capacity of the 12-inch inlet to the Second Avenue Pump Station and overtop a one-foot weir in the diversion chamber, then pass through tide gates and into a floatables/settleable solids trap chamber measuring approximately 70 feet long, 35 feet wide, and 8 feet high (Figure 7-9). The dimensions of the chamber allow the flow to slow as it enters the trap, and heavier solids settle to the bottom while floatable items rise to the surface. At its downstream end, the chamber contains a baffle/weir combination that acts to retain the floatables and settled solids within the trap while allowing flow to pass under the baffle and over the weir to the chamber exit. Over time, solids and floatables accumulate in the chamber and can eventually affect the functionality of the baffle/weir combination if not removed. Historically, the chamber has not been cleaned regularly and hence has provided limited removal efficiencies.

[5] The engineer's cost estimate of $8.1 million reflects conditions shown in note 4.



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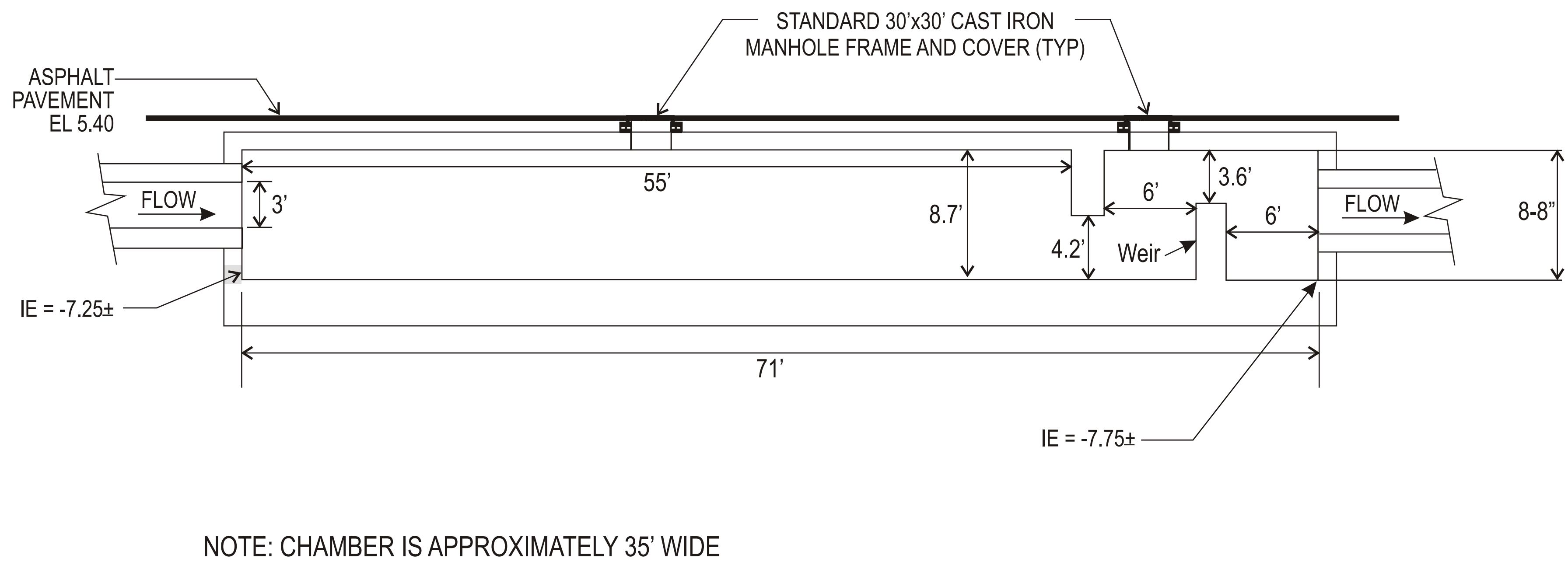
Projected Hourly Discharge Rates at Gowanus Pump Station (with Upgrade) for Design (Typical) Precipitation Year

FIGURE 7-8



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OH-007 Floatables/Solids Trap Chamber

FIGURE 7-9

Several floatables-control alternatives were evaluated for OH-007. The first option is to initially clean the trap chamber to restore its intended functionality, and to inspect the chamber to ensure that the baffle/weir combination is intact. As part of its sewer and outfall cleaning operations, the NYCDEP cleaned the chamber in April 2006 and performed an entry for inspection in June 2006. Post-construction floatables monitoring in Gowanus Canal will subsequently determine whether the floatables controls are operating properly.

Augmenting the existing trap chamber with additional floatables controls was also considered. In-line netting systems and automatically raked bar screens both provide a high rate of floatables capture. An inline netting system capable of handling the 5-minute peak CSO flow rate of 93 MGD in the design (typical) precipitation year is estimated to require a PTPC of approximately $2.3 million, plus ongoing operation and maintenance (O'Brien & Gere, April 2006). Similarly, an in-line netting system capable of handling a peak CSO flow rate that is exceeded only three times in the same period (57 MGD) is estimated to have a PTPC of approximately $1.8 million. Raked vertical bar screens with 1.25-inch open spacing would require a PTPC of about $37.1 million and $30.5 million, plus operation and maintenance, for the 93 MGD and 57 MGD capacities, respectively (O'Brien & Gere, May 2006). Raked horizontal bar screens with 0.25-inch open spacing would require a PTPC of about $21.1 million and $18.3 million, plus operation and maintenance, for the 93 MGD and 57 MGD capacities, respectively (O'Brien & Gere, May 2006).

The recommended alternative for floatables controls at OH-007 is to initiate programmatic inspection of the trap chamber. Initially, to develop an understanding of how quickly the trap chamber accumulates materials, a frequent program of inspections will be performed. Monthly inspections will be made from the surface and will involve probing to determine the depth of accumulated materials at various locations within the chamber. Additional inspections are recommended following severe wet-weather events, such as a once-in-ten-year storm. To the extent possible, a visual inspection of the interior will also provide information relative to retained floatables and condition of the floatables baffle. An annual inspection of the structural integrity of the baffle, weir, and chamber by a qualified Engineer is recommended to ensure that these structures are in good operating condition. Cleaning, which may involve confined-space entry and dewatering of the chamber, will be performed as necessary to remove accumulated materials and maintain the functionality of the trap, based on the inspection information. For example, if the inspections show that material accumulation rates begin to decrease, this could indicate that the optimum retention has been reached and materials are beginning to wash through the chamber, and hence cleaning should be performed to maintain optimal removal performance. Records of the inspections and cleanings will be retained and analyzed to determine accumulation rates and other factors that may impact the performance of the trap. Once the accumulation rates have been sufficiently characterized, and again in the future as deemed appropriate or necessary to respond to seasonal or other long-term changes, the inspection and/or cleaning frequency may be modified. Written procedures and schedules will be kept to describe the Operational Plan for the facility, and records of the inspections and cleanings—including quantity of materials removed—will be kept for assessment purposes.

Gowanus Canal currently features an in-basin, floatables-containment boom that is operated under NYCDEP's Interim Floatables Containment Program (IFCP). The containment boom, designed to retain floatables discharges from CSOs near the head of the Canal, was installed at Sackett Street on June 1, 1994. The NYCDEP dispatches a tributary skimmer vessel to Gowanus Canal to remove floatables from the containment boom following wet-weather events. The original intent of the IFCP was to maintain interim floatables containment systems until permanent controls were implemented. In the case of Gowanus Canal, the CSO floatables screening being installed at the Gowanus Pump Station as part of the Gowanus Facilities Upgrade project would replace the existing containment boom. However, to address any remaining floatables issues in the Canal from the remaining CSOs, periodic open-water skimming of the Canal with a skimmer vessel is recommended to control floatables on an as-needed basis, such as following a wet-weather event that exceeds the capacity of the Gowanus Pump Station CSO screening facility.

Overall, the reductions associated with the Gowanus Facilities Upgrade Project, restoration of the functionality of the OH-007 trap chamber, periodic open-water floatables skimming, and continued implementation of NYCDEP's City-Wide CSO Floatables Control Plan will substantially reduce floatables discharges to the Canal.

7.3.6 Dredging

Dredging is the removal of waterbody sediments that have a deleterious effect on the surrounding environment and/or hinder navigation or waterbody access. The impacts of more than a century of watershed urbanization has resulted in continuing deposition of organic and inorganic sediments in Gowanus Canal, particularly near the head. In turn, these sediments impart a considerable oxygen demand and otherwise impair aquatic habitat. In addition, hypoxic and anoxic conditions can result in the production of hydrogen sulfide, leading to odors and other secondary effects. Dredging Gowanus Canal was a component of the Inner Harbor CSO Facility Plan. Dredging was performed at the head as part of the reconstruction and reactivation of the Gowanus Canal Flushing Tunnel. This action reportedly improved aesthetics in the Canal by reducing odors associated with exposed sediment mounds. Additional dredging of sediments in Gowanus Canal could be expected to provide several environmental benefits:

- Dredging deeply enough to keep residual organic-rich sediments submerged at low tide can greatly decrease fluxes of malodorous hydrogen sulfide to the atmosphere, because the hydrogen sulfide is oxidized rapidly in the water column;

- Dredging can decrease sediment oxygen demand and hydrogen sulfide production by removing the accumulation of organic-rich sediment;

- Dredging may allow the recruitment of a more diverse and abundant benthic community.

As described in Section 5, the NYCDEP is the non-federal, local sponsor of the USACE's ongoing Gowanus Bay and Canal Ecosystem Restoration Feasibility Study. The NYCDEP has recommended that USACE consider the feasibility of dredging Gowanus Canal as part of general restoration concepts that include recontouring the waterbody, removing any contaminated sediments, regrading shorelines to enhance tidal marshes, creating upland buffer zones, and restoring waterfront access. In support of the Ecosystem Restoration Study, the NYCDEP evaluated the impact on water quality of several dredging scenarios.

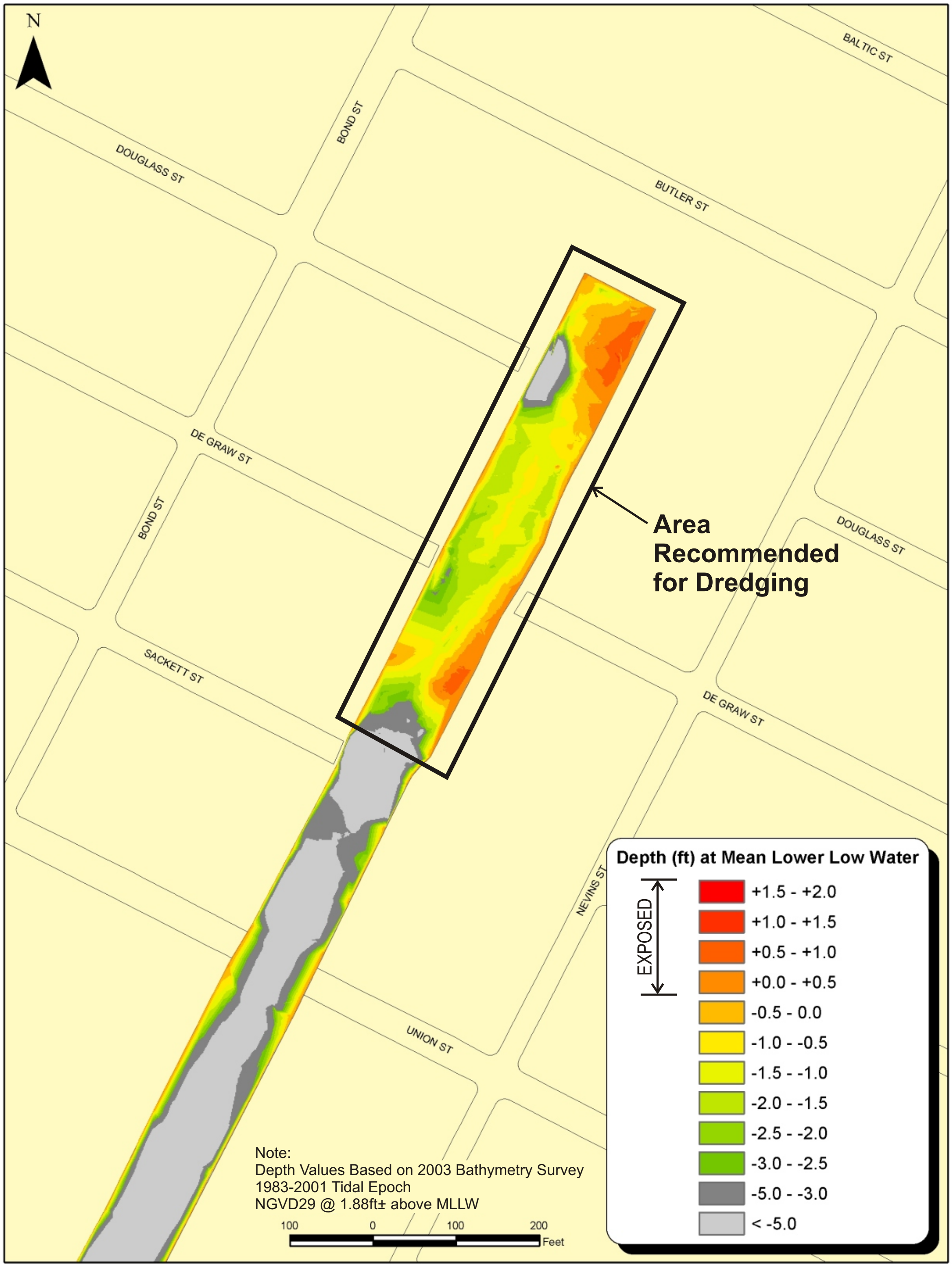
One evaluated alternative, described in Section 5.8.1, involved dredging a total of 1,700 linear feet of the Canal to remove a total of 26,600 cubic yards of sediment. Based on costs developed specifically for Gowanus Canal (O'Brien & Gere, 2006), this dredging a volume of about 10,000 cubic yards would likely cost about $382 per cubic yard removed, or a PTPC of about $10.2 million.

Modeling analyses developed for the above alternative, and for other alternatives including dredging the entire Canal, showed that the effects of dredging on water circulation and water quality within the Canal were not significant. As a result, the major benefit of dredging involves aesthetics—including the elimination of exposed CSO sediment mounds and the associated odors—and the potential of improving benthic habitat.

Therefore, another option that was evaluated involved dredging to eliminate exposed CSO sediment mounds. In Gowanus Canal, CSO sediment mounds are limited to the head of the Canal, in the roughly 750 feet upstream of Sackett Street, where the CSOs in that location have deposited sediments that have accumulated over time. As shown on Figure 7-10, at mean lower low tide, most of the Canal upstream of Sackett Street is less than 3 feet deep, with exposed sediment mounds (orange/red shades) located north of Douglass St and midway between Sackett and DeGraw Streets. Dredging the Canal north of Sackett Street and applying a 2-ft-deep sand cap to provide a final water depth of 3 ft below mean lower low water would eliminate the exposed sediments and the associated odors, improving the visual aesthetics of the waterbody, and improve the substrate for benthos habitat. This alternative would involve removing approximately 9,700 cubic yards of sediment and application of roughly 5,600 cubic yards of sand. Based on dredging costs of $633 per cubic yard and sand-cap costs of $1.1 million, the overall PTPC of this alternative is $7.2 million.

One negative aspect of dredging is that removing existing sediment from one side of an existing bulkhead that is in a compromised condition could lead to the failure and collapse of the bulkhead. A survey of bulkheads in Gowanus Canal did indicate a presence of marine borers and evidence of compromised structural integrity of bulkheads (Adam Brown, 2000). A more thorough investigation of affected bulkheads would be necessary before project costs can be established. However, there is approximately 1,500 linear feet of bulkhead surrounding the Canal north of Sackett Street, where heights from the top of the sand layer on the Canal bottom to the top of the existing bulkheads range up to 21 feet. According to the latest available costing information for bulkhead replacement (O'Brien & Gere, 2006), replacing these existing bulkheads would require a "tied-back" type at a cost of about $9,425 per linear foot, or up to a PTPC of about $14.2 million to replace all the bulkheads north of Sackett Street. An informal, visual observation of the condition of these bulkheads indicates that perhaps 600 linear feet could be in good condition. If this length of bulkhead did not need to be replaced, the total PTPC to replace impaired bulkheads could be closer to $8.5 million.

In summary, the most cost-effective approach to dredging would be to dredge the head of Gowanus Canal north of Sackett Street to a depth of 3.0 feet below mean lower low water, at a PTPC of $7.2 million. However, if replacement of existing, deteriorated bulkheads is required to ensure shoreline stability, this cost could increase by $8.5 million to $14.2 million. The total PTPC associated with this dredging alternative would then be $15.7 million to $21.4 million.



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Area Recommended for Dredging

Gowanus Canal Waterbody/Watershed Facility Plan

FIGURE 7-10

7.3.7 Implementing Instream Aeration

Implementation of the Gowanus Facilities Plan Upgrade and other recommended alternatives is expected to improve water quality conditions sufficiently to meet the applicable NYSDEC Class SD standard of 3.0 mg/L 100 percent of the time. However, even with 100 percent CSO abatement, water quality conditions are not projected to always achieve dissolved oxygen conditions sufficient to fully support aquatic life and propagation. Supplemental aeration may be a reasonable alternative for improving dissolved oxygen conditions to meet these uses.

The NYCDEP has conducted evaluations of instream aeration during various CSO facility planning efforts as an alternative for improving dissolved oxygen conditions. The NYCDEP is installing and evaluating instream aeration as a component of the Newtown Creek Water Quality Facility Planning Project. A demonstration application of instream aeration is anticipated to be operational in 2009 in English Kills, which is a tributary of Newtown Creek. The NYCDEP will conduct an evaluation of the effectiveness of this technology in improving dissolved oxygen and to determine the feasibility of implementing this technology in other waterbodies, considering operational, maintenance, and cost issues. In addition, instream, forced-air diffusion technology has also been piloted at the Shellbank Basin Destratification Facility, and the NYCDEP is planning a permanent installation there as part of its Jamaica Tributaries CSO Facility Plan. As a result, the City's experience with this technology will be advancing over time, which could be useful should the Waterbody/Watershed Facility Plan require future expansion to meet dissolved oxygen requirements.

Waterbody aeration can be accomplished practically using forced air diffusion, which involves delivering compressed air to the water column so that oxygen transfer to the surrounding water occurs as air bubbles rise to the surface. A low air-flow system with a PTPC cost of approximately $5.2 million could potentially provide a 1-2 mg/L improvement in minimum dissolved oxygen concentrations. However, an extensive network of diffusers delivering much higher aeration flows would have to be deployed throughout the Canal at an increased capital cost to fully support higher use levels 100 percent of the time.

There are several other disadvantages to installing instream aeration in Gowanus Canal. First, NYCDEP's experience is that this technology is susceptible to logistical problems associated with infrastructure requirements and maintenance, as well as vandalism. Second, modeling indicates that the minimum dissolved oxygen levels occur downstream of Hamilton Avenue when the elements of the Gowanus Facilities Upgrade are in place. This area of the Canal has frequent maritime traffic, making a diffuser system vulnerable to damage. Third, the effectiveness of aeration in a particular waterbody is difficult to predict. Evaluations of effectiveness during wet weather events indicate that increased levels of aeration would be required to counter-balance the impacts of CSO discharges for relatively short periods of time. In addition, forced-air diffusion requires sufficient depth to achieve beneficial oxygen transfer. Dredging to provide a suitable area for the diffuser network could increase the risk of failure of deteriorated bulkheads and could require bulkhead replacement at significant cost. In total, the instream aeration alternative could have significant capital costs, significant operation and maintenance costs, and frequent disruptions due to the concerns listed above. Since these issues would make instream aeration a questionable and perhaps undesirable alternative for application in Gowanus Canal, the alternative is not recommended at this time.

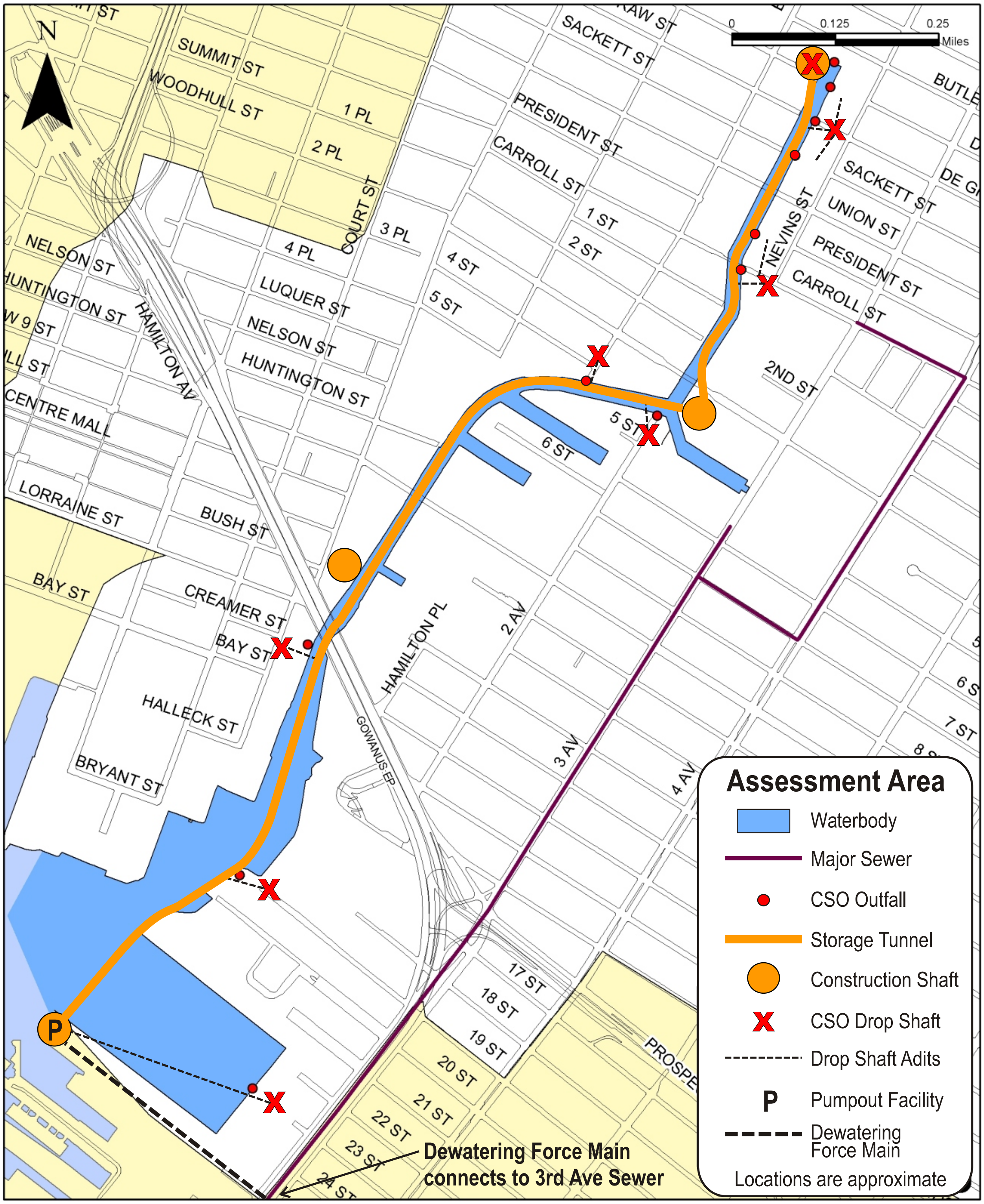
7.3.8 Implementing CSO Retention Facilities

As described in Section 7.2.5, CSO retention facilities include closed concrete tanks, storage pipelines/conduits, and deep tunnels. Due to the relatively high storage requirement and number (11) of CSO outfalls in Gowanus Canal, storage pipelines were eliminated in favor of tanks or storage tunnels. Several plans involving multiple storage tanks were considered, although siting of the tanks was determined to be potentially infeasible. Tunnel storage was identified as potentially more feasible with respect to siting requirements, though as described below, tunnel storage is less cost effective than tanks for smaller storage volumes. Conceptual designs were developed for storage capacities providing CSO reductions from about 50 percent up to 100 percent relative to the Baseline condition.

Due to the distance between the major CSO outfalls, individual tanks were most cost-effectively placed at or near the major CSOs. For example, placement of a 4 MG storage tank near RH-034 (the Gowanus Pump Station) would provide the largest benefit (CSO storage), since RH-034 is the largest CSO discharging to the Canal. Though this size tank may not capture all the CSO discharged at that location during large storms, increasing the size of the tank at this location provides marginally less CSO capture, and at some point it becomes more effective to construct a second tank at the next-largest CSO. For planning purposes, a variety of tank sizes and costs were evaluated and a cost-effective range of tank storage alternatives were developed, based on the assumption that any storage would be in addition to the elements being implemented as part of the Gowanus Facilities Upgrade project. This analysis of tank storage, which was expanded to consider tunnel storage as well, is described in more detail later in this subsection.

A conceptual design for a storage tunnel was developed for planning purposes (Figure 7-11). This tunnel design features a tunnel that is 8,400 feet in length, starting at the head of the Canal and essentially running under the Canal, to its terminus near the mouth of the Canal (at about 25th Street). The tunnel would have a depth of approximately 100 feet below grade, and would have a slight slope (0.1%) leading toward the southern end, where a pumping station would be located to dewater the tunnel following the storm event. Stored flows would be pumped into the Third Avenue Sewer for treatment at the Owls Head WPCP. Due to limitations of the turning radius of the tunnel boring machine, the tunnel would be constructed in two segments, each terminating at a large (40- to 100-foot diameter) vertical shaft rising to a point on land. Of these four shafts, one would be retained as an access shaft, one would be used as the pump station dewatering shaft, and the remaining two would provide routing for CSO flow to the tunnel. An additional 8 smaller drop shafts would be required to divert flow from the remaining CSO locations to the tunnel.

The CSO-control goal (such as 100 percent CSO capture, 85 percent CSO capture, or 4 CSO events per typical year) determines the required tunnel capacity (a function of the tunnel diameter), as well as the capacity of the dewatering pump station and the specific type and design of the individual drop shafts. To capture 100 percent of the CSO generated in the design (typical) precipitation year, modeling analyses indicated that a storage volume of 33 MG would be required and the drop shafts had to be capable of handling peak (5-minute) discharge flow rates ranging from about 1.5 MGD at RH-033 to about 172 MGD at RH-034. Less-stringent CSO goals were also considered, and these required lower capacities at reduced estimated cost.



CSO Storage Tunnel Conceptual Design

FIGURE 7-11

Figure 7-12 and Table 7-4 demonstrate the relative cost effectiveness of tank storage and tunnel storage for various levels of CSO volume control in Gowanus Canal. The upper panel of Figure 7-12 shows the total projected CSO volume reduction (with respect to Baseline) and estimated costs associated with the adding CSO retention to the controls associated with the Gowanus Facilities Upgrade project; Table 7-4 presents a key and specific information for each scenario. As shown, CSO reductions above about 80 percent are most cost-effectively accomplished with CSO storage tunnels. CSO reductions less than about 65 percent are most cost-effectively accomplished with a single CSO tank at RH-034, and reductions between 65 and 80 percent are most cost-effectively accomplished with a second tank placed at OH-007; adding a third tank at OH-024 is not cost effective. As a result of this analysis, subsequent performance-cost evaluations of retention facilities and other controls (Section 7.4) are based on tunnels for CSO-control goals above 80 percent, and based on tanks for CSO-control goals below 80 percent.

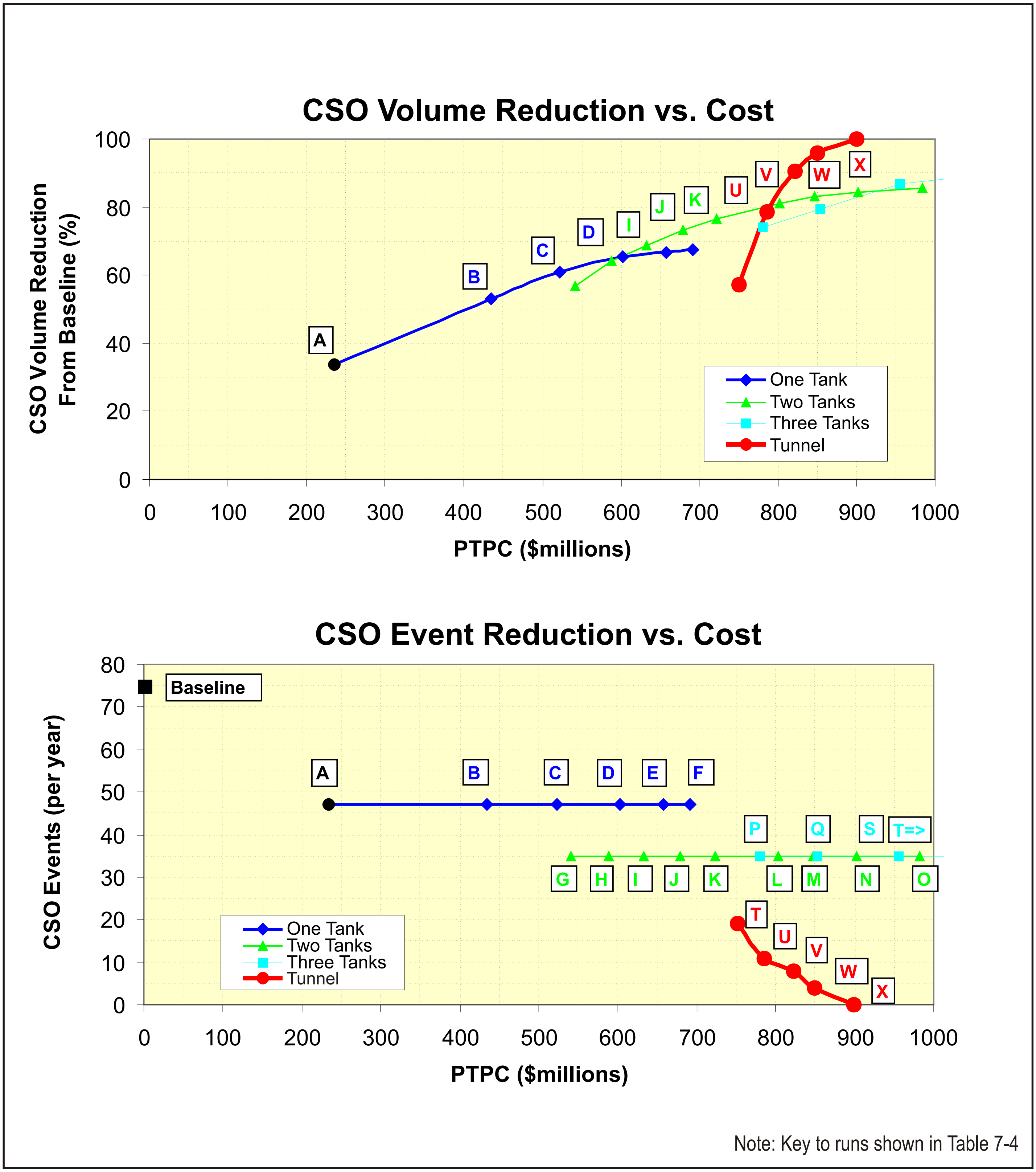
One important difference between tank storage and tunnel storage is that all CSOs are routed to the tunnel, whereas tanks at individual outfalls do not capture CSOs from other outfalls. As a result, tunnels can more effectively reduce the number of CSO events impacting the Canal than a few individual tanks. The lower panel of Figure 7-12 demonstrates this again. Table 7-4 presents a key and additional information for each scenario.

Alone, retention facilities would produce water-quality benefits. However, the impact of CSO reduction on water quality is substantially diminished when the flushing effect of the Gowanus Canal Flushing Tunnel is active. This point will be discussed in more detail later in Section 7.6.

7.3.9 Water Quality Improvement Plan

Analyses of the elements of the Gowanus Facilities Upgrade project (presented in Section 5.9) performed under the USA project determined that those elements would be sufficient to achieve the applicable numeric Class SD water-quality standards in Gowanus Canal. Additional controls were selected to achieve the applicable narrative water-quality standards. The Gowanus Canal Water Quality Improvement Plan therefore includes the following components:

- Continued implementation of programmatic controls
- Modernization of the Gowanus Canal Flushing Tunnel
- Reconstruction of the Gowanus Pump Station
- Cleaning/inspection of the OH-007 floatables/solids trap
- Periodic waterbody floatables skimming
- Dredging



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Gowanus Canal Waterbody/Watershed Facility Plan

CSO-Control Scenarios with Retention Facilities

FIGURE 7-12

Table 7-4 CSO-Control Scenarios with Retention Facilities

	Scenario		CSO Storage (MG) RH-034	CSO Storage (MG) OH-007	CSO Storage (MG) OH-024	Total Captured Volume (MG)	Annual CSO Volume (MG)	CSO Volume Reduction from Baseline (%)	CSO Events	CSO Event Reduction from Baseline (%)	Total Cost ($M)
	Baseline					0	377	0	75	0	0
A	Gowanus Facilities Upgrade					0	250	34	47	37	234.9
B	GFU + 1 Tank:	4 MG	4			73	177	53	47	37	435
C		8 MG	8			103	147	61	47	37	523
D		12 MG	12			120	130	65	47	37	603
E		15 MG	15			125	125	67	47	37	657
F		17 MG	17			127	123	67	47	37	691
G	GFU + 2 Tanks:	4 MG	2	2		87	163	57	35	53	541
H		6 MG	4	2		115	135	64	35	53	588
I		8 MG	6	2		132	118	69	35	53	633
J		10 MG	6	4		149	101	73	35	53	680
K		12 MG	8	4		162	88	77	35	53	723
L		16 MG	12	4		179	71	81	35	53	803
M		18 MG	12	6		186	64	83	35	53	848
N		21 MG	15	6		191	59	84	35	53	902
O		25.2 MG	17	8.2		196	54	86	35	53	983
P	GFU + 3 Tanks:	9.7 MG	4	4	1.7	152	98	74	35	53	781
Q		13 MG	6	6	1	172	78	79	35	53	854
R		18 MG	12	4	2	201	49	87	35	53	956
S		27.9 MG	17	8.2	2.7	219	31	92	35	53	1,153
T	GFU + Tunnel:	4.0 MG				89	161	57	19	75	751
U		11.1 MG				169	81	78	11	85	786
V		17.8 MG				214	36	90	8	89	822
W		23.9 MG				236	15	96	4	95	850
X		33.0 MG				250	0	100	0	100	900

The benefits of the selected Water Quality Improvement Plan can be quantified on a performance basis. Table 7-5 summarizes the CSO and stormwater discharges to Gowanus Canal for both the Baseline scenario (as discussed in Section 3) and the Water Quality Improvement Plan scenario (including the elements of the Gowanus Facilities Upgrade Facilities Plan discussed above and in Section 5.9). As shown, CSO discharges to the Canal are projected to decrease by 34 percent for the design precipitation year, to 250 MG from 377 MG. As noted above, these reductions in CSO discharges, along with the modernization of the Flushing Tunnel, re expected to achieve the applicable Class SD numeric water-quality standards (as discussed in Section 7.6).

With respect to the narrative criteria for floatables, the Plan provides for a 90 percent reduction in the CSO discharges from the Bond Lorraine Sewer and adds floatables controls on the two principal remaining CSO discharges to the Canal: virtually all CSO at the Gowanus Pump Station (RH-034) will be screened, and the rehabilitation of the floatables trap at OH-007 should improve floatables retention there. Periodic waterbody floatables skimming is specified to address any remaining floatables issues in the Canal, if any. In addition, the elements of the Floatables Plan would continue to be implemented in the Gowanus Canal watershed.

With respect to aesthetic criteria related to sediment mounds and odors, dredging will eliminate exposed sediment mounds at the head of the Canal. This will eliminate the associated odors and, because a clean sand cap will be placed in the dredged area for a final water depth of 3 ft below mean lower low water, the substrate will be improved for benthic habitat.

Estimated costs for the selected Gowanus Facilities Upgrade Project Element are summarized in Table 7-6. The estimated total cost of the selected alternatives is $251.4 to $257.1, depending on the need and cost required for bulkhead replacement for dredging. Note that elements and costs associated with the USACE Ecosystem Restoration Project for Gowanus Bay and Canal are yet to be determined and hence are not included in the above. Also note that these costs are in addition to the $11.1 million actual cost the NYCDEP has already incurred implementing the Gowanus Canal elements of the Inner Harbor CSO Facility Plan.

7.4 WATERBODY/WATERSHED PLANNING

Based on the initial screening of alternatives described in Section 7.2, the investigation of alternatives described in Section 7.3, and in accordance with the requirements of the CSO Control Policy described in Section 7.1, performance-cost (knee-of-the-curve) analyses were conducted for a number of CSO control alternatives. These alternatives are individually described below. Although none of the alternatives had been implemented at the time the CSO Consent Order was adopted, many of the important elements had progressed to various phases of design under the Gowanus Facilities Upgrade project. As such, the Waterbody/Watershed Planning efforts described herein evaluated additional CSO-control alternatives that could be implemented to further improve water quality in the Canal beyond the benefits expected from the Gowanus Facilities Upgrade project.

Table 7-5. Gowanus Canal Discharge Summary for Baseline and Water Quality Improvement Plan Conditions[1,2]

	Baseline Condition			Water Quality Improvement Plan Condition		
Outfall	**Discharge Volume (MG)**	**Percentage of CSO or Stormwater Volume**	**Number of Wet-Weather Events[3]**	**Discharge Volume (MG)**	**Percentage of CSO or Stormwater Volume**	**Number of Wet-Weather Events[3]**
Combined Sewer						
RH-034	121	32.1	56	127	50.7	35
RH-035	111	29.5	75	3	1.4	12
OH-007	69	18.4	47	69	27.7	47
RH-031	35	9.4	33	11	4.2	17
OH-024	23	6.2	35	23	9.4	35
OH-006	13	3.3	33	13	5.0	33
RH-036	1.6	0.4	21	1,6	0.6	20
RH-038	0.9	0.2	18	0.9	0.4	15
OH-005	0.7	0.2	5	0.7	0.3	5
RH-037	0.5	0.1	16	0.5	0.2	16
RH-033	0.2	0.1	14	0.2	0.1	14
Total CSO	377	100	75	250	100	47
Storm Sewer						
OH-601	10	13.8	66	10	13.8	66
RH-032	1.5	2.1	38	1.5	2.1	38
OH-008	0.1	0.2	10	0.4	0.5	10
OH-602	0.1	0.2	3	0.1	0.2	3
Overland Runoff	62	83.8	79	62	83.5	79
Total Stormwater	74	100	79	75	100	79
Total	452	NA	NA	325	NA	NA

[1] Simulated conditions reflect design precipitation record (JFK, 1988) and sanitary flows projected for year 2045 (Red Hook WPCP: 40 MGD, Owls Head WPCP: 115 MGD)
[2] Totals may not sum precisely due to rounding.
[3] Reflects minimum modeled flow of 0.01 MGD per 5-minute interval and minimum 12-hr inter-event time.

Table 7-6. Cost Summary of Water Quality Improvement Plan Components

Construction Component	Cost[1] (Millions)	PTPC[2] (Millions)
Gowanus Facilities Upgrade		
Pump Station Reconstruction		
Service Building and Site Facilities	$ 22.9	$ 36.1
Wastewater Pump Station (Capacity Increase)	$ 23.7	$ 37.0
Wastewater Force Main and Associated Tunnel Work	$ 42.1	$ 65.9
CSO Floatables Screening System	$ 8.1	$ 12.8
Subtotal	$ 96.8	$ 151.7
Flushing Tunnel Pumping System		
Permanent System	$ 47.9	$ 75.0
Oxygenation System (to operate during construction only)	$ 5.2	$ 8.2
Subtotal	$ 53.1	$ 83.2
Total Cost of Gowanus Facilities Upgrade	$ 149.9	$ 234.9
Clean/Inspect Trap basin at OH-007 [3]		$ -
Periodic Skimming [3]		$ 0.9
Dredging [4]		$ 7.2
Bulkhead Replacement for Dredging [5]		$ 14.2
Total Cost of Selected Alternatives		**$ 257.1**

[1] Q1 2007 dollars; includes markups of 13% contractor mobilization and general conditions, 17% contractor field and home office, 10% profit, 3% payment performance bonds & insurance, 10% construction contingency, 10% change order allowance, escalation to midpoint 3.2 yrs @8.5%, 8% design contingency. From Dvirka & Bartilluci, 2008a.
[2] June 2008 dollars; PTPC estimate by O'Brien & Gere, 2008 based on above, backed into bare costs.
[3] Capital costs reflect cost of skimmer vessel.
[4] PTPC (June 2008 dollars) to dredge 9,700 cy to eliminate exposed sediments and place clean sand cap.
[5] Potential PTPC (June 2008 dollars) to replace 1,500 ft of 21-ft exposed face, tied-back bulkhead.

Development of the Gowanus Canal Waterbody/Watershed Facility Plan, described in the following section, involved an evaluation of alternatives that was performed in a manner that is consistent with USEPA's CSO Policy and guidance for long-term CSO planning. Evaluated alternatives corresponded to a range of CSO reductions from the Baseline condition up to 100 percent CSO abatement. Each of these alternatives was then evaluated in terms of projected compliance with applicable water-quality criteria and designated uses. Compliance with fish and aquatic-life uses was evaluated by comparing projected dissolved oxygen conditions to New York State water-quality standards and draft proposed aquatic-life criteria (described in Section 9). Aesthetics and riparian uses were evaluated by comparing projected levels of floatables, sediment mounds, and other aesthetic conditions to narrative water-quality standards. In all cases, attainment of stakeholder water-use goals was evaluated.

USEPA's CSO Control Policy acknowledges the utility of mathematical modeling analyses and supports their use to improve understanding of waterbody response to CSO controls and other factors affecting the waterbody. A modeling framework incorporating both landside (Section 3.4) and receiving water (Section 4.1.4) components was developed, calibrated, and validated using field data collected during facility planning and other studies. The model was used to perform full-year simulations to assess sewer system performance and/or the water quality response associated with the selected alternatives.

To properly assess the performance and efficacy of the selected alternatives to achieve the desired water quality and use goals, all model simulations were performed using a set of conditions designed to isolate the effects and impacts of each alternative. This was accomplished through the establishment of a Baseline condition; results of each evaluated alternative were compared to results of the Baseline condition to determine the impacts of the alternative relative to the Baseline.

Baseline Design Condition

As indicated above, all model simulations were conducted using a common set of conditions appropriate for long-term planning. The specific design conditions established for the Baseline scenario are discussed in Section 3.4.3 (landside/watershed model) and Section 4.5.4 (receiving water models). The Baseline condition represents the state and operation of the sewer system and other facilities in a manner that predates implementation of any long-term CSO abatement plans, but does include implementation of the CSO Policy nine minimum controls and existing permit requirements regarding system wet-weather capacity, and a projected future condition with regard to population and water use. Briefly, the Baseline design condition represents the following:

- A typical annual precipitation record (JFK 1988) having long-term average total rainfall volume and storm duration;

- Other environmental conditions (meteorology, tidal conditions, water temperature and salinity, winds, etc.) corresponding to the 1988 calendar year selected above;

- Dry-weather flow rates at year 2045 projections; for the Red Hook (40 MGD) and Owls Head (115 MGD) WPCPs;

- Wet-weather capacity from 2003, as determined from the "top-ten storm" analysis at the Red Hook (113 MGD) and Owls Head (235 MGD) WPCPs and at the Gowanus Pump Station (28.5 MGD);

- Gowanus Pump Station discharging flow to the Bond-Lorraine Sewer (per current conditions);

- Sedimentation levels in sewers associated with reasonable maintenance. In most cases, sewers were modeled as clean conduits. However, in the 72-inch-diameter Bond-Lorraine Sewer, where sedimentation buildup has been a chronic problem, modeling analysis assumed 15 inches through most of the sewer and 18 inches upstream of the constriction at Bond and 5th Streets.

- No operation of the Gowanus Canal Flushing Tunnel

The remainder of Section 7.5 presents each of the evaluated alternatives, where each alternative represents a cost-effective combination of controls consistent with a particular level of control. Table 7-7 summarizes the costs associated with each evaluated alternative and provides a breakdown of costs of elements included in each alternative. Section 7.6 presents a summary of how selected alternatives comply with criteria related to CSO-reduction and compliance with water-quality standards and/or uses.

Table 7-7 Costs and Elements of Evaluated Alternatives

Evaluated Alternative	Estimated PTPC ($million)	Element Description
Low Cost #1	0.9	Periodic skimming (3)
	0.9	
Low Cost #2	0.9	Periodic skimming (3)
	7.2	Dredging (1,4)
	14.2	Bulkhead replacement for dredging (1,5)
	22.2	
Dredging + Floatables Controls	0.9	Periodic skimming (3)
	7.2	Dredging (1,4)
	14.2	Bulkhead replacement for dredging (1,5)
	0.0	OH-007 trap cleaning (6)
	12.8	GPS CSO screens (2,7)
	35.0	

Table 7-7 Costs and Elements of Evaluated Alternatives

Evaluated Alternative	Estimated PTPC ($million)	Element Description
Water Quality Improvement Plan	0.9	Periodic skimming [3]
	7.2	Dredging [1,4]
	14.2	Bulkhead replacement for dredging [1,5]
	0.0	OH-007 trap cleaning [6]
	12.8	GPS CSO screens [2,7]
	139.0	GPS expansion [2,8]
	83.2	Modernize Flushing Tunnel [2,9]
	257.1	
Water Quality Improvement Plan+ 4 MG Retention	257.1	Water Quality Improvement Plan
	200.0	4.0 MG Tank at RH-034 [1,10]
	457.1	
Water Quality Improvement Plan+ 8 MG Retention	257.1	Water Quality Improvement Plan
	244.9	6.0 MG Tank at RH-034 [1,10]
	153.1	2.0 MG Tank at OH-007 [1,10]
	655.1	
Water Quality Improvement Plan+ 11.1 MG Retention	257.1	Water Quality Improvement Plan
	550.6	11.1 MG Tunnel [1,10]
	807.8	
Water Quality Improvement Plan+ 17.8 MG Retention	257.1	Water Quality Improvement Plan
	587.1	17.8 MG Tunnel [1,10]
	844.3	
Water Quality Improvement Plan+ 23.9 MG Retention	257.1	Water Quality Improvement Plan
	614.7	23.9 MG Tunnel [1,10]
	871.8	
Water Quality Improvement Plan+ 33.4 MG Retention (100% CSO)	257.1	Water Quality Improvement Plan
	664.7	33.4 MG Tunnel [1,10]
	921.8	
Sewer Separation	**1,592.3**	Sewer Separation[1]

Notes
(1) PTPC "Project Total Probable Cost" in June 2008 dollars
(2) PTPC estimated from Engineer's estimated cost (O'Brien & Gere, 2008; Dvirka & Bartilucci, 2008a)
(3) Skimmer vessel purchase price
(4) Dredging to eliminate exposed sediments (9,700 cy) and place clean sand cap.
(5) Bulkhead replacement of 1,500 ft of 21-ft exposed face, tied-back bulkhead
(6) Periodic cleaning of OH-007 trap basin - insignificant capital cost
(7) Horizontally raked CSO screens, 200 MGD capacity
(8) Expand capacity to 30 MGD; replace force main, associated tunnel work
(9) Modernize flushing system
(10) 8,400-ft long tunnel, 100-ft deep, with access shafts, drop shafts, and dewatering facility

7.4.1 Low Cost 1 – Periodic Skimming

The Low-Cost 1 scenario consists of periodic skimming as necessary to remove floatables in the Canal. This scenario represents a minimum additional investment by NYCDEP for water quality improvement management practices beyond those included in the Baseline scenario (such as attaining a wet-weather collection system capacity of twice design dry-weather flow). This scenario does not involve additional capture of combined sewage volume relative to the Baseline condition. A skimmer vessel of the type currently employed in Jamaica Bay would cost approximately $860,000, exclusive of operation and maintenance costs.

7.4.2 Low Cost 2 – Dredging and Periodic Skimming

The Low-Cost 2 scenario evaluates the benefits of adding dredging in Gowanus Canal to the periodic skimming of floatables practices, which comprise the Low-Cost 1 scenario presented above. Although the discharge characteristics of this scenario would still remain the same as in the Baseline condition, aesthetic uses of Gowanus Canal would be further improved by eliminating exposed CSO sediment mounds in the Canal that are both visually unattractive and a source of odors. Additional benefits of dredging may also result from the removal of poor quality substrate, which does not support a healthy benthic community, and the removal of a demand on water column dissolved oxygen.

As discussed previously in Section 7.3.6, dredging to eliminate the CSO sediment mounds that are exposed at low tides north of Sackett Street is estimated to cost $7.2 million, but replacement of deteriorating bulkheads, if necessary, could add up to $14.2 million, increasing the total cost of dredging to $21.4 million. The total PTPC for this alternative is therefore estimated to be $22.2 million.

7.4.3 Dredging and Floatables Control at Major CSOs

Further aesthetic benefits could be attained by adding direct floatables control at RH-034 and OH-007, which together account for over half of the total CSO discharge to the Canal in the Baseline condition (Table 3-11). As described in Section 7.3.5, the PTPC to install retrofitted horizontal screens at the Gowanus Pump Station (RH-034) is approximately $12.8 million, whereas controlling floatables at OH-007 through a program to operate and maintain the existing floatables trap would not require significant capital budget. Adding these costs to the above cost of $22.2 million for periodic skimming plus dredging (including bulkhead replacement) yields a PTPC of $35.1 million for this alternative. Again, this alternative would not reduce the volume or frequency of CSO discharges to the Canal.

7.4.4 Water Quality Improvement Plan

This alternative, which was developed as part of the USA study, incorporates the elements of the Gowanus Facilities Upgrade project (which are already in design) and adds to them measures addressing aesthetics issues in order to create a plan that is expected to satisfy all requirements of the Waterbody/Watershed Facility Plan. The elements of the Water Quality Improvement Plan are:

- Continued implementation of programmatic controls (Sections 5.3 & 5.4)
- Reconstruction of the Gowanus Pump Station (Section 5.9.1 & 7.3.3)
- Modernization of the Gowanus Canal Flushing Tunnel (Section 5.9.2 & 7.3.4)
- Cleaning/inspection of the OH-007 floatables/solids trap (Section 7.3.5)
- Periodic waterbody floatables skimming (Section 7.3.5)
- Dredging to remove exposed sediment mounds (Section 7.3.6)

The reconstruction of the Gowanus Pump Station and the modernization of the Flushing Tunnel are expected to improve the modeled parameters: CSO volume and frequency, and receiving water concentrations of dissolved oxygen and pathogens. The cleaning of the OH-007 floatables/solids trap was not assumed to affect modeled parameters, such as sediment oxygen demand (SOD) or discharged CSO volume or frequency. Similarly, sensitivity analyses performed using the model indicated that non-aesthetic water-quality impacts associated with dredging would be minor. Therefore, the non-aesthetic water-quality impacts of the Water Quality Improvement Plan are identical to those associated with the Gowanus Facilities Upgrade project.

For the design (typical precipitation) year, the Water Quality Improvement Plan is expected to reduce CSO discharges to Gowanus Canal by 127 MG (34 percent) overall, and to reduce the number of CSO events to 47 from 75 (a 37 percent reduction). At the same time, the Plan enhances the circulation of the Canal and addresses aesthetics issues such as floatables and exposed sediment mounds.

The capital costs associated with the individual elements of the Water Quality Improvement Plan are summarized in Table 7-7. As shown, the total cost is $257.1 million, including an allowance of up to $14.2 million for bulkhead replacement, if required.

7.4.5 Water Quality Improvement Plan Plus 4 MG CSO Retention

This scenario evaluates the efficacy of augmenting the Water Quality Improvement Plan with 4 million gallons of CSO retention in the form of a storage tank serving RH-034, the largest remaining CSO discharge to the Canal, as described previously in Section 7.3.8. During the design (typical precipitation) year, this storage volume captures an additional 73 MG of CSO beyond the Water Quality Improvement Plan. Overall, the total CSO volume reduces to 177 MG, a 53 percent reduction from the 377 MG CSO in the Baseline condition. Although the tank completely captures an additional 15 CSO events, no reduction is accomplished at OH-007, and the number of CSO events remains unchanged at 47 per year.

The PTPC associated with a 4 MG tank storage facility is approximately $200.0 million. Adding the $257.1 million cost of the Water Quality Improvement Plan gives a total cost for this scenario of $457.1 million.

7.4.6 Water Quality Improvement Plan Plus 8 MG CSO Retention

This scenario builds upon the previous scenario by increasing the size of the tank at RH-034 and placing a second tank at the second-largest remaining CSO discharge, OH-007. In the design (typical precipitation) year, a 6 MG tank at RH-034 would capture 90 MG and a 2 MG tank at OH-007 would capture 42 MG, for a total capture of 132 MG beyond the Water Quality

Improvement Plan. Overall, the CSO volume reduces to 118 MG, for a total CSO reduction of 69 percent from the Baseline. The number of overflow events is reduced to 11 per year at RH-034 and 16 per year at OH-007, but other CSOs discharge to the Canal up to 35 times per year.

The PTPC associated with a 6 MG tank at RH-034 and a 2 MG tank at OH-007 is approximately $398.0 million. Adding the $257.1 cost of the Water Quality Improvement Plan gives a total cost for this scenario of $655.1.

7.4.7 Water Quality Improvement Plan Plus 11.1 MG CSO Retention

This scenario builds upon the previous scenario by increasing the CSO retention to 11.1 MG with deep-tunnel storage. As described in Section 7.3.8, a 100-ft-deep tunnel running the 8,400 ft length of Gowanus Canal would accept CSO flows from each CSO via a system of drop shafts. A tunnel diameter of 15 ft would provide the specified storage capacity, and a dewatering facility would empty the contents to the 3rd Avenue Sewer for treatment at the Owls Head WPCP after the storm. In the design (typical precipitation) year, this retention facility would capture 169 MG beyond the Water Quality Improvement Plan. Overall, the CSO volume reduces to 81 MG, for a total CSO reduction of 78 percent from the Baseline. Because the tunnel accepts at least some flow from all CSO outfalls, the number of overflow events is reduced to 11 per year, an 85 percent reduction from the Baseline.

The PTPC associated with an 11.1 MG tunnel is approximately $550.6 million. Adding the $257.1 cost of the Water Quality Improvement Plan gives a total cost for this scenario of $807.8.

7.4.8 Water Quality Improvement Plan Plus 17.8 MG CSO Retention

Increasing the diameter of the 8,400-ft storage tunnel to 19 ft increases the storage capacity to 17.8 MG. During the design (typical precipitation) year, this scenario captures a total of 214 MG, an additional 45 MG of CSO beyond the previous scenario. Overall, the total CSO volume reduces to 36 MG, a 90 percent reduction from the 377 MG CSO in the Baseline condition. This scenario completely captures 3 additional CSO events, resulting in a total of 8 CSO events per year, a reduction of 89 percent from the Baseline.

The PTPC associated with the 17.8 MG storage facility is approximately $587.1 million, or about $36.5 million more than the 11.1 MG tunnel. Adding the $257.1 million cost of the Water Quality Improvement Plan gives a total cost for this scenario of $844.3 million.

7.4.9 Water Quality Improvement Plan Plus 23.9 MG CSO Retention

Increasing the diameter of the 8,400-ft storage tunnel to 22 ft increases the storage capacity to 23.9 MG. During the design (typical precipitation) year, this scenario captures a total of 236 MG, an additional 21 MG of CSO beyond the previous scenario. Overall, the total CSO volume reduces to 14 MG, a 96 percent reduction from the 377 MG CSO in the Baseline condition. This scenario completely captures 4 additional CSO events, resulting in a total of 4 CSO events per year.

The PTPC associated with the 23.9 MG storage facility is approximately $614.7 million, or about $27.6 million more than the 17.8 MG tunnel. Adding the $257.1 million cost of the Water Quality Improvement Plan gives a total cost for this scenario of $871.8 million.

7.4.10 Water Quality Improvement Plan Plus 33.4 MG CSO Retention (100% CSO Abatement)

Increasing the diameter of the 8,400-ft storage tunnel to 26 ft increases the storage capacity to 33.4 MG. During the design (typical precipitation) year, this scenario captures the remaining 14 MG of CSO from the previous scenario. Overall, the total CSO volume reduces to 0 MG, a 100 percent reduction from the 377 MG CSO in the Baseline condition. Similarly, this scenario completely captures the remaining 4 additional CSO events, resulting in zero CSO events per year.

The PTPC associated with the 33.4 MG storage facility is approximately $664.7 million, or about $50.0 million more than the 23.9 MG tunnel. Adding the $257.1 million cost of the Water Quality Improvement Plan gives a total cost for this scenario of $921.8 million.

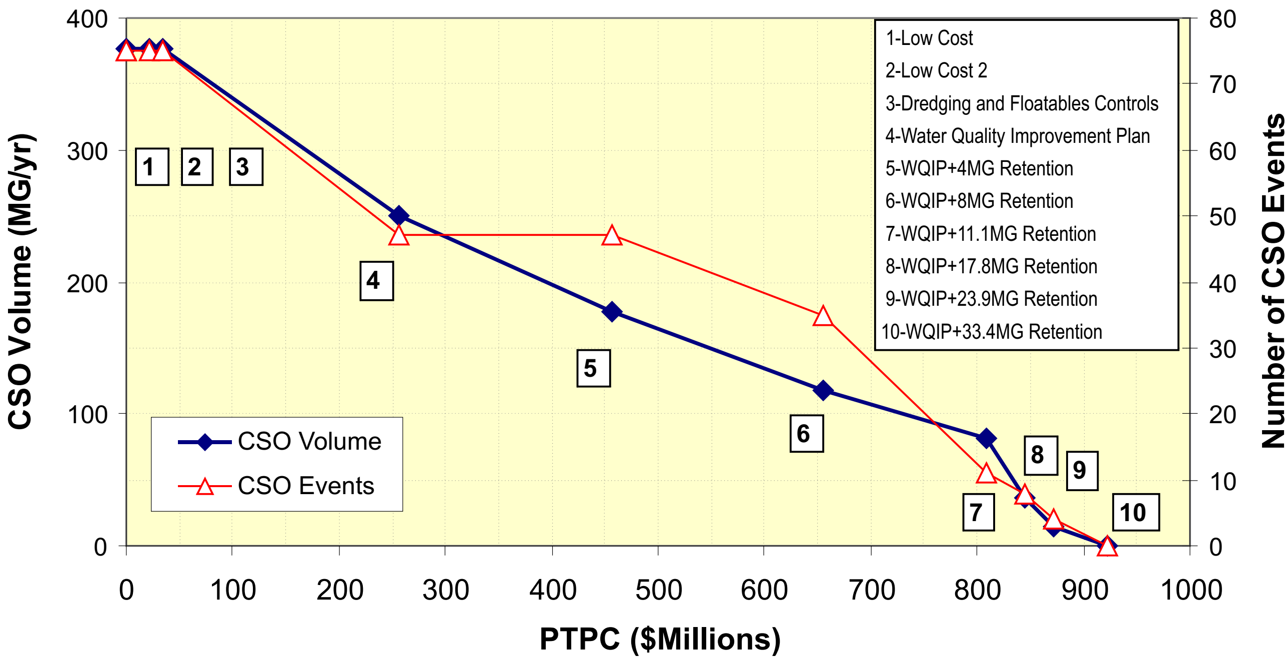
7.4.11 Sewer Separation

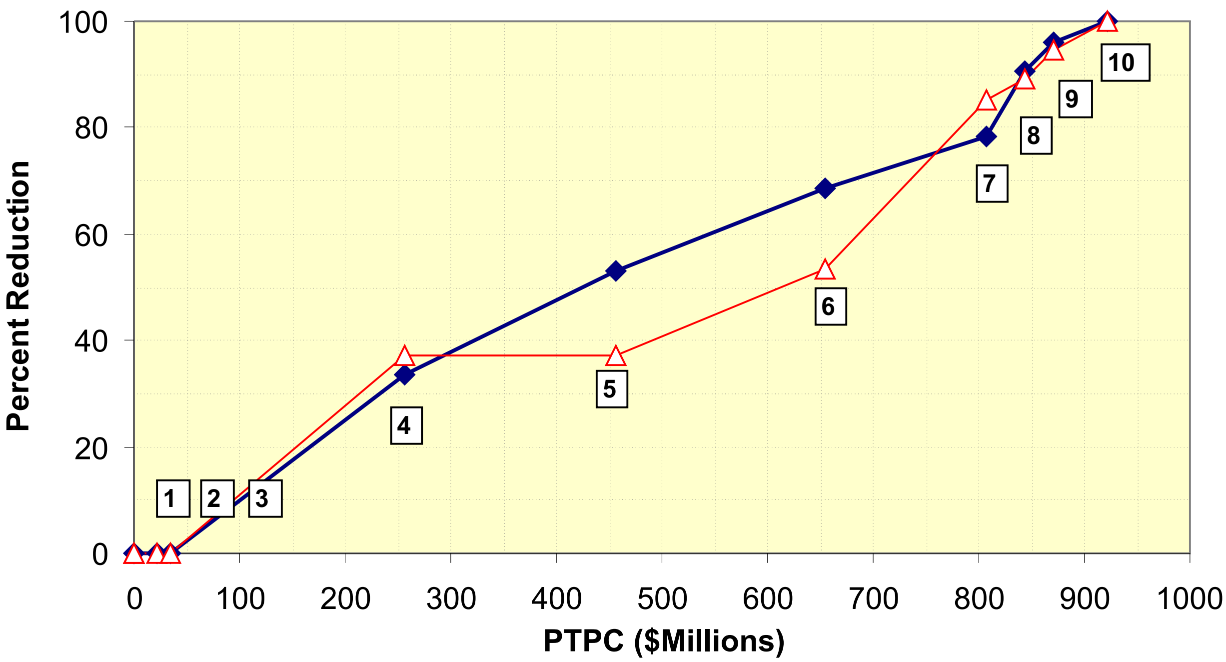
USEPA's CSO guidance recommends that CSO elimination by sewer separation or outfall relocation be considered when evaluating long-term CSO controls (USEPA, 1995). Within the use attainability framework, the sewer separation and 100 percent CSO abatement scenarios assist in realistically determining water quality attainability and representing a condition in which the urbanization of a watershed follows today's practice of separated-sewer construction for stormwater conveyance and disposal. Long-term control planning guidance (USEPA, 1995) states that "..if a municipality evaluates sewer separation as an alternative, it should consider the impact of increased storm water loads on receiving waters." Therefore, this alternative evaluates the impact of removing sanitary sewage from discharges to the Canal, but including all generated rainfall runoff as stormwater discharges to the Canal. Relative to the Baseline condition, this sewer separation more than doubles the total wet-weather discharge volume to the Canal (to 1,507 MG from 452 MG). Loadings of TSS and BOD were projected to increase by 204 and 110 percent, respectively, while loadings of total coliform, fecal coliform and enterococci loads were projected to decrease to 18, 15, and 73 percent of Baseline levels, respectively. The estimated PTCP of sewer separation is $1,592 million.

7.5 PERFORMANCE-COST ANALYSIS OF ALTERNATIVES

The CSO Policy (USEPA, 1994a) expects that long-term CSO control planning will “consider a reasonable range of alternatives” that would achieve a range of CSO control levels, up to 100 percent capture. The Policy further states that the “analysis of alternatives should be sufficient to make a reasonable assessment of cost and performance,” and that the selected alternative must provide “the maximum pollution reduction benefits reasonably attainable.” For the alternatives presented in Section 7.4, an evaluation of cost and performance was conducted in to assist in the alternative selection.

Figure 7-13 presents a graphic representation of the performance and cost of the evaluated alternatives. The upper panel shows the performance, in terms of CSO volume and number of events, versus cost, where each alternative is represented as a point along a curve





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CSO Discharge Reduction vs. Cost for Evaluated Alternatives

FIGURE 7-13

connecting all of the alternatives from the least costly/effective to the most costly/effective. The blue line/closed triangles represent calculated CSO volume and the red line/open triangles represent number of CSO events (scale on right side). As shown, successive alternatives represent higher levels of CSO control and higher costs. The alternatives reduce the annual CSO volume from 377 MG to 0 MG, and the number of CSO events from 75 to 0, for costs ranging up to $921.8 million. The lower panel is similar, except that percentage reduction from Baseline CSO volume and number of CSO events is shown. The percentage reductions range from zero to 100 percent.

The cost of additional tunnel storage adds a large marginal cost to the controls of the Water Quality Improvement Plan, with a relatively small incremental cost for additional retention capacity. However, as discussed below in Section 7.7, the Water Quality Improvement Plan represents a cost-effective point of control beyond which additional water quality benefits are not realized.

7.6 WATER QUALITY AND USE BENEFITS OF ALTERNATIVES

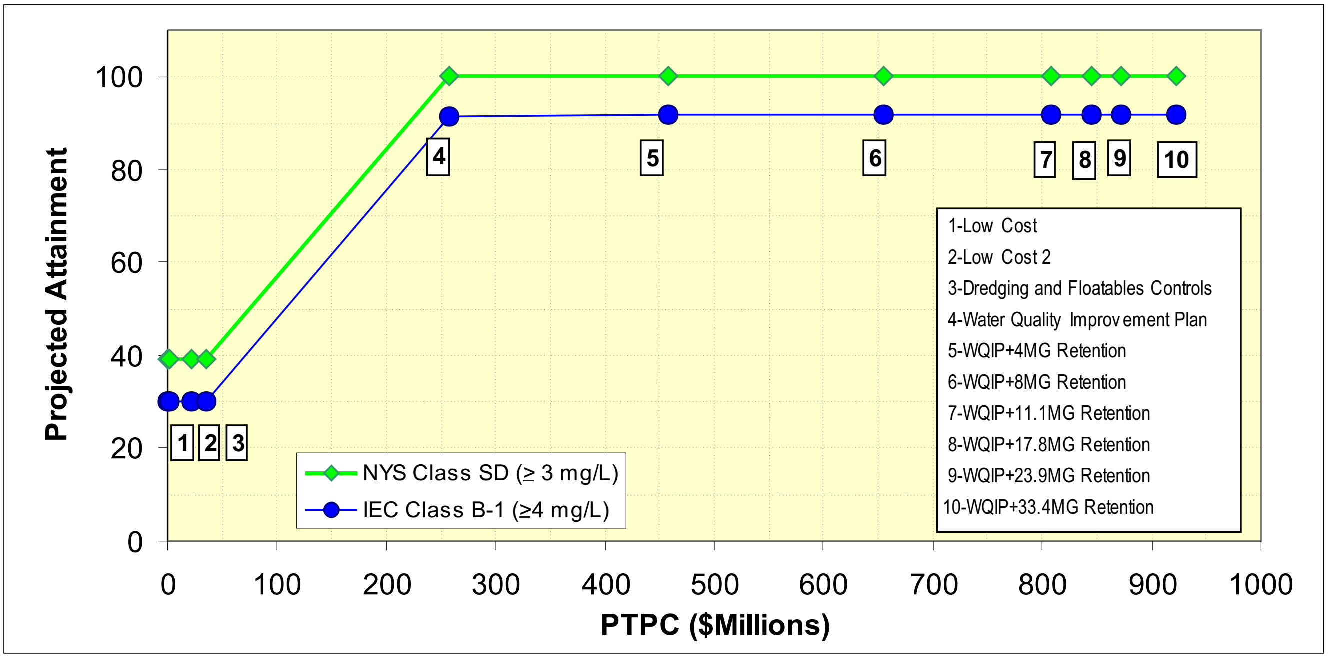
To complete the assessment of alternatives, an evaluation must be made of whether and how cost-effectively each alternative achieves water quality and water use objectives. According to the CSO Policy, a selected alternative must be adequate to meet water quality standards and designated uses unless those standards and uses are unattainable through CSO control, unless water quality standards or uses cannot be met through CSO control.

7.6.1 Dissolved Oxygen

Figure 7-14 presents water quality cost-benefit curves that depict projected water quality benefits versus cost for each evaluated alternative. The figure presents projected annual attainment of various dissolved oxygen criteria for Gowanus Canal. Here, water quality benefit is determined as the projected percentage of hours during the year that attain either the applicable existing NYSDEC Class SD criterion or the IEC Class B-1 criterion. As shown, the selected Water Quality Improvement Plan clearly represents a “knee-of-the-curve,” with significant improvement from lesser alternatives, but little or no benefit realized from additional controls—regardless of cost. The Class SD criterion (never less than 3.0 mg/L) is projected to be met at all times for the Water Quality Improvement Plan and successive alternatives. The IEC Class B-1 criterion (never less than 4.0 mg/L) is projected to be met at least 93 percent of the time (or more, depending on location within the Canal) for the Water Quality Improvement Plan. It is important to note that no alternative—not even 100 Percent CSO Abatement—improves attainment of this criterion more than 1 percent beyond the Water Quality Improvement Plan.

7.6.2 Aesthetics

Aesthetics issues such as floatables and odors are difficult to quantify. With respect to floatables, each of the alternatives considered provides an additional level of control. The “Low-Cost” alternatives include only periodic, open-water skimming of the Canal. While this alternative would help to control the levels of floatables in the Canal, it does not reduce the discharge of these materials into the Canal. The “Environmental Dredging and Floatables Control at Major CSOs” alternative eliminates floatables discharges in the design (typical) precipitation year from the Gowanus Pump Station (RH-034, representing over 60 percent of the



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Projected Attainment of Dissolved Oxygen Criteria vs. Cost for Evaluated Alternatives

Baseline condition CSO discharge to the Canal), and also controls floatables discharged from OH-007 (representing another 22 percent of CSO discharges). The Water Quality Improvement Plan further reduces the possibility of floatables discharges from the Gowanus Pump Station by increasing the pumping capacity of the station. Adding CSO retention facilities further reduces floatables discharges through the capture of CSO volumes.

With respect to the control of odors, the elimination of CSO sediment mounds, the improvement of dissolved oxygen levels, and to some extent the reduction of CSO discharges can all contribute to the reduction of odors. Though the "Low-Cost 1" alternative does not address any of these controls, the "Low-Cost 2" alternative and all subsequent alternatives do include the elimination of the CSO sediment mounds at the head of the Canal. This element is expected to provide the greatest effect in reducing odors. The "Environmental Dredging and Floatables Control at Major CSOs" alternative, however, is not expected to improve dissolved oxygen or to reduce CSO discharges. The Water Quality Improvement Plan alternative is expected to greatly improve dissolved oxygen, primarily through the modernization of the Flushing Tunnel, and to significantly reduce CSO discharges, both of which will also contribute to reduced odors. Although adding CSO retention facilities will further reduce CSO discharges, these alternatives are not expected to improve dissolved oxygen levels and hence may not significantly improve odors.

7.6.3 Indicator Bacteria

Gowanus Canal's SD classification is not suited to contact recreational uses and no bacteria standards apply. However, the Water Quality Improvement Plan, CSO retention, and Sewer Separation alternatives are projected to improve the levels of indicator bacteria in the Canal. These improvements are shown graphically in Appendix D.

7.6.4 Summary

In summary, the water quality benefit versus cost curve demonstrates that the Water Quality Improvement Plan represents the most cost-effective alternative to attain existing water quality standards and designated uses. This level of control is projected to provide attainment of higher dissolved oxygen criteria most of the time. Higher levels of control are not projected to further improve water quality.

7.7 CRITERIA ATTAINMENT WITH SELECTED ALTERNATIVES

To further clarify how the Water Quality Improvement Plan compares to the maximum levels of CSO control, this section compares the projected attainment of applicable water-quality criteria for the 100 Percent CSO Abatement, Complete Sewer Separation, Water Quality Improvement Plan, and Baseline alternatives. Table 7-8 summarized the projected attainment of dissolved oxygen criteria. Additional, supplemental graphics are presented in Appendix D.

With respect to the existing, applicable NYS Class SD dissolved oxygen standard of never-less-than 3 mg/L, all three evaluated alternatives are projected to attain the criterion 100 percent of the time—a significant improvement over the Baseline's 39 percent attainment. Notably, three is no benefit gained from the more expensive 100 Percent CSO Abatement or Complete Sewer Separation alternatives.

With respect to the IEC Class B-1 criterion of never-less-than 4 mg/L, all three evaluated alternatives provide significant improvements over the Baseline's 30 percent attainment, but none is projected to attain the criterion 100 percent of the time. The 100 Percent CSO Abatement alternative provides a 1 percent margin over the Water Quality Improvement Plan and Complete Sewer Separation alternatives.

Table 7-8. Projected Attainment(1) of Water Quality Standards and Criteria with Selected Alternatives

Dissolved Oxygen Criterion(2)	Baseline	100% CSO Abatement	Water Quality Improvement Plan	Sewer Separation
NYSDEC Class SD (≥ 3 mg/L)	39	100	100	100
IEC Class B-1 (≥ 4 mg/L)	30	92	91	91

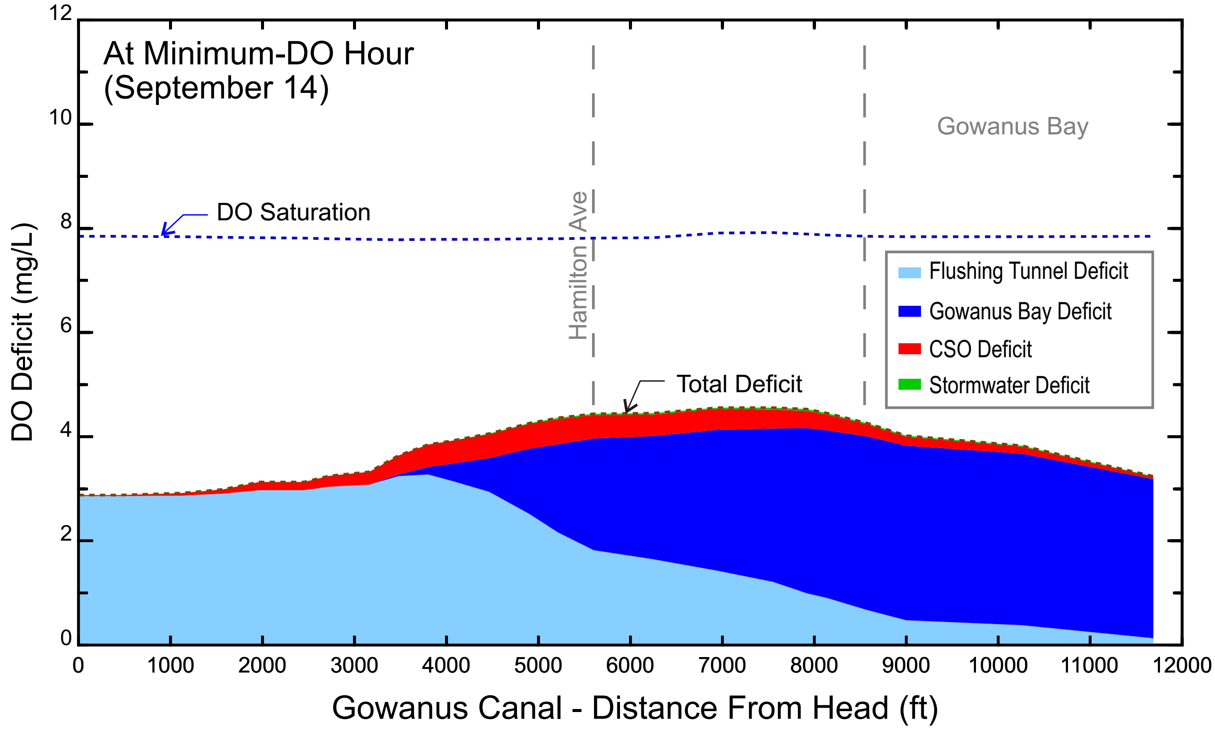
(1) Percent of hours that minimum dissolved oxygen criterion is attained for entire length of Canal.
(2) Annual compliance projected for design (typical precipitation) year

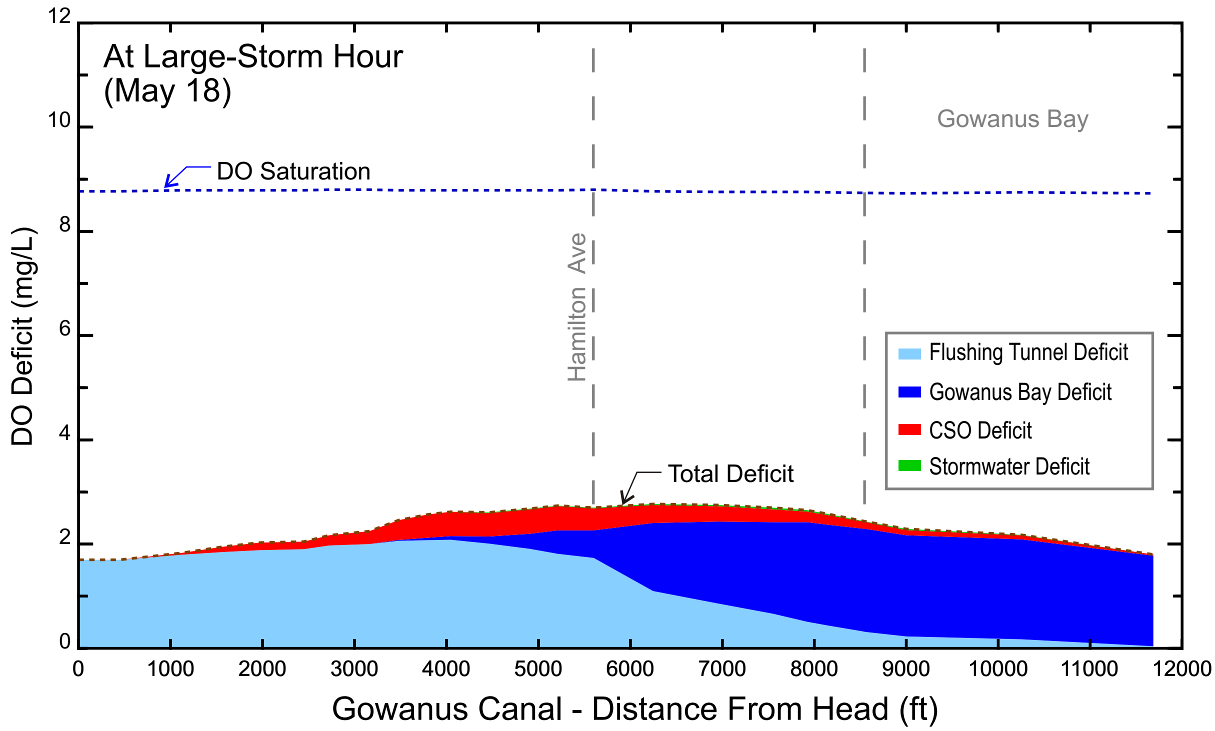
7.8 DISSOLVED OXYGEN COMPONENT ANALYSIS

As noted in the previous subsection, even complete abatement of CSOs is not projected to result in dissolved oxygen levels that are never less than 4.0 mg/L. With 100 percent CSO abatement, dissolved oxygen levels along the length of the Canal are projected to drop below 4.0 mg/L approximately 8 percent of all hours during the year; this figure is about 9 percent with the Gowanus Canal Water Quality Improvement Plan.

Model projections were developed to determine the relative importance of the various pollutant sources impacting Gowanus Canal dissolved oxygen levels under the Water Quality Improvement Plan. These sources are: the remaining CSOs discharging to Gowanus Canal under the Water Quality Improvement Plan, all stormwater sources (including both storm sewers and overland runoff from unsewered areas), Buttermilk Channel (from which 215 MGD will be pumped directly to the head of the Canal, per the improvements to be made under the Gowanus Facilities Upgrade project), and Gowanus Bay (which has significant tidal exchange with the Canal as an adjacent waterbody). The analysis accounted for the influence of dissolved oxygen concentrations and biochemical oxygen demanding material in discharged flow and in adjacent water bodies, and accounted for the impact of solids from these sources on sediment oxygen demand in the Canal. All impacts associated with a particular source are attributed to that source. This analysis determined a "snapshot" of the impact of each of these sources on dissolved oxygen in the Canal at a particular time during the design precipitation year used for the projections.

Figure 7-15 presents the impact of each of these factors on dissolved oxygen concentrations along the length of the Canal. The upper panel presents the impacts at the hour that the lowest dissolved oxygen concentration was projected in the Canal, on September 14. The lower panel presents the impacts at a time during a different period (May 18) associated with a large storm input. As shown, the relative impacts of the various sources are similar in both





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Components of Dissolved Oxygen Deficit Remaining With Water Quality Improvement Plan

FIGURE 7-15

cases; the principle difference is the waterbody temperature and the associated dissolved oxygen deficit.

As shown in the upper panel, the hour of minimum dissolved oxygen (about 3.4 mg/L) corresponds to an oxygen saturation of about 7.8 mg/L and a maximum total oxygen deficit of nearly 4.5 mg/L at a location just downstream of Hamilton Avenue. This maximum deficit is primarily associated with the model boundaries, and to a lesser extent, CSO loads. Stormwater inputs do not significantly impact dissolved oxygen. Together, Buttermilk Channel and Gowanus Bay account for 90 to 100 percent of the deficit in the Canal, with Buttermilk Channel strongly influencing the Canal upstream of Hamilton Avenue, and Gowanus Bay strongly influencing the Canal downstream of Hamilton Avenue. At Hamilton Avenue, the impact from each boundary is roughly equal, totaling about 4.0 mg/L, but peaking at around 4.2 mg/L slightly downstream. Considering the 7.8 mg/L oxygen saturation, these boundary-related deficits would prevent the Canal from achieving never less than 4.0 mg/L dissolved oxygen even with no CSO inputs.

The lower panel presents a similar view of the deficit components for a different period associated with a large storm event. The trends are similar to the critical dissolved oxygen case discussed above, though here the dissolved oxygen saturation is higher (about 8.4 mg/L) and the deficit associated with the boundaries is lower. Though the deficit associated with CSOs is roughly the same, it represents a higher portion of the total deficit than it did under the critical dissolved oxygen case.

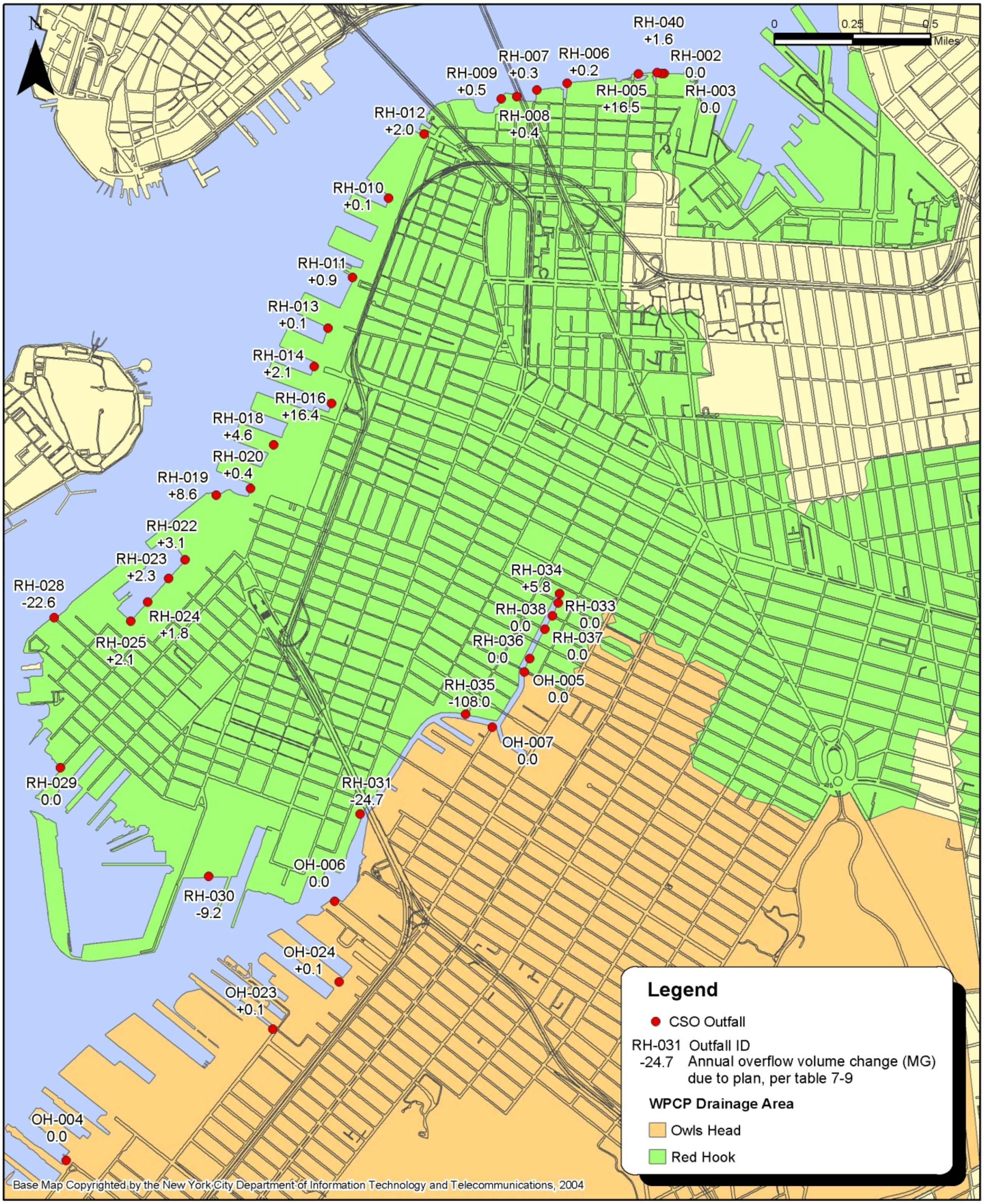
7.9 TRANSFER OF CSO TO OTHER WATERBODIES

Elements of the Gowanus Facilities Upgrade project and, by incorporation, the Water Quality Improvement Plan, act to reduce CSO discharges to and increase flushing of pollutants from Gowanus Canal. However, these actions also tend to transfer CSO and CSO pollutants to other waterbodies. This subsection addresses both the quantity of CSO transferred to other waterbodies, and the projected impacts of these transferred CSOs and other actions of the Water Quality Improvement Plan on those waterbodies.

The Gowanus Water Quality Improvement Plan will not impact discharged volumes or frequencies from outfalls within the Owls Head WPCP service area. Table 7-9 and Figure 7-16 present the projected discharges from all CSO outfalls within the Red Hook WPCP service area. With respect to the Baseline Condition, the Gowanus Water Quality Improvement Plan is projected to decrease annual CSO discharges to Gowanus Canal by 127 MG and to Gowanus Bay/Upper New York Bay by 9 MG, while simultaneously increasing flows treated at the Red Hook WPCP by 93 MG. The Plan is projected to increase discharges to Atlantic Basin by 9 MG, to Buttermilk Channel by 9 MG, and to the East River by 21 MG. Overall, the Plan is projected to decrease the annual CSO volume discharged from the Red Hook WPCP service area by 95 MG, with a shift of CSO from Gowanus Canal to the East River and Buttermilk Channel. As described below, this shift measurably improves Gowanus Canal, but does not significantly impact Gowanus Bay, Upper New York Bay, Buttermilk Channel, or the East River, where natural tidal exchange and circulation provide much higher assimilative capacities than Gowanus Canal.

Table 7-9. Annual CSO Discharge (MG) to Gowanus Canal and Adjacent Waterbodies

CSO Outfall	Baseline	Gowanus Plan	Change From Baseline to Gowanus Plan	Receiving Water
RH-034	121.1	127.0	5.8	Gowanus Canal
RH-033	0.2	0.2	0.0	Gowanus Canal
RH-038	0.9	1.0	0.0	Gowanus Canal
RH-037	0.5	0.5	0.0	Gowanus Canal
RH-036	1.6	1.6	0.0	Gowanus Canal
OH-005	0.7	0.7	0.0	Gowanus Canal
OH-007	69.4	69.4	0.0	Gowanus Canal
RH-035	111.3	3.4	-108.0	Gowanus Canal
RH-031	35.3	10.6	-24.7	Gowanus Canal
OH-006	12.6	12.6	0.0	Gowanus Canal
OH-024	23.4	23.5	0.1	Gowanus Canal
RH-030	18.3	9.1	-9.2	Gowanus Bay
OH-023	0.7	0.8	0.1	Gowanus Bay
OH-004	1.0	1.0	0.0	Gowanus Bay
RH-029	2.1	2.1	0.0	Upper NY Bay
RH-028	96.5	73.9	-22.6	Buttermilk Channel
RH-025	5.4	7.4	2.1	Atlantic Basin
RH-024	1.9	3.8	1.8	Atlantic Basin
RH-023	1.8	4.1	2.3	Atlantic Basin
RH-022	2.4	5.5	3.1	Atlantic Basin
RH-019	13.4	22.0	8.6	Buttermilk Channel
RH-020	0.1	0.6	0.4	Buttermilk Channel
RH-018	4.3	8.8	4.6	Buttermilk Channel
RH-016	17.9	34.2	16.4	Buttermilk Channel
RH-014	19.7	21.9	2.1	Buttermilk Channel
RH-013	0.2	0.3	0.1	Buttermilk Channel
RH-011	2.9	3.8	0.9	East River
RH-010	0.3	0.3	0.1	East River
RH-012	8.3	10.3	2.0	East River
RH-009	1.9	2.5	0.5	East River
RH-008	2.4	2.8	0.4	East River
RH-007	1.4	1.7	0.3	East River
RH-006	7.8	7.9	0.2	East River
RH-005	153.0	169.4	16.5	East River
RH-003	0.2	0.2	0.0	East River
RH-002	0.0	0.0	0.0	East River
RH-040	37.2	38.8	1.6	East River
Summary by Waterbody				
Subtotal	377	250	-127	Gowanus Canal
Subtotal	22	13	-9	Gowanus Bay/Upper NY Bay
Subtotal	152	162	10	Buttermilk Channel
Subtotal	11	21	9	Atlantic Basin
Subtotal	215	238	22	East River
Total	**778**	**683**	**-95**	**Overall**



Locations and Changes in Annual Discharge Volumes of CSO Outfalls Impacted by the Gowanus Canal Water Quality Improvement Plan

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As presented in the East River and Open Waters Waterbody/Watershed Facility Plan Report (June 2007), the maximum impact of all CSOs citywide on dissolved oxygen is less than 0.20 mg/L in Upper New York Bay/Buttermilk Channel, and less than 0.25 mg/L in the lower East River. The increases in CSO discharges to Buttermilk Channel and the lower East River represent 10 to 11 percent of the total CSO discharge to these waterbodies from just the Red Hook service area, and an even smaller percentage of the total volume if the additional CSO from lower Manhattan is considered. Therefore, the impact on dissolved oxygen would be less than 0.025 mg/L. Similarly, the impact on pathogens is also small and does not affect the attainment of pathogen standards in Gowanus Bay, the East River, or Buttermilk Channel.

7.10 PROTECTION OF SENSITIVE AREAS

As discussed in Section 4.7, NYSDEC included Gowanus Canal on a list of sensitive areas because it is a waterbody targeted for a regional watershed management plan. Per federal CSO policy, EPA expects a permittee's CSO LTCP to give the highest priority to controlling overflows to sensitive areas. For such areas, the CSO LTCP should consider control alternatives that (a) eliminate the CSO; (b) relocate the outfall away from the sensitive area; or (c) provide a level of treatment necessary to meet water-quality standards for full protection of existing and designated uses. As presented earlier in this section, this waterbody/watershed planning effort evaluated complete elimination of CSO discharges through both CSO retention for treatment and through complete sewer separation. Reduction of CSO discharges through redirection of CSO flow and other means were also evaluated as part of the Water Quality Improvement Plan and other alternative scenarios. Attainment of applicable water-quality standards and designated uses is projected to be attained with the Water Quality Improvement Plan. As such, no further evaluation of controls is necessary in this waterbody/watershed planning effort.

7.11 ESTABLISHMENT OF WATERBODY/WATERSHED FACILITY PLAN

In summary, the Water Quality Improvement Plan alternative is projected to achieve water quality that is significantly improved versus the Baseline condition and that meets or exceeds the applicable NYS water quality standards and use criteria. No alternative was projected to achieve the IEC criterion for Class B-1 waters for dissolved oxygen of greater than 4.0 mg/L 100 percent of the time, although the Water Quality Improvement Plan is projected to achieve this level 93 percent of the time. This level of improvement is virtually the same that projected for the much more costly 100 Percent CSO Abatement alternative (94 percent). The Sewer Separation alternative, which was the most costly alternative evaluated, is projected to achieve dissolved oxygen results that are similar to the 100 Percent CSO Abatement and Water Quality Improvement Plan alternatives. However, Sewer Separation is not projected to achieve similar water quality improvement for indicator bacteria, particularly enterococci, for which projections with Sewer Separation showed degradation below the Baseline condition.

Because the Water Quality Improvement Plan alternative is projected to cost-effectively comply with the applicable NYS water quality standards and use criteria, it is herein selected as the "Waterbody/Watershed Facility Plan."

8.0 Waterbody/Watershed Facility Plan

Gowanus Canal received remedial action as early as 1911, when the Flushing Tunnel was originally activated in an attempt to reduce noxious odors emanating from the Canal. Since then, actions to further remediate water quality in the Canal have met with varying levels of success. The efforts of the NYCDEP to develop an approach to achieve the goals of the CWA have culminated herein with the development of a Waterbody/Watershed Facility Plan that recognizes achieving water quality objectives will require not only a reduction in CSO discharges, but also in-stream mitigation measures. The multi-faceted approach incorporates several cost-effective engineering solutions with demonstrable positive impacts on water quality, including increased dissolved oxygen concentrations, decreased coliform concentrations, and reductions in the deleterious aesthetic consequences of CSO discharges such sediment mounds, nuisance odors and floatables. The recommended approach also maximizes utilization of the existing collection system infrastructure and treatment of combined sewage at the Red Hook and Owls Head WPCPs.

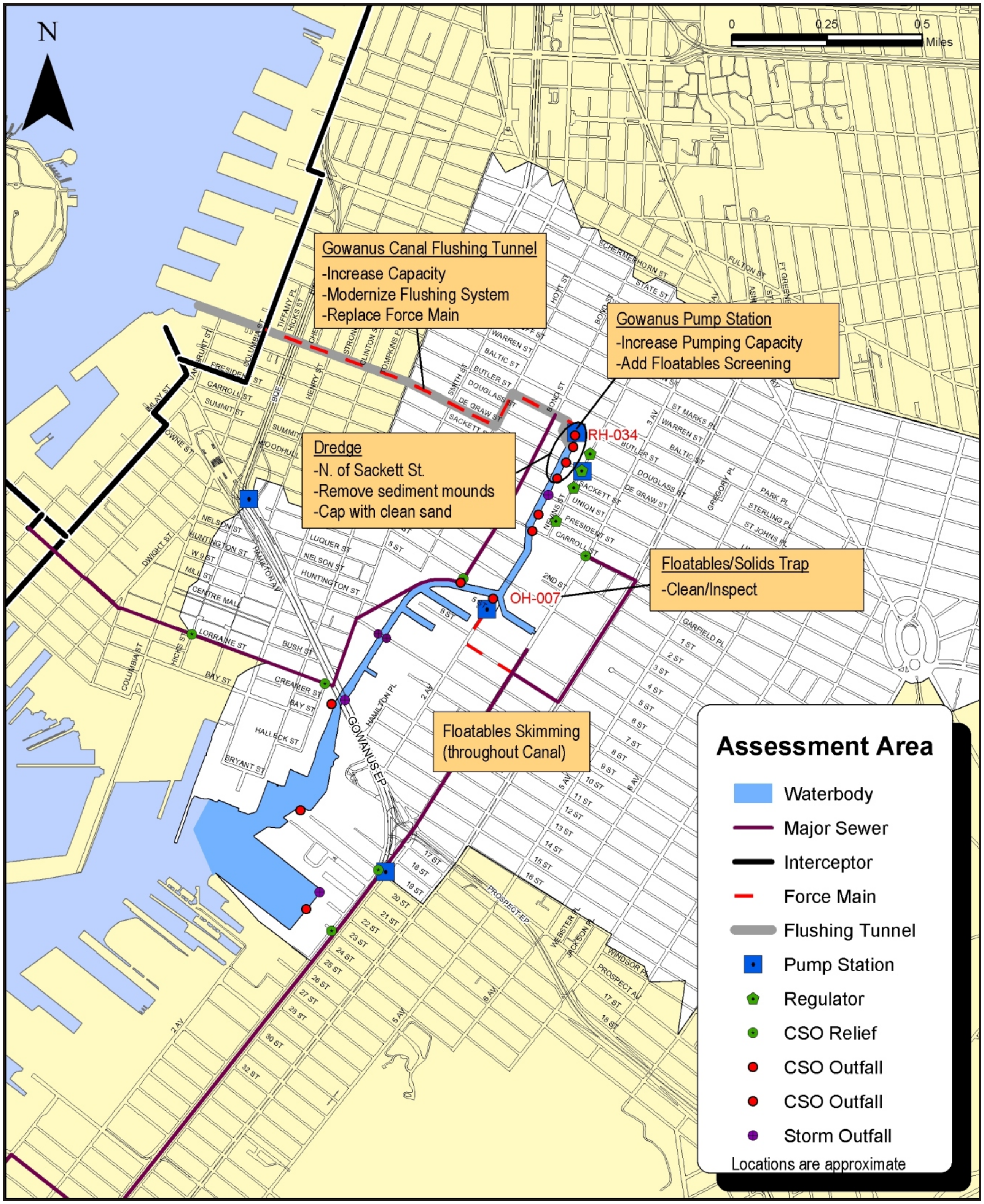
The subsections that follow present the CSO controls recommended to attain water-quality criteria and achieve the use goals for Gowanus Canal. Some additional assessments, required prior to implementation of some CSO controls, are also presented. Results of these assessments, which potentially include post-construction monitoring, sewer and/or water-quality monitoring, pilot testing, detailed facility planning, preliminary design, etc., could require that the proposed controls be refined and adapted so that the fully implemented program achieves the goals of the Waterbody/Watershed Facility Plan. Post-construction monitoring, discussed in detail in Section 8.5, is an integral part of the Plan and is the basis of the adaptive-management approach planned for Gowanus Canal.

8.1 PLAN COMPONENTS

The components of the Waterbody/Watershed Facility Plan for Gowanus Canal are listed as follows:

- Continued implementation of programmatic controls;
- Modernization of the Gowanus Canal Flushing Tunnel;
- Reconstruction of the Gowanus Wastewater Pump Station;
- Cleaning/inspection of the OH-007 floatables/solids trap;
- Periodic waterbody floatables skimming; and,
- Dredging.

Locations of the selected alternatives for the Waterbody/Watershed Facility Plan are shown on Figure 8-1. Costs of the selected alternatives were summarized in Table 7-7. The total estimated cost of the selected alternatives is from $251.4 million to $257.1 million, depending on the need for bulkhead replacement, and not including the O&M costs associated with periodic skimming and inspection/cleaning of the OH-007 floatables/solids chamber. These planning-level cost estimates are in addition to the NYCDEP's previously incurred cost of $11.1 million to implement the Gowanus Canal elements of the Inner Harbor CSO Facility Plan.



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Gowanus Canal Waterbody/Watershed Facility Plan

Locations of Waterbody/Watershed Facility Plan Components

FIGURE 8-1

8.1.1 Continued Implementation of Programmatic Controls

As discussed in detail in Section 5.0, NYCDEP currently operates several programs designed to reduce CSO to a minimum and provide treatment levels appropriate to protect waterbody uses. As the effects of the LTCP become understood through long-term monitoring, ongoing programs will be routinely evaluated based on receiving water quality considerations. Floatables reduction plans, targeted sewer cleaning, real-time level monitoring, and other operations and maintenance controls and evaluations will continue, in addition to the following:

- The 14 BMPs for CSO control required under the City's 14 SPDES permits. In general, the BMPs address operation and maintenance procedures, maximum use of existing systems and facilities, and related planning efforts to maximize capture of CSO and reduce contaminants in the combined sewer system, thereby reducing water quality impacts.

- Sustainable Stormwater Management – The NYCDEP will continue to develop green solutions for stormwater management and the programmatic implementation of sustainable stormwater practices in cooperation with other City agencies and the Mayor's Office of Long-Term Planning and Sustainability. Once New York City has developed a City-Wide program that includes sustainable practices, then the NYCDEP will incorporate those practices in a future modification to the current Waterbody/Watershed Facility Plan, either when the Plan is converted to a drainage-basin specific LTCP, or when the subsequent City-Wide LTCP is developed.

- The City-Wide Comprehensive CSO Floatable Plan (HydroQual, 2005b and 2005c) provides substantial control of floatables discharges from CSOs throughout the City and provides for compliance with appropriate NYSDEC and IEC requirements. Like the Waterbody/Watershed Facility Plan, the Floatables Plan is a living program that is expected to change over time based on continual assessment and changes in related programs.

8.1.2 Modernization of the Gowanus Canal Flushing Tunnel

The main elements of the Gowanus Canal Flushing Tunnel modernization are replacing the Flushing Tunnel pumping system and improving conveyance in the Flushing Tunnel. Replacement of the original pumping system—a single propeller within the tunnel itself—with a new system of multiple, redundant axial-flow pumps that can be changed out individually without interrupting pumping operations, will eliminate shutdowns at low tide and will substantially reduce shutdowns for maintenance and repairs. Furthermore, the conveyance capacity of the Flushing Tunnel itself will be expanded by increasing the cross-sectional area available for flow at an existing constriction in the tunnel.

The Gowanus Canal Flushing Tunnel modernization will increase the amount of water being conveyed from Buttermilk Channel to the head of Gowanus Canal. Overall, the modernization will increase the average daily pumping rate by 40 percent, to 215 MGD from 154 MGD. During high tide, the pumping rate will increase to 252 MGD from 195 MGD, and during low tide the pumping rate will increase to 175 MGD from as low as 0 MGD. This will improve circulation throughout the Canal and will substantially improve water quality and aesthetic conditions. The modernization of the flushing system will also provide equipment redundancy and improve reliability, thereby minimizing shut downs.

The Gowanus Canal Flushing Tunnel modernization is being implemented as part of the Gowanus Facilities Upgrade Project (Sections 5.9 and 7.3.4) at a PTPC of $83.2 million.

8.1.3 Reconstruction of the Gowanus Wastewater Pump Station

The Gowanus Pump Station reconstruction will increase pump station capacity, restore force main flow, and add floatables screening at RH-034, which will represent over half the CSO flow to Gowanus Canal upon implementation of the Waterbody/Watershed Facility Plan. The increase in pump station capacity to 30 MGD represents a nearly 50 percent increase in design flow to the force main, though only a slight increase beyond its current 28.5 MGD capacity pumping to the overburdened Bond Lorraine Sewer. Replacing the currently inoperable force main with a new, more reliable and higher-capacity conduit will restore force main flow to the Columbia Street Interceptor and will reduce overflows from the Bond Lorraine Sewer to the Canal from RH-035 and RH-031 by 132 MG annually—a reduction of over 90 percent from these locations. In addition, this work will also reduce a constriction in the Flushing Tunnel by removing the wastewater force main from the portion of the Flushing Tunnel where the Columbia Street Interceptor already limits the flow area, as mentioned in Section 8.1.2 above. Last, a CSO-floatables screening system will be installed to provide treatment of all CSO discharges to the Canal from RH-034 for the design (typical) precipitation year.

Overall, this element of the Waterbody/Watershed Facility Plan will decrease CSOs to Gowanus Canal by 127 MG (34 percent) annually from the Baseline condition, and will provide screening for 32 percent of the annual CSO discharge. This will improve water quality and aesthetic conditions in the Canal. These reconstruction activities, which are being implemented as part of the Gowanus Facilities Upgrade described in Section 5.9, are estimated to have a PTPC of $151.7 million.

8.1.4 Inspection/Cleaning of the OH-007 Floatables/Solids Trap

Under the Waterbody/Watershed Facility Plan, CSO discharges from OH-007 represent about 28 percent of the total to Gowanus Canal in a typical year. A chamber measuring 35 ft wide by 70 ft long and featuring a baffle/weir combination intended to prevent the discharge of floatables and settleable solids is installed in the sewer line just upstream of the outfall. Over time, floatables and settleable solids can build up in the chamber and can reduce the effectiveness of the trap device. Periodic inspections of material buildup within the trap, particularly in the area of the weir/baffle combination, as well as post construction monitoring of floatables in the Canal will help to ensure that the trap remains functional.

The NYCDEP will initiate programmatic inspection/cleaning of the trap chamber. A program of frequent inspection will be performed initially to develop an understanding of how quickly the trap accumulates materials. Monthly inspections made from the surface and involving probing to determine the depth of accumulated materials would be performed to establish accumulation rates within the trap. Additional inspections following severe wet-weather events, such as a once-in-ten-year storm, may also be made to establish the impact of such events on the accumulated materials. Cleaning to remove accumulated materials from the chamber would be scheduled based on the results of the inspections. For example, if the inspections show that material accumulation rates begin to decrease, this could indicate that the optimum retention has been reached and materials are beginning to wash through the chamber, and hence cleaning should be performed to maintain optimal removal performance. Once the accumulation rates have been sufficiently characterized, and again in the future as deemed necessary to respond to seasonal or other long-term changes, the inspection and/or cleaning frequency can be modified as appropriate.

This plan element does not involve a significant capital expenditure. The NYCDEP performed an initial cleaning of the trap in April 2006 and an initial inspection in June 2006.

8.1.5 Periodic Waterbody Floatables Skimming

As discussed above, floatables discharges to Gowanus Canal will be substantially reduced with the continued implementation of city-wide programmatic controls, the reduction in CSO discharges to the Canal from the Bond-Lorraine Sewer, and the floatables controls being implemented at the major CSO outfalls (RH-034 and OH-007). Once the reconstruction of the Gowanus Pump Station is completed and the CSO floatables screening system is on-line, the interim floatables containment boom located at Sackett Street in Gowanus Canal will be removed, and the NYCDEP will then periodically dispatch a skimmer vessel to conduct waterbody floatables removal on an as-needed basis, such as following large storm events that overwhelm the capacity of the CSO screening system that will be installed at RH-034. The skimmer vessel will conduct waterbody skimming to collect floatables discharged to the Canal from CSOs and/or stormwater outfalls. The capital cost of such a skimmer vessel is estimated to be approximately $0.9 million.

8.1.6 Dredging

The NYCDEP will dredge the upper 750 ft of Gowanus Canal (north of Sackett Street, see Figure 7-10) and will apply a 2-ft-deep sand cap to provide a final water depth of 3 ft below mean lower low water. Overall, this will eliminate exposed sediments and the associated odors, improve the visual aesthetics of the waterbody, and improve substrate for benthos habitat.

As discussed in Section 7.3.6, removing approximately 9,700 cubic yards of sediment at $590 per cubic yard, and applying 5,600 cubic yards of sand at a cost of $1.1 million would total approximately $7.2 million. Furthermore, it is possible that dredging in Gowanus Canal could undermine failing bulkheads, which could lead to bulkhead collapse unless the bulkheads were first replaced. There is approximately 1,500 linear feet of bulkhead north of Sackett Street, though at least about 600 feet of this appears to be in good condition at the surface. Heights from the top of the existing natural sand layer on the Canal bottom to the top of the existing bulkheads range up to 21 feet. According to the latest available costing information (O'Brien & Gere, 2006), replacing the existing bulkheads would require the "tied-back" type at a cost of about $9,425 per linear foot, or up to about $14.2 million to replace all bulkheads north of Sackett Street. Therefore, it is recommended that the existing bulkheads be characterized to determine whether the proposed dredging would necessitate bulkhead replacement. If the 600 linear feet of bulkhead that appears to be in good condition did not have to be replaced, the cost would be closer to $8.5 million. Therefore, the total estimated cost associated with dredging and bulkhead replacement could be $15.7 million to $21.4 million.

It should also be noted that the USACE is currently conducting its Gowanus Bay and Canal Ecosystem Restoration Project, for which the NYCDEP is a local, non-federal sponsor providing half of the project cost in funding and in-kind services. Although the urbanization of Gowanus Canal has irreversibly altered the waterbody and degraded the original natural habitat and ecology, even limited restoration efforts would likely include as a first step the removal of CSO solids to the extent necessary to create an environment favorable to the reintroduction of formerly indigenous ecological communities. Beyond the dredging and benthic improvement discussed above, the NYCDEP will continue to work with the USACE to investigate the potential to combine USACE ecological restoration efforts with the City's various water quality initiatives and to continue providing funding support for the additional actions that the USACE may identify through the Ecosystem Restoration Project.

8.2 ANTICIPATED WATER QUALITY IMPROVEMENTS

Implementation of the Waterbody/Watershed Facility Plan will provide both sewer-system performance benefits and water-quality benefits. The various components of the Plan will reduce CSO discharges, improve aesthetic conditions, and enhance habitat to levels consistent with regulatory and stakeholder use goals.

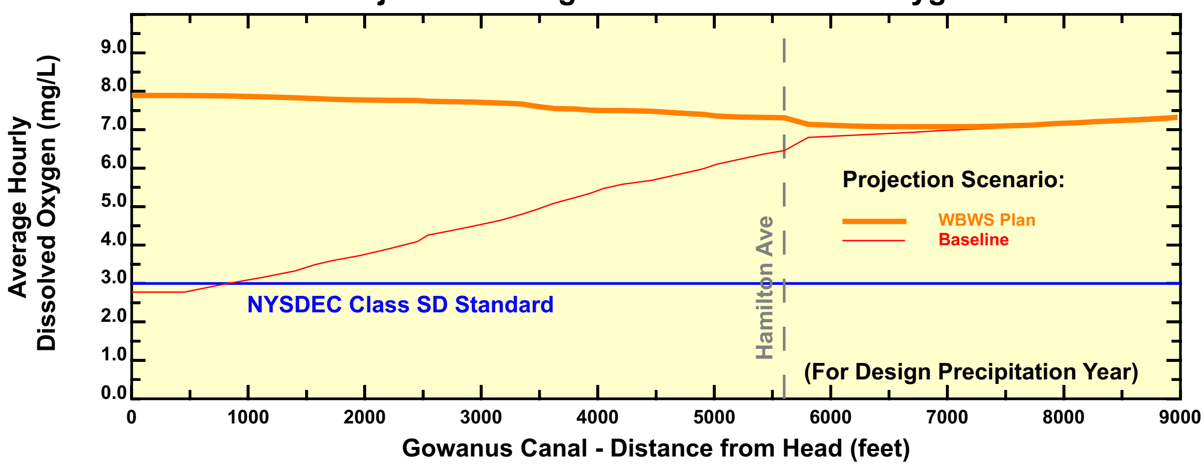
Sewer-system performance benefits of the Waterbody/Watershed Facility Plan can be described using the results of the landside modeling projections for the design (typical) precipitation year. As summarized in Table 7-5, the CSO discharge volume to the Canal will be reduced by 34 percent (to 250 million gallons from 377 million gallons).

Although the Waterbody/Watershed Facility Plan will provide significant benefits with respect to sewer-system performance and reduction of CSO discharges, the projected improvement to water quality affords a more meaningful measure of the impact of the Plan. Water quality conditions projected with implementation of the Waterbody/Watershed Facility Plan are presented in Figures 8-2 through 8-4, and in Appendices D and E. Anticipated water quality improvements to dissolved oxygen, aesthetics, and bacteria are discussed below.

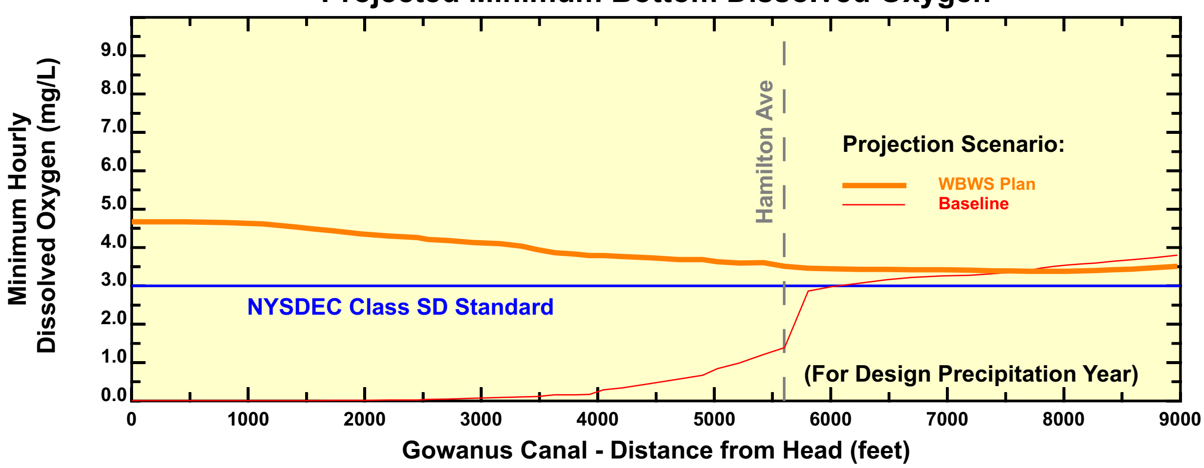
8.2.1 Dissolved Oxygen

Dissolved oxygen is perhaps the most meaningful measure of the impact of the Gowanus Canal Waterbody/Watershed Facility Plan because it is due to low levels of dissolved oxygen that Gowanus Canal is currently on NYSDEC's 303(d) list of impaired waterbodies. As shown on Figure 8-2, implementation of the Waterbody/Watershed Facility Plan is projected to substantially increase dissolved oxygen levels throughout the Canal. As shown on Figure 8-3, implementation of the Plan is projected to result in dissolved oxygen levels that attain the NYS Class SD criterion ($\geq$ 3.0 mg/L) at all times for the entire length of the Canal, and to meet higher aquatic-life uses most of the time.

Projected Average Bottom Dissolved Oxygen



Projected Minimum Bottom Dissolved Oxygen



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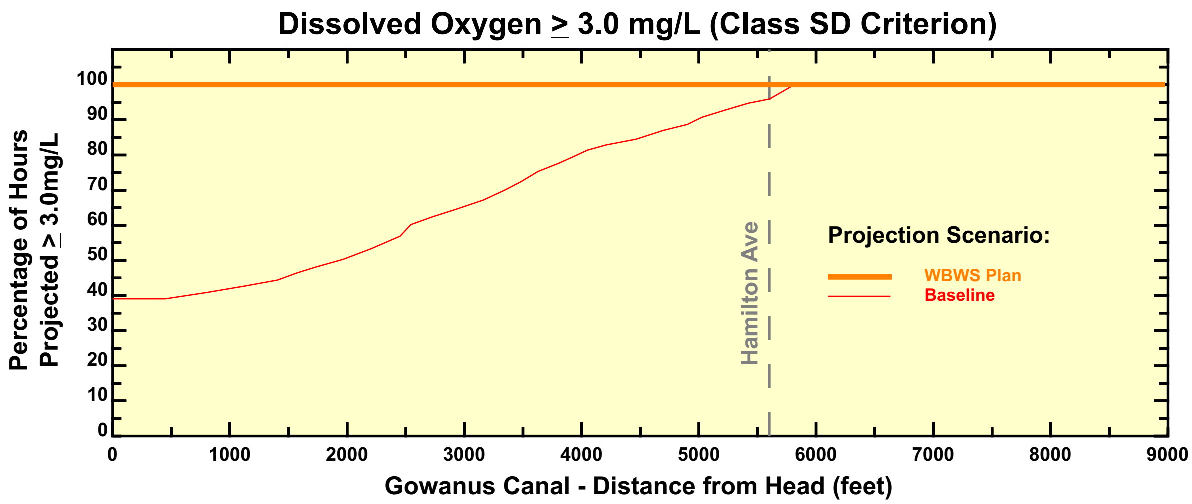
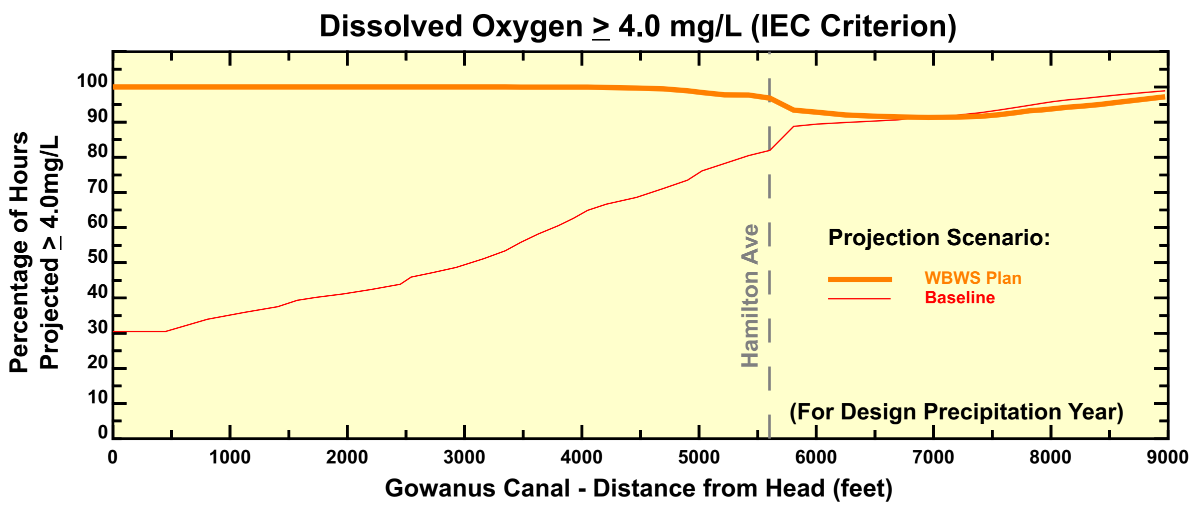
Projected Dissolved Oxygen Concentrations Waterbody/Watershed Facility Plan





Projected Attainment of Dissolved Oxygen Standards Waterbody/Watershed Facility Plan

As discussed in Section 7.7 and summarized in Table 7-8, implementation of the Gowanus Canal Waterbody/Watershed Facility Plan is expected to provide the highest dissolved-oxygen levels—and corresponding aquatic-life uses—that can be reasonably attained in the waterbody through CSO control. Higher levels of control, including complete elimination of all CSO discharges, do not significantly improve the attainment of higher use levels in the Canal beyond what is achieved with the Waterbody/Watershed Facility Plan. For example, attainment of the IEC Class B-1 ($\geq$ 4.0 mg/L) is projected to be 91 percent under the Waterbody/Watershed Facility Plan and 92 percent under 100 Percent CSO Abatement.

8.2.2 Aesthetics

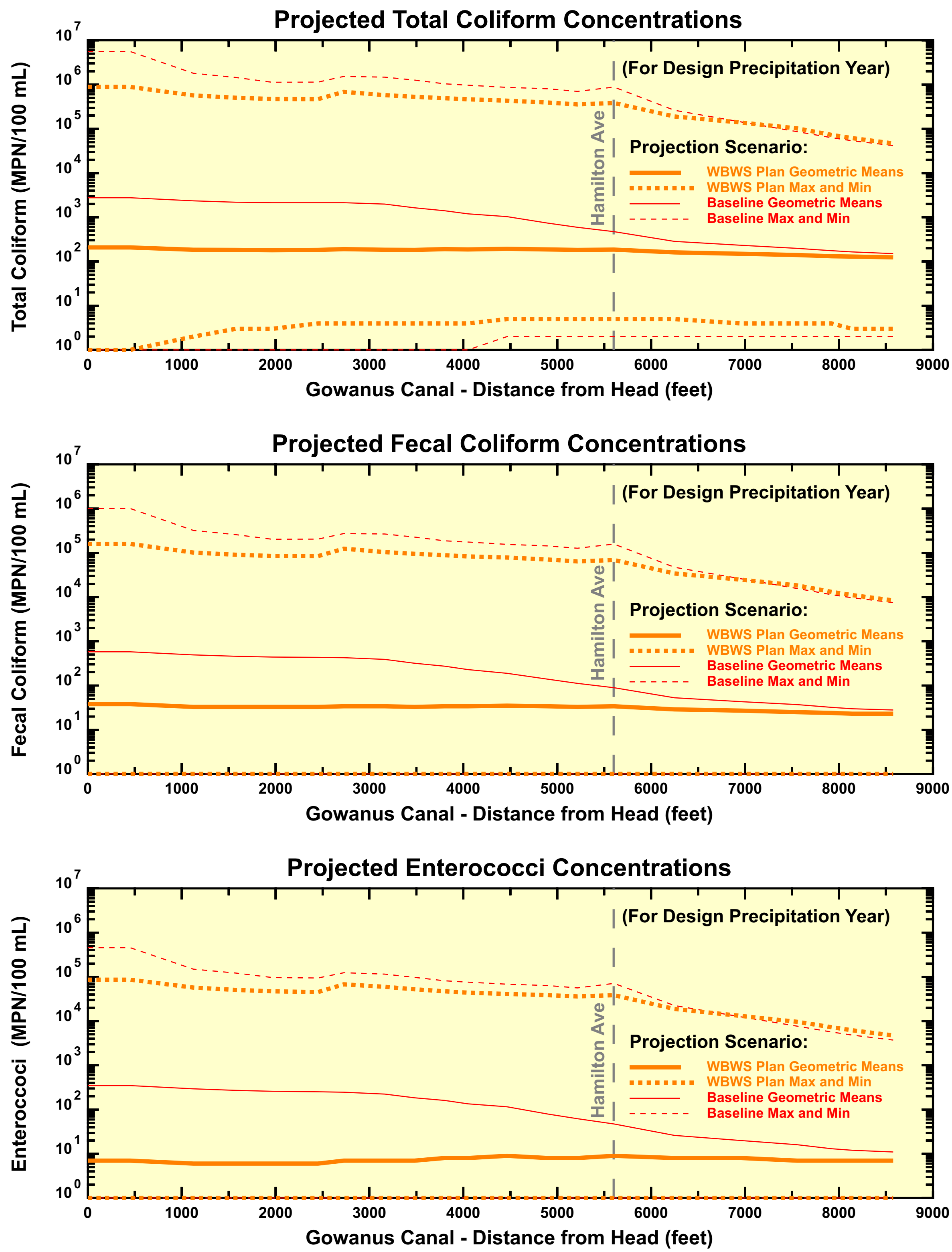
The Waterbody/Watershed Facility Plan is expected to substantially reduce floatables as well as odors associated with exposed CSO sediment mounds. In addition to the reductions of floatables and solids that will result from the city-wide implementation of the Floatables Plan and the 14 BMPs for CSO control, the Waterbody/Watershed Facility Plan is projected to reduce CSO discharges containing these materials by about 34 percent while simultaneously increasing the flushing of Canal waters by 40 percent (with improvements to the Flushing Tunnel). Floatables and solids control will also be implemented at OH-007, which will represent about 28 percent of the total CSO discharge to the Canal once the Waterbody/Watershed Plan is implemented. Additional floatables control will be implemented at the Gowanus Pump Station (RH-034, which represents over 50 percent of the total CSO discharge to the Canal under the Plan). Remaining floatables issues will be addressed with periodic deployment of a skimmer vessel to conduct waterbody floatables removal. Dredging will eliminate exposed sediments and the associated odors at the head of the Canal, and the placement of a sand cap will provide a clean substrate.

8.2.3 Bacteria

The NYSDEC designates Gowanus Canal as a Class SD waterbody. This classification is not suitable for contact recreation and hence is not subject to associated indicator bacteria standards. However, levels of indicator bacteria were projected for purposes of comparison between the Baseline and Waterbody/Watershed Facility Plan. Figure 8-4 presents spatial profiles of the median, maximum, and minimum concentrations of total coliform, fecal coliform, and Enterococci bacteria in Gowanus Canal projected for the design (typical) precipitation year for the Baseline and Waterbody/Watershed Facility Plan conditions. As shown, the Waterbody/Watershed Facility Plan is projected to reduce median and maximum concentrations overall, particularly near the head of the Canal.

8.3 OPERATIONAL PLAN

USEPA guidance specifies that municipalities should be required to develop and document programs for operating and maintaining the components of their combined sewer systems (USEPA, 1995a). Once a long-term control plan has been approved, the municipality's operation and maintenance program should be modified to incorporate the facilities and operating strategies associated with selected controls.



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Projected Pathogen Concentrations Waterbody/Watershed Facility Plan

Components of the Waterbody/Watershed Facility Plan such as the modernization of the Gowanus Canal Flushing Tunnel and the reconstruction of the Gowanus Pump Station are currently in the planning and preliminary design stages of NYCDEP's Gowanus Facilities Upgrade. Preliminary operational plans for the facilities have been developed and are presented in Appendix F. Other components of the Waterbody/Watershed Facility Plan are in similar stages of planning and implementation. The Waterbody/Watershed Facility Plan requires review by the NYSDEC for acceptance prior to implementing the plan as a long-term CSO control plan. As such, the operational plan will be finalized following NYSDEC review of the Waterbody/Watershed Facility Plan and after all components are designed.

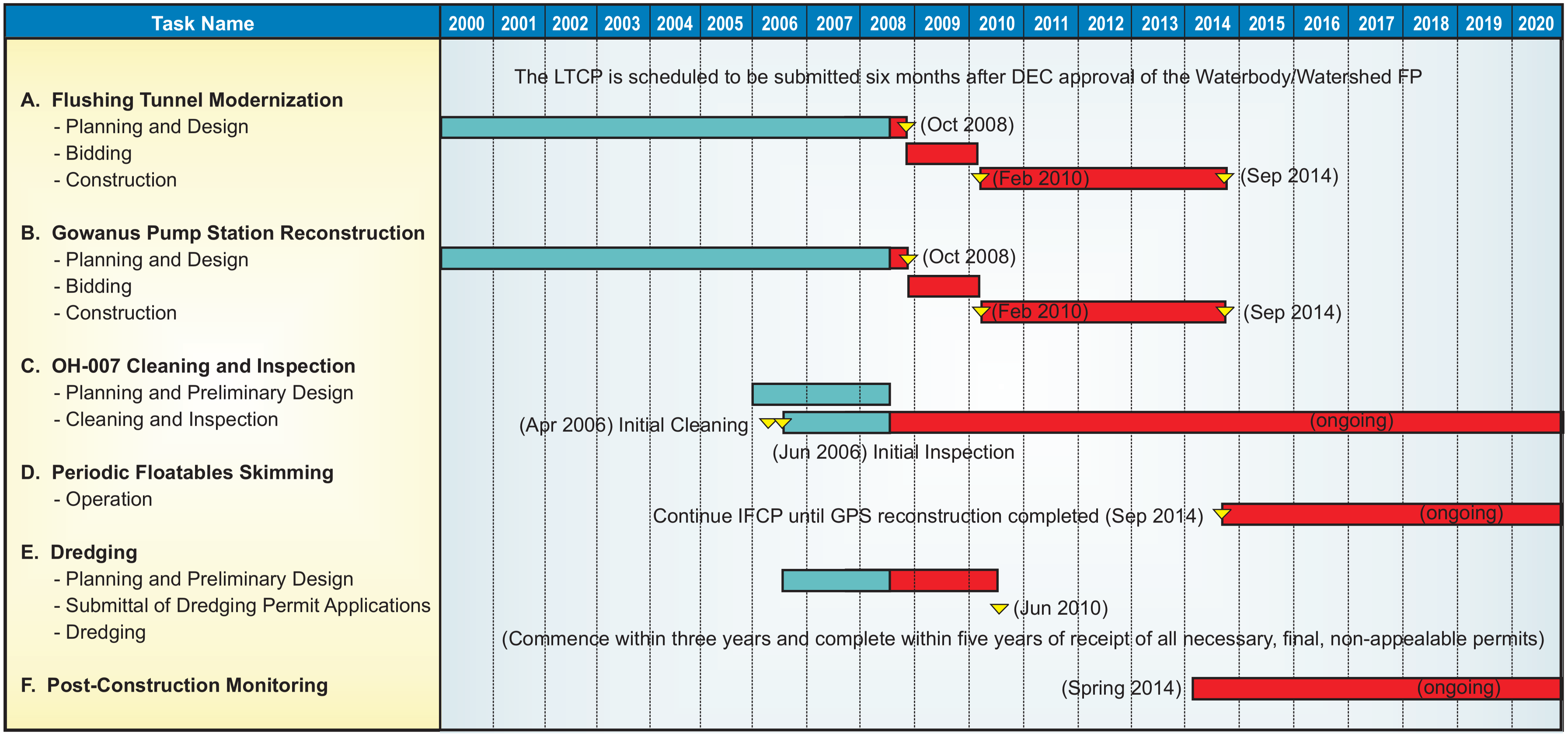
Upon implementation of the Waterbody/Watershed Facility Plan elements, NYCDEP intends to operate the facilities as designed. However, it is both environmentally responsible and fiscally prudent to be responsive to changing and unforeseen limitations and conditions. An adaptive management approach will be employed to accomplish this flexibility. Post-construction compliance monitoring (described in Section 8.5) may trigger a sequence of more detailed investigations that, depending on the findings, could culminate in corrective actions. During the first ten post-construction years, the analysis will ultimately determine whether the performance of the CSO controls was adequate. If the performance is unacceptable, the finding will be verified, the causes will be identified, and reasonable corrective actions will be taken. Modifications and retrofits that are implemented and demonstrate improvement will be documented through the issuance of an LTCP update, subject to NYSDEC approval.

8.4 IMPLEMENTATION SCHEDULE

The time frames anticipated to develop and implement the elements of the Waterbody/Watershed Facility Plan are presented in Figure 8-5. As shown, all elements of the Plan will be implemented by December 2013, with the exception of dredging, as discussed below. It should be noted that elements shown in this schedule address the implementation of the recommended Waterbody/Watershed Facility Plan elements only. As noted in the Order on Consent (Section III.C.2), "once the Department approves a Drainage Specific LTCP, the approved Drainage Specific LTCP is hereby incorporated by reference, and made an enforceable part of this Order." As such, a schedule will be incorporated by reference only when this Waterbody/Watershed Facility Plan is further developed and submitted as an LTCP in accordance with dates presented in Appendix A of the Order on Consent. Implementation of Plan elements is contingent upon NYSDEC approval of the Plan.

The design phase of the Gowanus Facilities Upgrade project was underway at the time of the writing of this report. Preliminary design commenced in 2004. Final design is scheduled to be completed in October 2008. Bidding and contract awards are scheduled to follow, and contractor mobilization to begin construction is anticipated by February 2010. The project is expected to be completed and fully operational by September 2014.

NYCDEP performed an initial cleaning of the OH-007 floatables/solids trap in April 2006. Inspections and periodic cleanings as necessary to maintain the functionality of the weir/baffle device will continue, as will post-construction monitoring of floatables in the Canal. The floatables containment boom in Gowanus Canal will remain in place until the Gowanus Facilities Upgrade is completed. Following that, periodic waterbody floatables skimming will be conducted by the NYCDEP using a skimmer vessel.



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Gowanus Canal Waterbody/Watershed Facility Plan

Gowanus Waterbody/Watershed Facility Plan Implementation Schedule

FIGURE 8-5

The NYCDEP is committed to removing the CSO sediment mound to eliminate the exposure of CSO sediments during low tides. This dredging activity will involve the preparation of dredging permits requiring bathymetry, sediment characterization, bulkhead characterization, and other studies. The NYCDEP will prepare and submit the applicable dredging permits by June 2010 Dredging will commence within three years and will be completed within five years of receipt of all necessary, final, non-appealable permits. In addition, the NYCDEP will also continue to support and sponsor the USACE in its Gowanus Bay and Canal Ecosystem Restoration Project, and to support the recommend actions when that study is finalized.

Figure 8-5 also shows the schedule for post-construction compliance monitoring. Post-construction compliance monitoring activities are summarized below.

8.5 POST-CONSTRUCTION COMPLIANCE MONITORING

The Post-Construction Compliance Monitoring Program (PCM) will be integral to the optimization of the Gowanus Canal Waterbody/Watershed Facility Plan because it will provide data for model validation and an assessment metric for the effectiveness of these facilities. Each year's data set will be compiled and evaluated to refine the understanding of the interaction between the New York City collection system and Gowanus Canal, with the ultimate goal of fully attaining applicable, existing water-quality standards or for supporting a Use-Attainability Analysis to revise such standards. The monitoring will contain three basic components:

1. Monitoring and reporting requirements contained in the Red Hook WPCP and Owls Head WPCP SPDES permits;;

2. Collection of receiving-water data in Gowanus Canal and nearby open-water areas at existing NYCDEP Harbor Survey locations and adding stations as necessary; and

3. Modeling of Gowanus Canal to characterize water-quality.

In 2008, interim PCM Programs were submitted for the Flushing Bay & Creek, and Spring Creek waterbodies. The PCM described herein for Gowanus Canal conforms with the interim PCM programs, which were approved by the NYSDEC. As part of the development of these interim programs, monitoring began prior to Summer 2007, when facilities associated with those waterbodies were placed into service. The specifics of the program are being developed under the City-Wide LTCP project and include monitoring and laboratory protocols, quality assurance/quality control (QA/QC), and other aspects to ensure adequate spatial coverage, consistency, and a technically sound sampling program for the entire New York Harbor. The specifics provided herein are limited to the Gowanus Canal PCM and may be modified as the City-Wide program becomes further developed. Any further modifications to the PCM will be submitted to the NYSDEC for review and approval as part of the drainage-basin-specific LTCPs.

8.5.1 Receiving-Water Monitoring

Initially, the PCM program will continue along the existing New York City Harbor Survey protocols, including measurement of the parameters and methods listed in Table 8-1. Historically, the Harbor Survey has measured dissolved oxygen (DO), fecal coliform, chlorophyll a, and secchi depth to identify water-quality trends throughout New York Harbor. Secchi depth and chlorophyll a have been monitored since 1986; DO and fecal coliform have been monitored since before 1972. Recently, enterococci analysis has been added to the program. Except for secchi depth and pathogens, each parameter is collected and analyzed at surface and bottom locations, which are three feet from the surface and bottom, respectively, to eliminate influences external to the water-column chemistry itself, such as wind and precipitation influences near the surface, and suspended sediments and aquatic vegetation near the bottom. Pathogens are analyzed in surface samples only. NYCDEP regularly samples 33 open-water stations annually, which are supplemented each year with approximately 20 rotating tributary stations or periodic special stations that are sampled in coordination with capital projects, planning, changes in facility operation, or in response to regulatory changes.

Table 8-1. Current Harbor Survey Laboratory Protocols

Parameter	Method
Ammonia (as N)	EPA 350.1
Chlorophyll ‘a’	EPA 445.0, modified for the Welschmeyer Method
Dissolved Oxygen	SM 4500-O C, Azide Modification (Winkler Method)
Dissolved Silica	SM 18-19 4500-Si D or USGS I-2700-85
Enterococcus	EPA Method 1600, Membrane Filter
Fecal Coliform	SM 18-20 9222D, Membrane Filter
Nitrate (as N)	EPA 353.2 or SM 18-20 4500-NO3 F
Orthophosphate (as P)	EPA 365.1
pH	SM 4500-H B, Electrometric Method
Total Kjeldahl Nitrogen	EPA 351.2
Total Phosphorus	EPA 365.4
Total Suspended Solids	SM 18-20 2540D
Notes: SM – Standard Methods for the Examination of Water and Wastewater; EPA – EPA’s Sampling and Analysis Methods. Field instrumentation includes an SBE 911 Sealogger CTD to collect salinity, temperature, conductivity, and other parameters.	

For the purposes of the post-construction monitoring of Gowanus Canal, sampling will be conducted at three locations: near the mouth, mid-length, and near the head. As shown on Figure 8-6, these locations would be at Harbor Survey stations G2 (mouth), GC5 (mid-length, at the 3rd Street bridge), and GC2 (head). All stations related to the PCM will be sampled at least twice per month from May through September and at least once per month during the remainder of the year. If sampling stations are covered with ice during cold weather, NYCDEP personnel will not engage in sampling activities.

Data collected during this program will primarily serve to verify the receiving-water model that will be used to demonstrate projected attainment of water-quality criteria in Gowanus Canal. Therefore, during each annual cycle of compliance monitoring, the model will be verified using the collected PCM data, and the calibrated model will be used to indicate compliance. Because the collected data will be used in this manner, annual evaluations of the data’s utility in model verification, and as a result sampling stations may be added, eliminated, or relocated. Similarly, the measured water-quality parameters will be evaluated for their utility and appropriateness for verifying the receiving-water model calibration. At a minimum, the program will collect those parameters with numeric water-quality criteria (i.e., DO, fecal coliform, and

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Gowanus Canal Post Construction Monitoring Sites

FIGURE 8-6

enterococci). In addition, moored instrumentation may be added or substituted at one or more of these locations if continuous monitoring is determined to be beneficial to model verification or if logistical considerations preclude the routine operation of the program (navigational limits, laboratory issues, etc.).

8.5.2 Floatables Monitoring

The Gowanus Canal Waterbody/Watershed Facility Plan incorporates by reference the *City-Wide Comprehensive CSO Floatables Plan Modified Facility Planning Report* (HydroQual, 2005b) and *Floatables Plan Addendum 1 – Pilot Floatables Monitoring Program* (HydroQual, 2005c). These documents contain a conceptual framework for the monitoring of floatables conditions in New York Harbor and a work plan for the ongoing pilot program to develop and test the monitoring methodology envisioned in the framework. The Floatables Plan provides a metric for LTCP performance, and floatables monitoring will be conducted in conjunction with PCM with regard to staffing, timing, and location of monitoring sites. The program will include the collection of basic floatables presence/absence data from monitoring sites throughout the Harbor to rate and track floatables conditions, correlate rating trends to floatables control programs where applicable, and trigger investigations into the possible causes of consistently poor ratings should they occur. Actions and investigations based on the floatables monitoring data could include short-term remediation in areas where monitored floatables conditions create acute human or navigation hazards and, as appropriate, longer term remediation actions and modifications to the Waterbody/Watershed Facility Plan if monitored floatables trends indicate impairment of waters relative to their intended uses.

Contingent upon completion of the pilot floatables monitoring program, it is anticipated that full-scale floatables monitoring will be conducted in conjunction with post-construction compliance monitoring with regard to staffing, timing, and location of monitoring sites.

8.5.3 Meteorological Conditions

The performance of any CSO control cannot be fully evaluated without a detailed analysis of precipitation characteristics such as storm intensity and total annual rainfall. NYCDEP has established the precipitation record measured in 1998 at JFK Airport as generally representative of long-term average conditions relative to CSO discharges and uses this record when analyzing the expected performance of facilities where "typical" conditions (rather than extreme conditions) serve as the basis for design. Table 8-2 presents a comparison of several precipitation statistics for the long-term record as well as the JFK 1988 record.

Table 8-2. Comparison of Annual 1988 and Long-Term Statistics JFK Rainfall Record (1970-2002) (1)

Rainfall Characteristic	Long-Term Statistics (1970-2002)	1988 Statistics	
	Median	Median	Return Period (years)
Annual Total Rainfall Depth (inches)	39.4	40.7	2.6
Average Storm Intensity (inch/hour)	0.057	0.068	11.3
Annual Average Number of Storms	112	100	1.1
Average Storm Duration (hours)	6.08	6.12	2.1
(1) (HydroQual, 2004a)			

As shown in Table 8-1, the aggregate statistics indicate that 1988 was representative of overall long-term conditions. With regard to storm intensity, an important parameter impacting CSOs, the 1988 value is more than one standard deviation greater than the median, indicating that using 1988 as a design year would provide conservative results with respect to CSOs and their water-quality impacts. Another characteristic that makes the 1988 rainfall record suitable as a design year is the fact that it contains critically high rainfall conditions during both a recreational period (July) and a shellfishing period (November). Nevertheless, considering the complexity and stochastic nature of rainfall, selection of any year as "typical" is ultimately qualitative. Evaluation of the response of Gowanus Canal to the Plan is not expected to correlate simply to annual rainfall volume or any other single rainfall statistic, and modeling procedures will be useful to interpret observed conditions during any particular period.

Multiple sources of rainfall data will be compiled as part of the final PCM. On an interim basis, the primary source of rainfall data will be from the four NOAA-maintained weather stations (located in Central Park and at JFK, LGA, and EWR airports), airports and from any NYCDEP gauges that may be available in the vicinity of the Gowanus Canal watershed. In addition, National Weather Service NEXRAD radar-measured precipitation data may also provide some additional information, although its use will be limited until its accuracy is fully demonstrated and understood. NYCDEP may discontinue any data sets determined to be of limited value in the analysis of compliance.

8.5.4 Analysis

The performance of the Gowanus Canal Waterbody/Watershed Facility Plan will be evaluated on an annual basis using computer models of the sewer system and of the water bodies, as approved by NYSDEC. These models will be calibrated and supported using monitoring data. Modeling offers several advantages over monitoring alone:

- Modeling provides a comprehensive vertical, spatial, and temporal coverage that cannot be achieved with a monitoring program;
- Modeling provides sufficient information to compute aggregate statistical values to calculate compliance with standards written as "geometric means," "never-less-than"

values, "not-to-exceed" values, and cumulative statistics (e.g., the 66-day deficit-duration for DO, to be promulgated by NYSDEC in the future.)

- Discrete grab sampling for data collection is necessarily biased to locations and periods of logistical advantage, such as navigable waters, safe weather conditions, daylight hours, etc.; and
- Quantification of certain chemical parameters must be performed in a laboratory setting which either (a) complicates the use of a smaller sampling vessel that is necessary to access shallower waters not navigable by a vessel with onboard laboratory facilities, or (b) limits the number of sampling locations that can be accessed due to holding times and other laboratory quality assurance requirements if remote (non vessel-mounted) laboratory facilities are used.

CSO volumes will be quantitatively analyzed on a monthly basis to isolate any performance issues and their impact on water quality. Water-quality modeling re-assessments will be conducted every two years, and will be based on the previous two years of water-quality field data. Modeling conditions will be based on the hydrodynamic and meteorological conditions for the study year, documented operational issues that may have impacted the facility performance, and water-quality boundary conditions based on the Harbor Survey data from outside Gowanus Canal. For validation purposes, modeling results will be compared to the PCM data collected within Gowanus Canal, and performance will be expressed in a quantitative attainment level for applicable numeric criteria. Should this analysis indicate that progress towards the desired results is not being made, the analysis will:

- Re-verify all model inputs, collected data and available QA/QC reports;
- Consult with operations personnel to ensure unusual operational problems (e.g., screening channel overload/shutdown, pump repair, etc.) were adequately documented;
- Evaluate specific periods of deviations from model-calculated performance;
- Confirm that all operational protocols were implemented, and that these protocols are sufficient to avoid operationally-induced underperformance;
- Re-evaluate protocols as higher frequency and routine problems reveal themselves; and
- Revise protocols as appropriate, and if necessary, conduct a Use Attainability Analysis (UAA) and revise the Waterbody/Watershed Plan.

Due to the dynamic nature of natural precipitation and receiving-water conditions, as well as approaches to non-compliance conditions, a period of ten years of operation will be necessary to generate the minimum amount of data necessary to perform meaningful statistical analyses for water-quality standards review and for any formal use-attainability analysis (UAA) that may be indicated. Following completion of the tenth annual report, a more detailed evaluation of the capability of the Gowanus Canal Waterbody/Watershed Facility Plan to achieve the desired water-quality goals will take place, with appropriate weight given to the various issues that New York City identified during the evaluations documented in the annual reports. If it is determined that the desired results are not achieved, NYCDEP will revisit the feasibility of cost-effective. Alternately, the water-quality standards revision process may commence with a UAA that would likely rely in part on the findings of the PCM program. The approach to future improvements beyond the 10-year PCM program will be dictated by the findings of that program as well as the input from NYSDEC SPDES permit and CSO Consent Order administrators. This schedule is not intended to contradict the 5-year cycle used for updating SPDES permits.

8.5.5 Reporting

Post-construction compliance monitoring will be added to the annual BMP report submitted by NYCDEP in accordance with the applicable SPDES permits. The monitoring report will provide summary statistics on rainfall, the amount of combined sewage generated, and the proportions of the combined sewage that overflow as CSO versus directed to the WPCP and bypassed after primary treatment or subject to full secondary treatment.. Verification and refinement of the model framework will be documented as necessary, and modeling results will be presented to assess water-quality impacts in lieu of high-resolution sampling. Analyses of precipitation, temperature effects, and other conditions external to Plan elements will also be included in the BMP report.

In addition to the information to be provided in the Annual CSO BMP Report, NYCDEP will submit a summary of the monitoring and modeling once every five years. NYSDEC has acknowledged that the variability in precipitation dynamics may require more than five successive years of data to statistically validate the models used for evaluating compliance, but nonetheless stated that this information will be used to identify areas of significant water-quality non-compliance and gaps in the water-quality modeling, and to measure progress with the LTCP goals. NYSDEC has also indicated an intent to verify the JFK 1988 rainfall record as an "average year."

8.6 CONSISTENCY WITH FEDERAL CSO POLICY

The Gowanus Canal Waterbody/Watershed Facility Plan was developed so that it satisfies the requirements of the federal CSO Control Policy. Through extensive water quality and sewer system modeling, data collection, community involvement, and engineering analysis, the NYCDEP has adopted a plan that incorporates the findings of over a decade of inquiry to achieve the highest reasonably attainable use of Gowanus Canal. This Watershed/Waterbody Facility Plan addresses each of the nine elements of long-term CSO control as defined by federal policy and shown in Table 8-3.

Table 8-3. Nine Elements of Long-Term CSO Control

Element	Report Section	Summary
1. Characterization, Monitoring, and Modeling of the Combined Sewer System	3.0	Addressed during Inner Harbor Facility planning (1993), Gowanus Facilities Upgrade (2001), USA Project (1999-2004), and Waterbody/Watershed Plan development (2004-2005).
2. Public Participation	6.0	The Waterbody/Watershed Plan was developed with active involvement from the affected public and other stakeholders during its development. In addition, five stakeholder meetings were held develop the plan during the USA Project.

Table 8-3. Nine Elements of Long-Term CSO Control

Element	Report Section	Summary
3. Consideration of Sensitive Areas	4.7	NYSDEC included Gowanus Canal on a list of sensitive areas because it is targeted for a regional watershed management plan. The Canal does not meet other EPA criteria for sensitive areas.
4. Evaluation of Alternatives	7.0	Detailed evaluations conducted during facility planning projects and herein clearly establish the combination of alternatives that comprise the Waterbody/Watershed Facility Plan.
5. Cost/Performance Considerations	7.0	Both facility planning and Waterbody/Watershed Plan development evaluations of cost suggest that the highest-level controls (100% CSO capture, sewer separation) provide insignificant additional water quality benefits despite inordinate costs. CSO facilities such as the GPS expansion were sized according to a "knee-of-the-curve" type cost-benefit analysis.
6. Operational Plan	8.0	NYCDEP will continue to satisfy the operational requirements of the 14 BMPs for CSO control, including the Red Hook and Owls Head WPCP Wet Weather Operating Plans, as required under the City SPDES permits. The BMPs satisfy the nine minimum control requirement of federal CSO policy. NYCDEP will also continue implementation of other programmatic controls.
7. Maximizing Treatment at the Existing WPCP	7.0	Maximization of treatment at the Red Hook and Owls Head WPCPs is included in the Waterbody/Watershed Plan through satisfaction of the operational requirements of the WPCP WWOPs. However, both WPCPs are remote from Gowanus Canal and their operation does not significantly affect CSO discharges to the Canal.
8. Implementation Schedule	8.0	The Gowanus Facility Upgrade was underway at the time of the writing of this report. Construction activity is anticipated to conclude in 2012. The USACE Ecosystem Restoration Project is ongoing; a recommended plan is anticipated by the end of 2006.
9. Post-Construction Compliance Monitoring	8.0	Post-construction monitoring will be performed per CSO Control Policy requirements: receiving water will be monitored per Harbor Survey protocols at three stations within Gowanus Canal. Monitoring data will be used to assess compliance, to optimize facility performance, and to trigger adaptive management alternatives.

Furthermore, the Gowanus Canal Waterbody/Watershed Facility Plan satisfies the metrics of the Demonstration Approach. These metrics are based primarily on whether the selected alternative is projected to meet applicable water quality standards. As described in Section 8.2 and shown on Figures 8-1 and 8-2, the Gowanus Canal Waterbody/Watershed Facility Plan is projected to meet the Class SD dissolved oxygen criterion 100 percent of the time during the design (typical) precipitation year, with higher criteria are attained most of the time. Higher levels of control—up to and including 100 percent CSO abatement—are not projected to provide significantly improved dissolved oxygen. For example, the 4.0 mg/L criterion (the IEC Class B-1 criterion for Gowanus Canal) is expected to be attainted 93 percent of the time under the Waterbody/Watershed Plan, and 94 percent of the time with 100 percent CSO abatement.

With respect to the narrative water quality criteria for aesthetics, the Waterbody/Watershed Facility Plan is expected to substantially reduce floatables and odors. The

Waterbody/Watershed Facility Plan will reduce the volume of CSO discharged to Gowanus Canal by 32 percent at the largest outfall and about 20 percent overall while simultaneously increasing the flushing of the Canal waters with the Flushing Tunnel by approximately 40 percent. To address floatables issues, the Waterbody/Watershed Plan will augment ongoing programmatic controls such as street sweeping, catch basin retention, and other best management practices described in the City-Wide Comprehensive CSO Floatables Plan (HydroQual, 2005b), by installing a new CSO screening system at the largest CSO, by restoring functionality to a floatables/settleable solids trap serving the second-largest CSO, and by addressing any remaining floatables issues with the deployment of skimmer vessels to conduct open-water floatables removal from the Canal. Finally, exposed CSO sediments and the odors associated with them will be addressed by dredging the Canal north of Sackett St. to a final water depth of 3.0 ft below mean lower low water. This dredging activity and final water depth includes placement of a 2-ft sand cap in dredged areas to provide a clean substrate.

9.0 Water Quality Standards Review and Revision

The Gowanus Canal Waterbody/Watershed Facility Plan is a component of the New York City Department of Environmental Protection's Combined Sewer Overflow LTCP. This Plan is being prepared in a manner fully consistent with the USEPA's CSO Control Policy, the Wet Weather Water Quality Act of 2000 and applicable USEPA guidance.

As noted in Section 1.2 and as stated in the CWA, it is a national goal to achieve "fishable/swimmable" water quality in the nation's waters wherever attainable. The CSO Policy also reflects the CWA's objectives to achieve WQS by controlling CSO impacts, but the Policy recognizes the site-specific nature of CSOs and their impacts and provides the necessary flexibility to tailor controls to local situations. The key principles of the CSO Policy were developed to ensure that CSO controls are cost-effective and meet the objectives of the CWA. In doing so, the Policy provides flexibility to municipalities to consider the site-specific nature of CSOs and to determine the most cost-effective means of reducing pollutants and meeting CWA objectives and requirements. The Policy also provides for the review and revision, as appropriate, of water quality standards when developing CSO control plans to reflect the site-specific wet weather impacts of CSOs.

In 2001, USEPA published guidance for coordinating CSO long-term planning with water quality standards reviews. This guidance re-affirmed that the USEPA regulations and guidance provide States with the opportunity to adapt their WQS to reflect site-specific conditions related to CSOs. The guidance encouraged States to define more explicitly their recreational and aquatic life uses and then, if appropriate, modify the criteria accordingly to protect the designated uses.

The Gowanus Canal Waterbody/Watershed Facility Plan was developed in a manner consistent with the CSO Policy and applicable guidance. Specifically, cost-effectiveness and knee-of-the-curve evaluations were performed for CSO load reduction evaluations using long term rainfall records representative of a typical year. Baseline and Waterbody/Watershed Facility Plan receiving water impact evaluations were performed for average annual rainfall conditions consistent with CSO Policy guidance. The plan resulting from following the USEPA regulations and guidance is expected to result in substantial benefits to Gowanus Canal. However, it does not fully attain the "fishable/swimmable" goal. When the planning process has this result, the national policy calls for a review and, where appropriate, a revision to water quality standards. The purpose of this section therefore is to address the water quality standards review and revision guidance applicable to the CSO Policy.

9.1 WATER QUALITY STANDARD REVIEW

This section reviews the applicable water quality standards and their attainability in Gowanus Canal. In addition, this section also presents a discussion about the waterbody uses expected to be restored under the Waterbody/Watershed Plan, as well as other practical considerations, such as partial attainment.

9.1.1 Numeric Water Quality Standards

New York State waterbody classifications and numerical criteria that are or may be considered applicable to Gowanus Canal are shown in Table 9-1.

Table 9-1. New York State Numeric Surface Water Quality Standards (Saline)

Class	Dissolved Oxygen (mg/L)	Bacteria (Pathogens) Total Coliform (3) (per 100 mL)	Fecal Coliform (4) (per 100 mL)	Enterococci(5) (per 100 mL)
SD	≥ 3.0	N/A	N/A	N/A
I	≥ 4.0	≤ 10,000	≤ 2,000	N/A
SB, SC	≥ 4.8(1) ≥ 3.0(2)	≤ 2,400 ≤ 5,000	≤ 200	≤ 35

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

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

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

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

(2) Acute standard (never less than 3.0 mg/L)
(3) Total coliform criteria are based on monthly geometric means for Class I, and on monthly medians for Classes SB and SC; second criterion for SC and SB is for 80% of samples.
(4) Fecal coliform criteria are based on monthly geometric means.
(5) The enterococci standard is based on monthly geometric means per the USEPA Bacteria Rule and applies to the bathing season. The enterococci coastal recreation water infrequent use reference level (upper 95% confidence limit) = 501/100 mL.
N/A: not applicable

At the present time, Gowanus Canal is classified as Class SD with a best usage of fishing. This classification is considered to be suitable for fish survival but not for fish propagation. This classification also has no bacteriological criteria specified and is not considered suitable for either secondary or primary contact. Class SD therefore is not consistent with the "fishable/swimmable" goals of the CWA. Satisfaction of the "fishable" goal would require Gowanus Canal to be reclassified to Class I, SB or SC, which are considered suitable for fish propagation and survival. It is understood at present that the Class I dissolved oxygen criterion of never less than 4.0 mg/L is considered satisfactory for fish propagation and survival, and therefore consistent with the fishable goal of the CWA. Satisfaction of the "swimmable" goal would require reclassification to Class SB or SC which are considered suitable for primary contact recreation. Reclassification to the fishable/swimmable Class SB/SC requires more stringent numerical coliform bacteria criteria and also modifies the dissolved oxygen requirement. The class SB/SC dissolved oxygen standards include an acute standard of never less than 3.0 mg/L and a chronic of greater than or equal to 4.8 mg/L based on a daily average. For the chronic standard the dissolved oxygen concentration may fall below 4.8 mg/L for a limited number of days based on the exposure-duration equation presented in Table 9-1.

The IEC waterbody classifications applicable to waters within the Interstate Environmental District are shown in Table 9-2. The upper New York Bay and it tidal tributaries including Gowanus Canal are classified as Class B-1 with best intended uses of fishing and secondary contact recreation.

Table 9-2. Interstate Environmental Commission and Classifications, Criteria and Best Uses

Class	Dissolved Oxygen	Best Intended Use
A	≥5.0 mg/L	Suitable for all forms of primary and secondary contact recreation and for fish propagation. In designated areas, they also shall be suitable for shellfish harvesting.
B-1	≥4.0 mg/L	Suitable for fishing and secondary contact recreation. They shall be suitable for the growth and maintenance of fish life and other forms of marine life naturally occurring therein, but may not be suitable for fish propagation.
B-2	≥3.0 mg/L	Suitable for passage of anadromous fish and for the maintenance of fish life in a manner consistent with the criteria established in Sections 1.01 and 1.02 of these regulations.

9.1.2 Narrative Water Quality Standards

The New York State narrative water quality standards that are applicable to Gowanus Canal and all waterbody classifications are shown in Table 9-3.

Table 9-3. New York State Narrative Water Quality Standards

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

In all cases, the narrative water quality standards apply a limit of "no" or "none," and only for selected parameters are these restrictions conditioned on the impairment of waters for their best usages.

The IEC narrative water quality regulations which are applicable to Gowanus Canal and all waters of the Interstate Environmental District are shown in Table 9-4.

Table 9-4. Interstate Environmental Commission Narrative Regulations

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

9.1.3 Attainability of Water Quality Standards

Section 7.4 describes water quality modeling analyses which were performed to evaluate attainability of water quality standards under Baseline and Waterbody/Watershed Facility Plan conditions. The results of these analyses are summarized graphically in Section 8 and in tabular form in Tables 9-5 through 9-9 for the various numerical criteria for dissolved oxygen and bacteria for current and fishable/swimmable classifications.

Attainability of Currently Applicable Standards

Table 9-5 summarizes projected percentage annual attainability of dissolved oxygen for current Class SD and Class B-1 criteria for Baseline and Waterbody/Watershed Facility Plan conditions at three locations: the head, the mouth, and an intermediate location within Gowanus Canal. The intermediate location, approximately 7,000 feet from the head, is the location of minimum dissolved oxygen attainment projected along the length of Gowanus Canal for various control scenarios. For Class SD, the Waterbody/Watershed Facility Plan improves the annual dissolved oxygen attainment at the head to 100 percent from 39 percent for Baseline conditions and significantly improves oxygen resources throughout the upper two-thirds of Gowanus Canal. For Class B-1 the Waterbody/Watershed Facility Plan improves attainment at the head to 100 percent from 30 percent under Baseline conditions, and achieves at least 91 percent attainment along the length of Gowanus Canal. The Gowanus Canal Waterbody/Watershed Facility Plan is therefore expected to fully achieve the current Class SD dissolved oxygen criteria and to attain a high annual level of compliance with the Class B-1 criterion

Table 9-5. Annual Attainability of Dissolved Oxygen Criteria for Design Year[1]

Location	Percent Attainment[2] Class SD (≥3.0 mg/L)		Percent Attainment[2] Class B-1 (≥4.0 mg/L)	
	Baseline	WBWS[3]	Baseline	WBWS[3]
Head End	39	100	30	100
Intermediate	100	100	91	91
Mouth	100	100	98	96

(1) Design year reflects "typical rainfall" condition as recorded in 1988 at JFK Airport
(2) Projected percentage of hours meeting criterion
(3) Waterbody/Watershed Facility Plan

Attainability of Potential Future Standards

As noted, the best usage of Gowanus Canal under the current NYSDEC (Class SD) and IEC (Class B-1) classifications for aquatic life protection is fishing. This usage is not fully compatible with the "fishable" goal of the CWA. For this purpose, Gowanus Canal would require reclassification to NYSDEC Class I and IEC Class A which support fish propagation and survival as the best usage.

Table 9-6 summarizes projected percentage annual attainability of NYSDEC Class I and IEC Class A dissolved oxygen criteria. Both regulatory agencies consider these criteria suitable for fish propagation and survival and therefore consistent with the "fishable" goal of the CWA. For Class I, the Waterbody/Watershed Facility Plan significantly improves the annual dissolved oxygen attainment at head end to 100 percent from 30 percent under Baseline conditions and achieves at least 91 percent attainment along the length of Gowanus Canal. For Class A, the Waterbody/Watershed Facility Plan improves annual attainment of the dissolved oxygen criterion at the head from 24 percent to 92 percent, significantly improves dissolved oxygen in the upper Canal, and maintains 75 percent to 81 percent attainment in the lower reach.

Table 9-6. Annual Attainability of Dissolved Oxygen Criteria for Design Year[1]

Location	Percent Attainment[2] Class I (≥4.0 mg/L)		Percent Attainment[2] Class A (≥5.0 mg/L)	
	Baseline	WBWS[3]	Baseline	WBWS[3]
Head End	30	100	24	92
Intermediate	91	91	74	75
Mouth	98	96	83	81

(1) Design year reflects "typical rainfall" condition as recorded in 1988 at JFK Airport
(2) Projected percentage of hours meeting criterion
(3) Waterbody/Watershed Facility Plan as recorded in 1988 at JFK Airport

The current NYSDEC Class SD designation for Gowanus Canal does not have an associated recreational best usage. Reclassification of Gowanus Canal to Class I would provide secondary contact recreation as a best usage and impose bacteriological criteria for total and fecal coliform. However, the Class I secondary contact use is not considered consistent with the "swimmable" goal of the CWA. To revise the classification of Gowanus Canal to be fully supportive of primary contact uses, it would be necessary to comply with Class SB/SC criteria for total and fecal coliform, and with the enterococci criterion and reference level established by USEPA. Tables 9-7 through 9-9 summarize the projected percentage annual attainability of these potential criteria for design year conditions.

Table 9-7 summarizes the projected percentage annual attainability of total coliform for potential Class I secondary contact and Class SB/SC primary contact criteria. Hamilton Avenue, approximately 5,600 feet from the head, is chosen as a convenient intermediate location designating the end of the more channelized portion of Gowanus Canal. The table indicates that for both the secondary contact and primary contact criteria, the Waterbody/Watershed Facility Plan achieves complete attainment along the length of Gowanus Canal from non-attainment under Baseline conditions. The improvement in attainability for the primary contact criteria, both geometric mean and upper limit, is pronounced.

Table 9-7. Annual Attainability of Total Coliform Criteria For Design Year[1]

Location	Percent Attainment[2] Class I (Secondary Contact) Monthly Geometric Mean ≤ 10,000 colonies/100mL		Percent Attainment[2] Class SB/SC (Primary Contact) Monthly Median (50th percentile value) ≤ 2,400 colonies/100mL		Percent Attainment[2] Class SB/SC (Primary Contact) Monthly Upper Limit (80th percentile value) ≤ 5,000 colonies/100mL	
	Baseline	WBWS[3]	Baseline	WBWS[3]	Baseline	WBWS[3]
Head End	67	100	42	100	8	100
Hamilton Avenue	100	100	83	100	42	100
Mouth	100	100	100	100	100	100

(1) Design year reflects "typical rainfall" condition as recorded in 1988 at JFK Airport
(2) Projected percentage of months meeting criterion
(3) Waterbody/Watershed Facility Plan

Table 9-8 shows similar conditions for fecal coliform. As for total coliform, for potential Class I secondary contact and Class SB/SC primary contact criteria, the Waterbody/Watershed Facility Plan significantly improves attainability from the Baseline and achieves complete attainment annually, for both water uses.

Table 9-8. Annual Attainability of Fecal Coliform Criteria For Design Year(1)

Location	Percent Attainment(2) Class I Monthly Geometric Mean ≤ 2,000 colonies/100mL		Percent Attainment(2) Class SB/SC Monthly Geometric Mean ≤ 200 colonies/100mL	
	Baseline	WBWS3	Baseline	WBWS3
Head End	67	100	25	100
Hamilton Avenue	100	100	67	100
Mouth	100	100	100	100

(1) Design year reflects "typical rainfall" condition as recorded in 1988 at JFK Airport
(2) Projected percentage of months meeting criterion
(3) Waterbody/Watershed Facility Plan

Table 9-9 summarizes projected attainment of potential enterococci criteria which could be applied to Gowanus Canal for primary contact water uses. It is noted that the USEPA enterococci criteria were developed from data collected at beaches during the bathing season. Therefore, the attainability values shown in Table 9-9 are shown for the three summer months of June, July and August which comprise the official bathing season at New York City's seven public bathing beaches. The table shows that the Waterbody/Watershed Facility Plan achieves 100 percent attainment of the seasonal geometric mean throughout Gowanus Canal but does not fully attain the infrequent use coastal recreation water reference level (upper 95 percent confidence limit).

Table 9-9. Recreation Season(1) Attainability of Enterococci Bacteria Criteria

Location	Percent Attainment2 Water Quality Criterion Monthly Geometric Mean ≤ 35 colonies 100mL		Percent Attainment2 Infrequent-Use Reference Level - Daily Maximum < 501 colonies/100mL	
	Baseline	WBWS FP*	Baseline	WBWS FP*
Head End	0	100	52	84
Hamilton Avenue	100	100	60	79
Mouth	100	100	91	88

(1) Recreation season is June, July, August of "typical rainfall" year (1988 at JFK Airport)
(2) Projected percentage of months or days meeting criterion
(3) Waterbody/Watershed Facility Plan as recorded in 1988 at JFK Airport

9.1.4 Attainment of Narrative Water Quality Standards

Table 9-3 summarizes NYSDEC narrative water quality standards that are applicable to Gowanus Canal and all waters of the State. The existing CSO discharges to the waterbody and the stormwater from the separate area discharge some amounts of materials which affect most or all of the listed parameters to some degree. Odors at the head of Gowanus Canal prior to the reactivation of the Flushing Tunnel are the result of deposition of organic solids and oil and floating substances and floatable materials (refuse) are discharged.

The Waterbody/Watershed Facility Plan will not completely eliminate, but will substantially reduce and lessen the severity of, the discharge of these materials to the Gowanus

Canal. The Plan will reduce the discharge of the parameters of concern by at least 19 percent based on volumetric capture, the dredging program will curtail odor formation and, in the case of floatable materials, the Gowanus Pump Station upgrade and other combined sewer system improvements will almost completely eliminate discharge. An additional safeguard for floatable materials will be the continuation of skimmer vessel operations. Consequently, the adverse impacts of the current discharges will be greatly diminished, although not completely eliminated as required by the narrative standards. Additionally, best management practices applied to the separate stormwater discharges will also not completely eliminate impacts from that source but will reduce loadings to the extent feasible.

The Waterbody/Watershed Facility Plan, although not completely eliminating all of the parameters of concern, will eliminate odors and will greatly reduce the deposition of organic solids and floatable materials, and will restore the aesthetic uses of Gowanus Canal to the maximum extent practicable.

9.1.5 Water Uses Restored

Fish and Aquatic Life Protection Use

Table 9-5 presents the expected improvements in dissolved oxygen to be attained by the Waterbody/Watershed Facility Plan as compared to Baseline conditions for current dissolved oxygen standards. The Plan is expected to achieve 100 percent attainment along the length of Gowanus Canal for the current Class SD dissolved oxygen standard on an annual basis and 93 to 100 percent attainment of the IEC Class B-1 criterion. This is considered to be a high level of attainment in terms of the protection of fish and aquatic life, various forms of which are present throughout the entire year. In addition, the anoxia which existed near the head of Gowanus Canal prior to reactivation of the Flushing Tunnel will be eliminated, thus producing habitat suitable for the restoration of a diversity of benthic organisms in this vicinity. In addition, the significant reduction in sediment total organic carbon resulting from the Waterbody/Watershed Facility Plan is expected to restore a significant number of benthic taxa to the upper reaches of Gowanus Canal further supporting the aquatic life habitat.

Table 9-6 presents expected attainment of the potential fish survival and propagation classifications, Class I and Class A. Table 9-6 indicates a very high level of expected attainability for the Class I criterion, greater than 93 percent on an annual basis, and shows a significant improvement from Baseline conditions in the upper reaches of the Canal. Expected attainability of a potential IEC Class A criterion would not be as great, but would achieve a minimum of 75 percent annually. As for Class I, the improvement in the upper reaches compared with the Baseline is quite substantial.

Primary and Secondary Contact Recreation Use

Tables 9-7 through 9-9 present expected attainment of various bacteriological water quality standards under both annual and recreational season conditions (enterococci) for the Baseline and Waterbody/Watershed Facility Plan conditions. The current Class SD water quality standards do not contain any maximum pathogen limits. Tables 9-7 (total coliform) and 9-8 (fecal coliform) indicate that the Waterbody/Watershed Facility Plan will attain Class I secondary contact water quality criteria along the length of the canal throughout the year, thus achieving an important recreational use that is not attained for Baseline conditions in Gowanus Canal. Tables 9-7 and 9-8 indicate that, for a potential Class SB/SC primary contact designation, the Waterbody/Watershed Facility Plan is also expected to achieve attainment of primary contact water quality criteria throughout the year, thus restoring a level of water quality supportive of this CWA goal.

For enterococci, Table 9-9 indicates that the Waterbody/Watershed Facility Plan is expected to attain the geometric mean requirement during the summer bathing season, the water use period for which the criterion was developed. However, the infrequent use coastal recreation water reference level (upper 95 percent confidence limit) of 501 which would be relevant to Gowanus Canal, will be exceeded due to periodic overflows and stormwater discharges in response to rainfall events. However, it is the geometric mean enterococci criterion which is more relevant to health protection and which is the enforceable numerical limit for this indicator.

From the results presented in Tables 9-7, 9-8 and 9-9, it is projected that the Waterbody/Watershed Facility Plan will achieve a level of bacteriological water quality sufficient to satisfy the numerical criteria supportive of primary contact.

Aesthetic Water Use

As discussed in Section 9.1.4, the Waterbody/Watershed Facility Plan will not completely eliminate all regulated parameters in the NYSDEC narrative water quality standards to zero discharge levels, but will greatly reduce the volumetric discharge and impact of such substances. The effect of floatable materials from CSOs will be virtually eliminated by the proposed positive floatables controls and skimmer vessel operations, and the effect of narrative materials from stormwater inputs will be reduced to the maximum extent practicable Accordingly, the aesthetic conditions in Gowanus Canal should improve to a level consistent with the other attained water uses and the nature of the adjacent shoreline uses.

9.1.6 Practical Considerations

The previous section describes the expected improvement in the level of attainment with the current Class SD and IEC Class B-1 dissolved oxygen classifications for fish survival. As indicated, the Waterbody/Watershed Facility Plan is expected to achieve complete attainment throughout the year along the entire length of Gowanus Canal for the Class SD criterion and 93 to 100 percent attainment of the IEC Class B-1 criterion.

The previous section also describes the improvement in the level of attainment with potential Class I and IEC Class A dissolved oxygen criteria which is expected to result from the Waterbody/Watershed Facility Plan. These classifications support both fish survival and propagation, the fishable goals of the CWA. As noted, the annual compliance is expected to be high for Class I, but dissolved oxygen is projected to be below the criteria for some limited periods of time over the annual cycle at certain locations in the canal.

For the majority of months, complete compliance with fishing and fish propagation criteria throughout the Canal is expected. In the other months where some criteria exceedences are expected, it should be noted that the impact on fish larval propagation is likely to be limited. Fish larvae spawning in Gowanus Canal will be exchanged with, and transported to, Upper Bay waters where dissolved oxygen will be greater. The organisms will therefore not be continuously exposed to Gowanus Canal dissolved oxygen which may be depressed below the criteria. Consequently, the impact on larval survival will be less than expected based on laboratory studies where organisms are confined and exposed continuously to the same depressed dissolved oxygen level. Because of the significant amount of larval transport that occurs in Gowanus Canal and throughout New York Harbor, and the exposure of the organisms to continuously varying, rather than static, dissolved oxygen concentrations, it is considered reasonable to view the New York Harbor ecosystem in its entirety rather than by individual tributary or sub-region for purposes of fish and aquatic life protection.

Additionally, direct kills of juvenile fish at the head of Gowanus Canal should not occur as there exists no fish passage and the organisms would avoid any temporarily depressed dissolved oxygen. As noted, minimum dissolved oxygen levels projected for the head should be sufficient to comply with the fish survival requirements of all classifications throughout the year.

For these reasons, it is considered that, for practical purposes, conditions in Gowanus Canal would be supportive of the fishable goal of the CWA.

Section 9.1.5 also notes that during the summer recreation season for enterococci, and throughout the year for total and fecal coliform, water quality is expected to be supportive of numerical criteria for the swimmable (primary contact recreation) goal of the CWA. However, swimming should not be considered as a best use due to periodic overflows from the Waterbody/Watershed Facility Plan and continuing stormwater discharges. This is consistent with the views of the majority of local stakeholders who do not view swimming as a desirable use of Gowanus Canal, though they do desire a level of water quality supportive of this use.

9.2 WATER QUALITY STANDARDS REVISION

9.2.1 Overview of Use Attainability and Water Quality Standards Recommendation

Section 9.1 summarizes the existing and potential water quality standards for Gowanus Canal and expected levels of attainment based on modeling calculations. For aquatic life protection, the attainment of the water use can be expected to be greater than that suggested by compliance with numerical criteria during the summer period due to the limited larval residence time in the Canal, organism transport to the Upper Bay and the appropriateness of considering the New York Harbor ecosystem, both open waters and tributaries, in its entirety rather than as individual components. In addition, the Gowanus Canal habitat has been significantly altered by human activity throughout the last century thus limiting its attractiveness as a fish habitat.

For recreational activity, modeling calculations indicate that compliance with the numerical criteria for both primary and secondary contact recreation is expected to be attained by the Waterbody/Watershed Facility Plan for all relevant bacteriological indicators, fecal coliform and enterococci, although bathing and swimming activities would not be considered the best use. This is a significant improvement from the current Class SD classification which does not include a recreational use.

As a result of the water quality conditions and uses expected to be attained in Gowanus Canal from the Waterbody/Watershed Facility Plan, it is recommended that the current waterbody classification, Class SD, be retained at this time. Once the Plan is fully implemented and becomes operational, it may be possible to reclassify Gowanus Canal to Class I. It is noted that the best usage for Class SD waters is fishing and that modeling calculations indicate that water quality suitable for fish propagation and survival and secondary and primary contact may be attained from the Waterbody/Watershed Facility Plan suggesting the possibility of a reclassification. However, as this expectation is based on modeling calculations with some inherent level of uncertainty, it is preferable to await confirmation from the post-construction long term monitoring program before taking such an action. Incremental reclassification is considered to be preferable to over-classification.

As noted, expected levels of water quality standards attainability are based on modeling calculations which are subject to some level of uncertainty. In addition, calculations are based on a typical year with an average amount of annual rainfall. Therefore, it is recommended that the actual improvements in water quality conditions resulting from the Waterbody/Watershed Facility Plan be assessed from the multi-year long term monitoring program described elsewhere in this Plan report. The monitoring program will document the actual attainment of uses: whether the Class SD uses are attained as expected; whether other levels of usage are actually achieved supporting a waterbody reclassification; or whether CWA "fishable/swimmable" goals are not attained therefore requiring a Use Attainability Analysis and subsequent water quality standards revision.

As described in this report, modeling calculations indicate that complete attainment of the Class SD narrative water quality criteria and a potential future Class I or IEC Class A dissolved oxygen criterion (Appendix Figure D-2) can not be attained even with 100 percent retention of the CSO discharges to Gowanus Canal. This water quality based effluent limit (WQBEL) of zero annual CSO overflows is neither cost-effective nor consistent with federal CSO policy. Therefore, until the long-term post-construction monitoring program is completed for Gowanus Canal to document conditions actually attained, it is recommended that a variance to the WQBEL be applied for, and approved, for the Gowanus Canal Waterbody/Watershed Facility Plan for appropriate effluent variables.

9.2.2 NYSDEC Requirements for Variances to Effluent Limitations

The requirements for variances to water quality based effluent limitations are described in Section 702.17 of NYSDEC's *Water Quality Regulations*. The following is an abbreviated summary of the variance requirements which are considered applicable to Gowanus Canal. The lettering and numbering are those used in Section 702.17.

(a) The department may grant, to a SPDES permittee, a variance to a water quality-based effluent limitation included in a SPDES permit.

(1) a variance applies only to the permittee identified in such variance and only to the pollutant specified in the variance. A variance does not affect or require the department to modify a corresponding standard or guidance value.

(5) a variance term shall not exceed the term of the SPDES permit. Where the term of the variance is the same as the permit, the variance shall stay in effect until the permit is reissued, modified or revoked.

(b) A variance may be granted if the requester demonstrates that achieving the effluent limitation is not feasible because:

(1) naturally occurring pollutant concentrations prevent attainment of the standard or guidance value;

(2) natural, ephemeral, intermittent or low flow conditions or water levels prevent attainment, unless these conditions may be compensated for by the discharge of sufficient volume of effluent to enable the standard or guidance value to be met without violating water conservation requirements.

(3) human-caused conditions or sources of pollution prevent attainment of the standard or guidance value and cannot be remedied or would cause more environmental damage to correct them to leave in place.

(4) dams, diversions or other types of hydrologic modifications preclude attainment of the standard or guidance value, and it is not feasible to restore the waterbody to its original condition or to operate such modification in a way that would result in such attainment.

(5) Physical conditions related to the natural features of the waterbody, such as the lack of a proper substrate cover, flow, depth, pools, riffles, and the like, unrelated to chemical water quality, preclude attainment of the standard or guidance value; or

(6) Controls more stringent than those required by section 754.1(a)(1) and (2) of this Title would result in substantial and widespread economic and social impact.

(c) In addition to the requirements of subdivision (b) of this section, the requestor shall also characterize, using adequate and sufficient data and principles, any increased risk to human health and the environment associated with granting the variance compared with attainment of the standard or guidance value absent the variance, and demonstrate to the satisfaction of the department that the risk will not adversely affect the public health, safety and welfare.

(d) The requestor shall submit a written application for a variance to the department. The application shall include:

(1) all relevant information demonstrating that achieving the effluent limitation is not feasible based on subdivision (b) of this section; and

(2) all relevant information demonstrating compliance with the conditions is subdivision (c) of this section.

(e) Where a request for a variance satisfies the requirements of this section, the department shall authorize the variance through the SPDES permit. The variance request shall be available to the public for review during the public notice period for the permit. The permit shall contain all conditions needed to implement the variance. Such conditions shall, at minimum, include:

(1) compliance with an initial effluent limitation that, at the time the variance is granted, represents the level currently achievable by the requestor, and that is no less stringent than that achieved under the previous permit where applicable.

(2) that reasonable progress be made toward achieving the effluent limitations based on the standard or guidance value, including, where reasonable, an effluent limitation more stringent than the initial effluent limitations;
(3) additional monitoring, biological studies and pollutant minimization measures as deemed necessary by the department.
(4) when the duration of a variance is shorter than the duration of a permit, compliance with an effluent limitation sufficient to meet the underlying standard or guidance value, upon the expiration of the variance; and
(5) a provision that allows the department to reopen and modify the permit for revisions to the variance.

(g) A variance may be renewed, subject to the requirements of this section. As part of any renewal application, the permittee shall again demonstrate that achieving the effluent limitation is not feasible based on the requirements of this section.

(i) The department will make available to the public a list of every variance that has been granted and that remains in effect.

9.2.3 Manner of Compliance with the Variance Requirements

Subdivision (a) authorizes NYSDEC to grant a variance to a "water quality based effluent limitation…included in a SPDES permit." It is assumed that the Gowanus Canal Waterbody/Watershed Facility Plan will be referenced in the Red Hook WPCP SPDES permit in order to provide an additional enforceable mechanism beyond the CSO Consent Order requiring implementation and operations of all plan components including the flushing tunnel. This array of facilities necessary to attain Class SD water quality standards can be interpreted as the equivalent of an "effluent limitation" in accordance with the "alternative effluent control strategies" provision of Section 302(a) of the CWA.

Subdivision (a)(1) indicates that a variance will apply only to a specific permittee, in this case, NYCDEP, and only to the pollutant specified in the variance. It is understood that "pollutant" can be interpreted in the plural and one application and variance can be used for one or more relevant pollutants. In Gowanus Canal, a variance would be needed for effluent constituents covered by narrative water quality standards (suspended colloidal and settleable solids; oil and floating substances).

Subdivision (b) requires the permittee to demonstrate that achieving the (water quality based) effluent limitation is not feasible due to a number of factors. It is noted that these factors are the same as those in 40CFR131.10(g) which indicate federal requirements for a Use Attainability Analysis. As with the federal regulations, it is assumed that any one of the six factors is justification for the granting of a variance. The Gowanus Canal Use Attainability Evaluation Report, to be completed under separate cover, will document the applicability of two of the six factors cited in Subdivision (b): (3) human caused conditions and (4) hydrologic modifications.

Subdivision (c) requires the applicant to demonstrate to the department any increased risk to human health associated with granting of the variance compared with attainment of the water quality standards absent the granting of the variance. The information documenting this analysis is contained elsewhere in the Waterbody/Watershed Facility Plan report. Report Section 7.0, Evaluation of Alternatives, describes bacteriological conditions which are expected under Baseline and Waterbody/Watershed Facility Plan conditions. As noted, secondary and primary water quality criteria, although not applicable to Gowanus Canal currently, are not attained under Baseline conditions but are expected to be achieved by the Waterbody/Watershed Facility Plan. Further, in the interim, and until the Waterbody/Watershed Facility Plan is fully implemented and operational, very little risk to human health is anticipated.

Subdivision (d) of the variance regulations requires that the requestor submit a written application for a variance to NYSDEC which includes all relevant information pertaining to Subdivisions (b) and (c). NYCDEP will submit a variance application for the Gowanus Canal Waterbody/Watershed Facility Plan to NYSDEC six months before the Plan is placed in operation. The application will be accompanied by the Gowanus Canal Waterbody/Watershed Facility Plan report, the Gowanus Canal Use Attainability Evaluation, and all other supporting documentation pertaining to Subdivisions (b) and (c) and as required by any other subdivisions of the variance requirements.

Subdivision (e) stipulates that approved variances be authorized through the appropriate SPDES permit, be available to the public for review and contain a number of conditions:

- It is assumed that the initial effluent limitation achievable by the permittee at the time the variance becomes effective, after the Waterbody/Watershed Facility Plan is fully implemented and operational, will be based upon the performance characteristics of the Waterbody/Watershed Facility Plan as agreed upon between NYSDEC and NYCDEP. These interim operational conditions will be based on the Plan's design specifications. It is expected that a fact sheet outlining the basis for the WQBEL and interim operational conditions will be appended to the SPDES permit.

- It is assumed that the requirement for demonstration of reasonable progress after construction as required in the permit will include NYCDEP activities such as implementation of the long-term monitoring program and additional waterbody improvement projects as delineated in Section 5 of this Waterbody/Watershed Facility Plan report. Such actions and projects include: 14 best management practices, the City-wide CSO plan for floatables abatement, other long term CSO control planning activities which may affect Gowanus Canal, various New York Harbor water quality improvement projects, and various ecosystem restoration activities. These activities are also required under section (3) of the Subdivision

- It is assumed that the SPDES permit authorizing the Gowanus Canal Waterbody/Watershed Facility Plan variance(s) will contain a provision that allows the department to reopen and modify the permit for revisions to the variance(s).

Subdivision (g) indicates that a variance may be renewed. It is anticipated that a variance for the Gowanus Canal Waterbody/Watershed Facility Plan would require renewals to allow for sufficient long term monitoring to assess the degree of water quality standards compliance. As appropriate, a variance renewal application will be submitted 180 days before SPDES permit expiration.

At the completion of the variance period(s), it is expected that the results of the long term monitoring program will demonstrate each of the following:

- The degree to which the Waterbody/Watershed Facility Plan attains the Class SD classification water quality standards and uses;
- The degree to which the Waterbody/Watershed Facility Plan achieves water quality criteria consistent with the fishable/swimmable goals of the CWA, whether any new cost-effective technology is available to enhance the Waterbody/Watershed Facility Plan performance, whether the waterbody classification for Gowanus Canal can be revised, or whether a Use Attainability Analysis should be approved.

In this manner, the approval of a WQBEL variance for Gowanus Canal together with an appropriate long term monitoring program can be considered as a step toward a determination of the following:

- Can Gowanus Canal be reclassified in a manner which is wholly or partially compatible with the fishable/swimmable goals of the Clean Water Act or
- Is a Use Attainability Analysis needed for Gowanus Canal and for which water quality criteria?

Although Gowanus Canal's current waterbody classification, Class SD, is not compatible with the goals of the Clean Water Act and would normally require reclassification or a UAA in the State's triennial review obligation, it is considered to be more appropriate to proceed with the more deliberative variance approval/monitoring procedure outlined above. The recommended procedure will determine actual improvements resulting from Waterbody/Watershed Facility Plan implementation, enable a proper determination for the appropriate waterbody classification for Gowanus Canal and perhaps avoid unnecessary, repetitive and possibly contradictory rulemaking.

9.2.4 Future Considerations

Urban Tributary Classification

The possibility is recognized that the long term monitoring program recommended for Gowanus Canal, and ultimately for other confined waterbodies throughout the City, may indicate that the highest attainable uses are not compatible with the use goals of the Clean Water Act. It is therefore recommended that consideration be given to the development of a new waterbody classification in NYSDEC Water Quality Regulations, that being "Urban Tributary."

The Urban Tributary classification would have the following attributes:

- Recognition of wet weather conditions in the designation of uses and water quality criteria.
- Application to urban confined waterbodies which satisfy any of the UAA criteria enumerated in 40CFR131.10(g).
- Definition of required baseline water uses
  - Fish and aquatic life survival (if attainable)
  - Secondary contact recreation (if attainable)

- Other attainable uses would be waterbody specific and dependent upon the effectiveness of the site-specific CSO LTCP based upon knee-of-the-curve considerations and technical feasibility and implementability.

The Urban Tributary classification could be implemented through the application of a generic UAA procedure for confined urban waterbodies based on the criteria of 40CFR131.10(g). This procedure could avoid the necessity for repeated UAAs on different waterbodies with similar characteristics. Those waterbodies which comply with the designation criteria can be identified at one time, and the reclassification completed in one rulemaking.

If either of the designated baseline uses of fish and aquatic life survival and secondary contact recreation did not appear to be attainable in a particular setting, then a site-specific UAA would be required.

Narrative Criteria

The recommendation for a WQBEL variance for the Gowanus Canal Waterbody/Watershed Facility Plan would apply with regard to the narrative water quality standards previously cited. However, a broad issue remains with the practical ability to attain the requirements of the narrative standards in situations where wet weather discharges are unavoidable and will occasionally occur after controls. Therefore, it is recommended that NYSDEC review the application of the narrative standards, provide for a wet weather exclusion with demonstrated need, or make all narrative standards conditional upon the impairment of waters for their best usage.

Synopsis

Although this Waterbody/Watershed Facility Plan is expected to result in significant improvements to the water quality in Gowanus Canal, it is not expected to completely attain all applicable water quality criteria. As such, the SPDES Permit for the Red Hook WPCP may require a variance for the Gowanus Canal Plan discharges if contravention of some criteria continues to occur. If either current or potential future “fishable/swimmable” water quality criteria are demonstrated to be unrealistic after a period of monitoring, NYCDEP would request reclassification of Gowanus Canal based on a Use Attainability Analysis (UAA). Until the recommended UAAs and required regulatory processes are completed, the current NYSDEC classification of Gowanus Canal (Class SD) should be temporarily retained.

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11.0 Glossary and Abbreviations

A Posteriori Classification: A classification based on the results of experimentation.

A Priori Classification: A classification made prior to experimentation.

ACO: Administrative Consent Order

Activated Sludge: The product that results when primary effluent is mixed with bacteria-laden sludge and then agitated and aerated to promote biological treatment, speeding the breakdown of organic matter in raw sewage undergoing secondary waste treatment.

Acute Toxicity: The ability of a substance to cause severe biological harm or death soon after a single exposure or dose. Also, any poisonous effect resulting from a single short-term exposure to a toxic substance (see chronic toxicity, toxicity).

Administrative Consent Order (ACO): A legal agreement between a regulatory authority and an individual, business, or other entity through which the violator agrees to pay for correction of violations, take the required corrective or cleanup actions, or refrain from an activity. It describes the actions to be taken, may be subject to a comment period, applies to civil actions, and can be enforced in court.

Administrative Law Judge (ALJ): An officer in a government agency with quasi-judicial functions including conducting hearings, making findings of fact, and making recommendations for resolution of disputes concerning the agency's actions.

Advanced Treatment: A level of wastewater treatment more stringent than secondary treatment; requires an 85-percent reduction in conventional pollutant concentration or a significant reduction in non-conventional pollutants. Sometimes called tertiary treatment.

Advanced Wastewater Treatment: Any treatment of sewage that goes beyond the secondary or biological water treatment stage and includes the removal of nutrients such as phosphorus and nitrogen and a high percentage of suspended solids. (See primary, secondary treatment.)

Advection: Bulk transport of the mass of discrete chemical or biological constituents by fluid flow within a receiving water. Advection describes the mass transport due to the velocity, or flow, of the waterbody. Example: The transport of pollution in a river: the motion of the water carries the polluted water downstream.

ADWF: Average Dry Weather Flow

Aeration: A process that promotes biological degradation of organic matter in water. The process may be passive (as when waste is exposed to air), or active (as when a mixing or bubbling device introduces the air). Exposure to additional air may be by means of natural of engineered systems.

Aerobic: Environmental conditions characterized by the presence of dissolved oxygen; used to describe biological or chemical processes that occur in the presence of oxygen.

Algae: Simple rootless plants that live floating or suspended in sunlit water or may be attached to structures, rocks or other submerged surfaces. Algae grow in proportion to the amount of available nutrients. They can affect water quality adversely since their biological activities can appreciably affect pH and low dissolved oxygen of the water. They are food for fish and small aquatic animals.

Algal Bloom: A heavy sudden growth of algae in and on a body of water which can affect water quality adversely and indicate potentially hazardous changes in local water chemistry. The growth results from excessive nutrient levels or other physical and chemical conditions that enable algae to reproduce rapidly.

ALJ: Administrative Law Judge

Allocations: Allocations are that portion of a receiving water's loading capacity that is attributed to one of its existing or future sources (non-point or point) of pollution or to natural background sources. (Wasteload allocation (WLA) is that portion of the loading capacity allocated to an existing or future point source and a load allocation (LA) is that portion allocated to an existing or future non-point source or to a natural background source. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading.)

Ambient Water Quality: Concentration of water quality constituent as measured within the waterbody.

Ammonia (NH_3): An inorganic form of nitrogen, is contained in fertilizers, septic system effluent, and animal wastes. It is also a product of bacterial decomposition of organic matter. NH3-N becomes a concern if high levels of the un-ionized form are present. In this form NH3-N can be toxic to aquatic organisms.

Anaerobic: Environmental condition characterized by zero oxygen levels. Describes biological and chemical processes that occur in the absence of oxygen. Anoxia. No dissolved oxygen in water.

Anthropogenic: Pertains to the [environmental] influence of human activities.

Antidegradation: Part of federal water quality requirements. Calls for all existing uses to be protected, for deterioration to be avoided or at least minimized when water quality meets or exceeds standards, and for outstanding waters to be strictly protected.

Aquatic Biota: Collective term describing the organisms living in or depending on the aquatic environment.

Aquatic Community: An association of interacting populations of aquatic organisms in a given waterbody or habitat.

Aquatic Ecosystem: Complex of biotic and abiotic components of natural waters. The aquatic ecosystem is an ecological unit that includes the physical characteristics (such as flow or velocity and depth), the biological community of the water column and benthos, and the chemical characteristics such as dissolved solids, dissolved oxygen, and nutrients. Both living and nonliving components of the aquatic ecosystem interact and influence the properties and status of each component.

Aquatic Life Uses: A beneficial use designation in which the waterbody provides suitable habitat for survival and reproduction of desirable fish, shellfish, and other aquatic organisms.

Assemblage: An association of interacting populations of organisms in a given waterbody (e.g., fish assemblage or benthic macro-invertebrate assemblage).

Assessed Waters: Waters that states, tribes and other jurisdictions have assessed according to physical, chemical and biological parameters to determine whether or not the waters meet water quality standards and support designated beneficial uses.

Assimilation: The ability of a body of water to purify itself of pollutants.

Assimilative Capacity: The capacity of a natural body of water to receive wastewaters or toxic materials without deleterious efforts and without damage to aquatic life or humans who consume the water. Also, the amount of pollutant load that can be discharged to a specific waterbody without exceeding water quality standards. Assimilative capacity is used to define the ability of a waterbody to naturally absorb and use a discharged substance without impairing water quality or harming aquatic life.

Attribute: Physical and biological characteristics of habitats which can be measured or described.

Average Dry Weather Flow (ADWF): The average non-storm flow over 24 hours during the dry months of the year (May through September). It is composed of the average dry weather inflow/infiltration.

Bacteria: (Singular: bacterium) Microscopic living organisms that can aid in pollution control by metabolizing organic matter in sewage, oil spills or other pollutants. However, some types of bacteria in soil, water or air can also cause human, animal and plant health problems. Bacteria of the coliform group are considered the primary indicators of fecal contamination and are often used to assess water quality. Measured in number of bacteria organisms per 100 milliliters of sample (No./ml or #/100 ml).

BASINS: Better Assessment Science Integrating Point and Non-point Sources

BEACH: Beaches Environmental Assessment and Coastal Health

Beaches Environmental Assessment and Coastal Health (BEACH): The BEACH Act requires coastal and Great Lakes States to adopt the 1986 USEPA Water Quality Criteria for Bacteria and to develop and implement beach monitoring and notification plans for bathing beaches.

Benthic: Refers to material, especially sediment, at the bottom of an aquatic ecosystem. It can be used to describe the organisms that live on, or in, the bottom of a waterbody.

Benthic Macroinvertebrates: See benthos.

Benthos: Animals without backbones, living in or on the sediments, of a size large enough to be seen by the unaided eye, and which can be retained by a U.S. Standard No. 30 sieve (28 openings/in, 0.595-mm openings). Also referred to as benthic macroinvertebrates, infauna, or macrobenthos.

Best Available Technology (BAT): The most stringent technology available for controlling emissions; major sources of emissions are required to use BAT, unless it can be demonstrated that it is unfeasible for energy, environmental, or economic reasons.

Best Management Practice (BMP): Methods, measures or practices that have been determined to be the most effective, practical and cost effective means of preventing or reducing pollution from non-point sources.

Better Assessment Science Integrating Point and Non-point Sources (BASINS): A computer tool that contains an assessment and planning component that allows users to organize and display geographic information for selected watersheds. It also contains a modeling component to examine impacts of pollutant loadings from point and non-point sources and to characterize the overall condition of specific watersheds.

Bioaccumulation: A process by which chemicals are taken up by aquatic organisms and plants directly from water as well as through exposure via other routes, such as consumption of food and sediment containing the chemicals.

Biochemical Oxygen Demand (BOD): A measure of the amount of oxygen per unit volume of water required to bacterially or chemically breakdown (stabilize) the organic matter in water. Biochemical oxygen demand measurements are usually conducted over specific time intervals (5,10,20,30 days). The term BOD generally refers to a standard 5-day BOD test. It is also considered a standard measure of the organic content in water and is expressed as mg/L. The greater the BOD, the greater the degree of pollution.

Bioconcentration: A process by which there is a net accumulation of a chemical directly from water into aquatic organisms resulting from simultaneous uptake (e.g., via gill or epithelial tissue) and elimination. In other words, the accumulation of a chemical in tissues of a fish or other organism to levels greater than the surrounding medium.

Biocriteria: A combination of narrative and numerical measures, such as the number and kinds of benthic, or bottom-dwelling, insects living in a stream, that describe the biological condition (structure and function) of aquatic communities inhabiting waters of a designated aquatic life use. Biocriteria are regulatory-based biological measurements and are part of a state's water quality standards.

Biodegradable: A substance or material that is capable of being decomposed (broken down) by natural biological processes.

Biodiversity: Refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequencies. For biological diversity, these items are organized at many levels, ranging from complete ecosystems to the biological structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species and genes.

Biological Assemblage: A group of phylogenetically (e.g., fish) or ecologically (e.g., benthic macroinvertebrates) related organisms that are part of an aquatic community.

Biological Assessment or Bioassessment: An evaluation of the condition of a waterbody using biological surveys and other direct measures of the resident biota of the surface waters, in conjunction with biological criteria.

Biological Criteria or Biocriteria: Guidelines or benchmarks adopted by States to evaluate the relative biological integrity of surface waters. Biocriteria are narrative expressions or numerical values that describe biological integrity of aquatic communities inhabiting waters of a given classification or designated aquatic life use.

Biological Indicators: Plant or animal species or communities with a narrow range of environmental tolerances that may be selected for monitoring because their absence or presence and relative abundances serve as barometers of environmental conditions.

Biological Integrity: The condition of the aquatic community inhabiting unimpaired waterbodies of a specified habitat as measured by community structure and function.

Biological Monitoring or Biomonitoring: Multiple, routine biological surveys over time using consistent sampling and analysis methods for detection of changes in biological condition.

Biological Nutrient Removal (BNR): The removal of nutrients, such as nitrogen and/or phosphorous during wastewater treatment.

Biological Oxygen Demand (BOD): An indirect measure of the concentration of biologically degradable material present in organic wastes. It usually reflects the amount of oxygen consumed in five days by biological processes breaking down organic wastes.

Biological Survey or Biosurvey: Collecting, processing and analyzing representative portions of an estuarine or marine community to determine its structure and function.

Biological Magnification: Refers to the process whereby certain substances such as pesticides or heavy metals move up the food chain, work their way into rivers and lakes, and are eaten by aquatic organisms such as fish, which in turn are eaten by large birds, animals or humans. The substances become concentrated in tissues or internal organs as they move up the food chain. he result of the processes of bioconcentration and bioaccumulation by which tissue concentrations of bioaccumulated chemicals increase as the chemical passes up through two or more trophic levels in the food chain. (See bioaccumulation.)

Biota: Plants, animals and other living resources in a given area.

Biotic Community: A naturally occurring assemblage of plants and animals that live in the same environment and are mutually sustaining and interdependent.

BMP: Best Management Practice

BNR: Biological Nutrient Removal

BOD: Biological Oxygen Demand; Biochemical Demand

Borrow Pit: See Subaqueous Borrow Pit.

Brackish: Water with salt content ranging between that of sea water and fresh water; commonly used to refer to Oligohaline waters.

Brooklyn Sewer Datum (BSD): Coordinate system and origins utilized by surveyors in the Borough of Brooklyn, New York City.

BSD: Brooklyn Sewer Datum

CAC: Citizens Advisory Committee

Calcareous: Pertaining to or containing calcium carbonate; Calibration; The process of adjusting model parameters within physically defensible ranges until the resulting predictions give a best possible fit to observed data.

Calibration: The process of adjusting model parameters within physically defensible ranges until the resulting predictions give a best possible fit to observed data.

CALM: Consolidated Assessment and Listing Methodology

Capital Improvement Program (CIP): A budget and planning tool used to implement non-recurring expenditures or any expenditure for physical improvements, including costs for: acquisition of existing buildings, land, or interests in land; construction of new buildings or other structures, including additions and major alterations; construction of streets and highways or utility lines; acquisition of fixed equipment; landscaping; and similar expenditures.

Capture: The total volume of flow collected in the combined sewer system during precipitation events on a system-wide, annual average basis (not percent of volume being discharged).

Catch Basin: (1) A buried chamber, usually built below curb grates seen at the curbline of a street, to relieve street flooding, which admits surface water for discharge into the sewer system and/or a receiving waterbody. (2) A sedimentation area designed to remove pollutants from runoff before being discharged into a stream or pond.

Carbonaceous Biochemical Oxygen Demand ($CBOD_5$): The amount of oxygen required to oxidize any carbon containing matter present in water in five days.

CATI: Computer Assisted Telephone Interviews

$CBOD_5$: Carbonaceous Biochemical Oxygen Demand

CEA: Critical Environmental Area

CEQR: City Environmental Quality Review

CERCLIS: Comprehensive Environmental Response, Compensation and Liability Information System

CFR: Code of Federal Regulation

Channel: A natural stream that conveys water; a ditch or channel excavated for the flow of water.

Channelization: Straightening and deepening streams so water will move faster or facilitate navigation - a tactic that can interfere with waste assimilation capacity, disturb fish and wildlife habitats, and aggravate flooding.

Chemical Oxygen Demand (COD): A measure of the oxygen required to oxidize all compounds, both organic and inorganic, in water.

Chlorination: The application of chlorine to drinking water, sewage, or industrial waste to disinfect or to oxidize undesirable compounds. Typically employed as a final process in water and wastewater treatment.

Chrome+6 (Cr+6): Chromium is a steel-gray, lustrous, hard metal that takes a high polish, is fusible with difficulty, and is resistant to corrosion and tarnishing. The most common oxidation states of chromium are +2, +3, and +6, with +3 being the most stable. +4 and +5 are relatively rare. Chromium compounds of oxidation state 6 are powerful oxidants.

Chronic Toxicity: The capacity of a substance to cause long-term poisonous health effects in humans, animals, fish and other organisms (see acute toxicity).

CIP: Capital Improvement Program

Citizens Advisory Committee (CAC): Committee comprised of various community stakeholders formed to provide input into a planning process.

City Environmental Quality Review (CEQR): CEQR is a process by which agencies of the City of New York review proposed discretionary actions to identify the effects those actions may have on the environment.

Clean Water Act (CWA): The Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972), Public Law 92-500, as amended by Public Law 96-483 and Public Law 97-117, 33 U.S.C. 1251 et seq. The CWA contains a number of provisions to restore and maintain the quality of the nation's water resources. One of these provisions is section 303(d), which establishes the Total maximum Daily Load (TMDL) program.

Coastal Waters: Marine waters adjacent to and receiving estuarine discharges and extending seaward over the continental shelf and/or the edge of the U.S. territorial sea.

Coastal Zone Boundary (CZB): Generally, the part of the land affected by its proximity to the sea and that part of the sea affected by its proximity to the land as the extent to which man's land-based activities have a measurable influence on water chemistry and marine ecology. Specifically, New York's Coastal zone varies from region to region while incorporating the following conditions: The inland boundary is approximately 1,000 feet from the shoreline of the mainland. In urbanized and developed coastal locations the landward boundary is approximately 500 feet from the mainland's shoreline, or less than 500 feet where a roadway or railroad line runs parallel to the shoreline at a distance of under 500 feet and defines the boundary. In locations where major state-owned lands and facilities or electric power generating facilities abut the shoreline, the boundary extends inland to include them. In some areas, such as Long Island Sound and the Hudson River Valley, the boundary may extend inland up to 10,000 feet to encompass significant coastal resources, such as areas of exceptional scenic value, agricultural ore recreational lands, and major tributaries and headlands.

Coastal Zone: Lands and waters adjacent to the coast that exert an influence on the uses of the sea and its ecology, or whose uses and ecology are affected by the sea.

COD: Chemical Oxygen Demand

Code of Federal Regulations (CFR): Document that codifies all rules of the executive departments and agencies of the federal government. It is divided into fifty volumes, known as titles. Title 40 of the CFR (references as 40 CFR) lists most environmental regulations.

Coliform Bacteria: Common name for Escherichia coli that is used as an indicator of fecal contamination of water, measured in terms of coliform count. (See Total Coliform Bacteria)

Coliforms: Bacteria found in the intestinal tract of warm-blooded animals; used as indicators of fecal contamination in water.

Collection System: Pipes used to collect and carry wastewater from individual sources to an interceptor sewer that will carry it to a treatment facility.

Collector Sewer: The first element of a wastewater collection system used to collect and carry wastewater from one or more building sewers to a main sewer. Also called a lateral sewer.

Combined Sewage: Wastewater and storm drainage carried in the same pipe.

Combined Sewer Overflow (CSO): Discharge of a mixture of storm water and domestic waste when the flow capacity of a sewer system is exceeded during rainstorms. CSOs discharged to receiving water can result in contamination problems that may prevent the attainment of water quality standards.

Combined Sewer Overflow Event: The discharges from any number of points in the combined sewer system resulting from a single wet weather event that do not receive minimum treatment (i.e., primary clarification, solids disposal, and disinfection, where appropriate). For example, if a storm occurs that results in untreated overflows from 50 different CSO outfalls within the combined sewer system (CSS), this is considered one overflow event.

Combined Sewer System (CSS): A sewer system that carries both sewage and storm-water runoff. Normally, its entire flow goes to a waste treatment plant, but during a heavy storm, the volume of water may be so great as to cause overflows of untreated mixtures of storm water and sewage into receiving waters. Storm-water runoff may also carry toxic chemicals from industrial areas or streets into the sewer system.

Comment Period: Time provided for the public to review and comment on a proposed USEPA action or rulemaking after publication in the Federal Register.

Community: In ecology, any group of organisms belonging to a number of different species that co-occur in the same habitat or area; an association of interacting assemblages in a given waterbody. Sometimes, a particular subgrouping may be specified, such as the fish community in a lake.

Compliance Monitoring: Collection and evaluation of data, including self-monitoring reports, and verification to show whether pollutant concentrations and loads contained in permitted discharges are in compliance with the limits and conditions specified in the permit.

Compost: An aerobic mixture of decaying organic matter, such as leaves and manure, used as fertilizer.

Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS): Database that contains information on hazardous waste sites, potentially hazardous waste sites and remedial activities across the nation. The database includes sites that are on the National Priorities List or being considered for the List.

Comprehensive Waterfront Plan (CWP): Plan proposed by the Department of City Planning that provides a framework to guide land use along the city's entire 578-mile shoreline in a way that recognizes its value as a natural resource and celebrates its diversity. The plan presents a long-range vision that balances the needs of environmentally sensitive areas and the working port with opportunities for waterside public access, open space, housing and commercial activity.

Computer Assisted Telephone Interviews (CATI): CATI is the use of computers to automate and control the key activities of a telephone interview.

Conc: Abbreviation for “Concentration”.

Concentration: Amount of a substance or material in a given unit volume of solution. Usually measured in milligrams per liter (mg/l) or parts per million (ppm).

Consolidated Assessment and Listing Methodology (CALM): EPA framework for states and other jurisdictions to document how they collect and use water quality data and information for environmental decision making. The primary purposes of these data analyses are to determine the extent that all waters are attaining water quality standards, to identify waters that are impaired and need to be added to the 303(d) list, and to identify waters that can be removed from the list because they are attaining standards.

Contamination: Introduction into the water, air and soil of microorganisms, chemicals, toxic substances, wastes or wastewater in a concentration that makes the medium unfit for its next intended use.

Conventional Pollutants: Statutorily listed pollutants understood well by scientists. These may be in the form or organic waste, sediment, acid, bacteria, viruses, nutrients, oil and grease, or heat.

Cost-Benefit Analysis: A quantitative evaluation of the costs, which would be incurred by implementing an alternative versus the overall benefits to society of the proposed alternative.

Cost-Share Program: A publicly financed program through which society, as a beneficiary of environmental protection, allocates project funds to pay a percentage of the cost of constructing or implementing a best management practice. The producer pays the remainder of the costs.

Cr+6: Chrome +6

Critical Condition: The combination of environmental factors that results in just meeting water quality criterion and has an acceptably low frequency of occurrence.

Critical Environmental Area (CEA): A CEA is a specific geographic area designated by a state or local agency as having exceptional or unique environmental characteristics. In establishing a CEA, the fragile or threatened environmental conditions in the area are identified so that they will be taken into consideration in the site-specific environmental review under the State Environmental Quality Review Act.

Cross-Sectional Area: Wet area of a waterbody normal to the longitudinal component of the flow.

Cryptosporidium: A protozoan microbe associated with the disease cryptosporidiosis in man. The disease can be transmitted through ingestion of drinking water, person-to-person contact, or other pathways, and can cause acute diarrhea, abdominal pain, vomiting, fever and can be fatal. (See protozoa).

CSO: Combined Sewer Overflow

CSS: Combined Sewer System

Cumulative Exposure: The summation of exposures of an organism to a chemical over a period of time.

Clean Water Act (CWA): Federal law stipulating actions to be carried out to improve water quality in U.S. waters.

CWA: Clean Water Act

CWP: Comprehensive Waterfront Plan

CZB: Coastal Zone Boundary

DDWF: design dry weather flow

Decay: Gradual decrease in the amount of a given substance in a given system due to various sink processes including chemical and biological transformation, dissipation to other environmental media, or deposition into storage areas.

Decomposition: Metabolic breakdown of organic materials; that releases energy and simple organics and inorganic compounds. (See Respiration)

Degradable: A substance or material that is capable of decomposition; chemical or biological.

Delegated State: A state (or other governmental entity such as a tribal government) that has received authority to administer an environmental regulatory program in lieu of a federal counterpart.

Demersal: Living on or near the bottom of a body of water (e.g., mid-water and bottom-dwelling fish and shellfish, as opposed to surface fish).

Department of Sanitation of New York (DSNY): New York City agency responsible for solid waste and refuse disposal in New York City

Design Capacity: The average daily flow that a treatment plant or other facility is designed to accommodate.

Design Dry Weather Flow (DDWF): The flow basis for design of New York City wastewater treatment plants. In general, the plants have been designed to treat 1.5 times this value to full secondary treatment standards and 2.0 times this value, through at least primary settling and disinfection, during stormwater events.

Designated Uses: Those water uses specified in state water quality standards for a waterbody, or segment of a waterbody, that must be achieved and maintained as required under the Clean Water Act. The uses, as defined by states, can include cold-water fisheries, natural fisheries, public water supply, irrigation, recreation, transportation, or mixed uses.

Deoxyribonucleic Acid (DNA): The genetic material of living organisms; the substance of heredity. It is a large, double-stranded, helical molecule that contains genetic instructions for growth, development, and replication.

Destratification: Vertical mixing within a lake or reservoir to totally or partially eliminate separate layers of temperature, plant, or animal life.

Deterministic Model: A model that does not include built-in variability: same input will always equal the same output.

Die-Off Rate: The first-order decay rate for bacteria, pathogens, and viruses. Die-off depends on the particular type of waterbody (i.e. stream, estuary , lake) and associated factors that influence mortality.

Dilution: Addition of less concentrated liquid (water) that results in a decrease in the original concentration.

Direct Runoff: Water that flows over the ground surface or through the ground directly into streams, rivers, and lakes.

Discharge Permits (NPDES): A permit issued by the USEPA or a state regulatory agency that sets specific limits on the type and amount of pollutants that a municipality or industry can discharge to a receiving water; it also includes a compliance schedule for achieving those limits. It is called the NPDES because the permit process was established under the National Pollutant Discharge Elimination System, under provisions of the Federal Clean Water Act.

Discharge: Flow of surface water in a stream or canal or the outflow of ground water from a flowing artesian well, ditch, or spring. It can also apply to discharges of liquid effluent from a facility or to chemical emissions into the air through designated venting mechanisms.

Discriminant Analysis: A type of multivariate analysis used to distinguish between two groups.

Disinfect (Disinfected): A water and wastewater treatment process that kills harmful microorganisms and bacteria by means of physical, chemical and alternative processes such as ultraviolet radiation.

Disinfectant: A chemical or physical process that kills disease-causing organisms in water, air, or on surfaces. Chlorine is often used to disinfect sewage treatment effluent, water supplies, wells, and swimming pools.

Dispersion: The spreading of chemical or biological constituents, including pollutants, in various directions from a point source, at varying velocities depending on the differential instream flow characteristics.

Dissolved Organic Carbon (DOC): All organic carbon (e.g., compounds such as acids and sugars, leached from soils, excreted from roots, etc) dissolved in a given volume of water at a particular temperature and pressure.

Dissolved Oxygen (DO): The dissolved oxygen freely available in water that is vital to fish and other aquatic life and is needed for the prevention of odors. DO levels are considered a most important indicator of a water body's ability to support desirable aquatic life. Secondary and advanced waste treatments are generally designed to ensure adequate DO in waste-receiving waters. It also refers to a measure of the amount of oxygen available for biochemical activity in a waterbody, and as an indicator of the quality of that water.

Dissolved Solids: The organic and inorganic particles that enter a waterbody in a solid phase and then dissolve in water.

DNA: deoxyribonucleic acid

DO: dissolved oxygen

DOC: Dissolved Organic Carbon

Drainage Area or Drainage Basin: An area drained by a main river and its tributaries (see Watershed).

Dredging: Dredging is the removal of mud from the bottom of waterbodies to facilitate navigation or remediate contamination. This can disturb the ecosystem and cause silting that can kill or harm aquatic life. Dredging of contaminated mud can expose biota to heavy metals and other toxics. Dredging activities are subject to regulation under Section 404 of the Clean Water Act.

Dry Weather Flow (DWF): Hydraulic flow conditions within a combined sewer system resulting from one or more of the following: flows of domestic sewage, ground water infiltration, commercial and industrial wastewaters, and any other non-precipitation event related flows (e.g., tidal infiltration under certain circumstances).

Dry Weather Overflow: A combined sewer overflow that occurs during dry weather flow conditions.

DSNY: Department of Sanitation of New York

DWF: Dry weather flow

Dynamic Model: A mathematical formulation describing the physical behavior of a system or a process and its temporal variability. Ecological Integrity. The condition of an unimpaired ecosystem as measured by combined chemical, physical (including habitat), and biological attributes.

EBP: Environmental Benefit Project. A project undertaken in partial settlement of an enforcement action that improves, restores, protects, and/or reduces risks to public health and/or the environment beyond that achieved by compliance with applicable laws and regulations.

E. Coli: Escherichia Coli.

Ecoregion: Geographic regions of ecological similarity defined by similar climate, landform, soil, natural vegetation, hydrology or other ecologically relevant variables.

Ecosystem: An interactive system that includes the organisms of a natural community association together with their abiotic physical, chemical, and geochemical environment.

Effects Range-Low: Concentration of a chemical in sediment below which toxic effects were rarely observed among sensitive species (10th percentile of all toxic effects).

Effects Range-Median: Concentration of a chemical in sediment above which toxic effects are frequently observed among sensitive species (50th percentile of all toxic effects).

Effluent: Wastewater, either municipal sewage or industrial liquid waste that flows out of a treatment plant, sewer or outfall untreated, partially treated, or completely treated.

Effluent Guidelines: Technical USEPA documents which set effluent limitations for given industries and pollutants.

Effluent Limitation: Restrictions established by a state or USEPA on quantities, rates, and concentrations in wastewater discharges.

Effluent Standard: See effluent limitation.

EIS: Environmental Impact Statement

EMAP: Environmental Monitoring and Assessment Program

EMC: Event Mean Concentration

Emergency Planning and Community Right-to-Know Act of 1986, The (SARA Title III): Law requiring federal, state and local governments and industry, which are involved in either emergency planning and/or reporting of hazardous chemicals, to allow public access to information about the presence of hazardous chemicals in the community and releases of such substances into the environment.

Endpoint: An endpoint is a characteristic of an ecosystem that may be affected by exposure to a stressor. Assessment endpoints and measurement endpoints are two distinct types of endpoints that are commonly used by resource managers. An assessment endpoint is the formal expression of a valued environmental characteristic and should have societal relevance. A measurement endpoint is the expression of an observed or measured response to a stress or disturbance. It is a measurable environmental characteristic that is related to the valued environmental characteristic chosen as the assessment endpoint. The numeric criteria that are part of traditional water quality standards are good examples of measurement endpoints.

Enforceable Requirements: Conditions or limitations in permits issued under the Clean Water Act Section 402 or 404 that, if violated, could result in the issuance of a compliance order or initiation of a civil or criminal action under federal or applicable state laws.

Enhancement: In the context of restoration ecology, any improvement of a structural or functional attribute.

Enteric: Of or within the gastrointestinal tract.

Enterococci: A subgroup of the fecal streptococci that includes S. faecalis and S. faecium. The enterococci are differentiated from other streptococci by their ability to grow in 6.5% sodium chloride, at pH 9.6, and at 10°C and 45°C. Enterococci are a valuable bacterial indicator for determining the extent of fecal contamination of recreational surface waters.

Environment: The sum of all external conditions and influences affecting the development and life of organisms.

Environmental Impact Statement (EIS): A document required of federal agencies by the National Environmental Policy Act for major projects or legislative proposals significantly affecting the environment. A tool for decision making, it describes the positive and negative effects of the undertaking and cites alternative actions.

Environmental Monitoring and Assessment Program (EMAP): The Environmental Monitoring and Assessment Program (EMAP) is a research program to develop the tools necessary to monitor and assess the status and trends of national ecological resources. EMAP's goal is to develop the scientific understanding for translating environmental monitoring data from multiple spatial and temporal scales into assessments of current ecological condition and forecasts of future risks to our natural resources.

Epibenthic: Those animals/organisms located at the surface of the sediments on the bay bottom, generally referring to algae.

Epibenthos: Those animals (usually excluding fishes) living on the top of the sediment surface.

Epidemiology: All the elements contributing to the occurrence or non-occurrence of a disease in a population; ecology of a disease.

Epifauna: Benthic animals living on the sediment or on and among rocks and other structures.

EPMC: Engineering Program Management Consultant

Escherichia Coli: A subgroup of the fecal coliform bacteria. E. coli is part of the normal intestinal flora in humans and animals and is, therefore, a direct indicator of fecal contamination in a waterbody. The O157 strain, sometimes transmitted in contaminated waterbodies, can cause serious infection resulting in gastroenteritis. (See Fecal coliform bacteria)

Estuarine Number: Nondimensional parameter accounting for decay, tidal dispersion, and advection velocity. Used for classification of tidal rivers and estuarine systems.

Estuarine or Coastal Marine Classes: Classes that reflect basic biological communities and that are based on physical parameters such as salinity, depth, sediment grain size, dissolved oxygen and basin geomorphology.

Estuarine Waters: Semi-enclosed body of water which has a free connection with the open sea and within which seawater is measurably diluted with fresh water derived from land drainage.

Estuary: Region of interaction between rivers and near-shore ocean waters, where tidal action and river flow mix fresh and salt water. Such areas include bays, mouths of rivers, salt marshes, and lagoons. These brackish water ecosystems shelter and feed marine life, birds, and wildlife (see wetlands).

Eutrophication: A process in which a waterbody becomes rich in dissolved nutrients, often leading to algal blooms, low dissolved oxygen and changes in the composition of plants and animals in the waterbody. This occurs naturally, but can be exacerbated by human activity which increases nutrient inputs to the waterbody.

Event Mean Concentration (EMC): Input data, typically for urban areas, for a water quality model. EMC represents the concentration of a specific pollutant contained in stormwater runoff coming from a particular land use type within a watershed.

Existing Use: Describes the use actually attained in the waterbody on or after November 28, 1975, whether or not it is included in the water quality standards (40 CFR 131.3).

Facility Plan: A planning project that uses engineering and science to address pollution control issues and will most likely result in the enhancement of existing water pollution control facilities or the construction of new facilities.

Facultative: Capable of adaptive response to varying environments.

Fecal Coliform Bacteria: A subset of total coliform bacteria that are present in the intestines or feces of warm-blooded animals. They are often used as indicators of the sanitary quality of water. They are measured by running the standard total coliform test at an elevated temperature (44.5EC). Fecal coliform is approximately 20 percent of total coliform. (See Total Coliform Bacteria)

Fecal Streptococci: These bacteria include several varieties of streptococci that originate in the gastrointestinal tract of warm-blooded animals such as humans (Streptococcus faecalis) and domesticated animals such as cattle (Streptococcus bovis) and horses (Streptococcus equinus).

Feedlot: A confined area for the controlled feeding of animals. The area tends to concentrate large amounts of animal waste that cannot be absorbed by the soil and, hence, may be carried to nearby streams or lakes by rainfall runoff.

FEIS: Final Environmental Impact Statement

Field Sampling and Analysis Program (FSAP): Biological sampling program undertaken to fill-in ecosystem data gaps in New York Harbor.

Final Environmental Impact Statement (FEIS): A document that responds to comments received on the Draft EIS and provides updated information that has become available after publication of the Draft EIS.

Fish Kill: A natural or artificial condition in which the sudden death of fish occurs due to the introduction of pollutants or the reduction of the dissolved oxygen concentration in a waterbody.

Floatables: Large waterborne materials, including litter and trash, that are buoyant or semi-buoyant and float either on or below the water surface. These materials, which are generally man-made and sometimes characteristic of sanitary wastewater and storm runoff, may be transported to sensitive environmental areas such as bathing beaches where they can become an aesthetic nuisance. Certain types of floatables also cause harm to marine wildlife and can be hazardous to navigation.

Flocculation: The process by which suspended colloidal or very fine particles are assembled into larger masses or floccules that eventually settle out of suspension.

Flux: Movement and transport of mass of any water quality constituent over a given period of time. Units of mass flux are mass per unit time.

FOIA: Freedom of Information Act

Food Chain: A sequence of organisms, each of which uses the next, lower member of the sequence as a food source.

Freedom of Information Act (FOIA): A federal statute which allows any person the right to obtain federal agency records unless the records (or part of the records) are protected from disclosure by any of the nine exemptions in the law.

FSAP: Field Sampling and Analysis Program

gallons per day per foot (gpd/ft): unit of measure

Gastroenteritis: An inflammation of the stomach and the intestines.

General Permit: A permit applicable to a class or category of discharges.

Geochemical: Refers to chemical reactions related to earth materials such as soil, rocks, and water.

Geographical Information System (GIS): A computer system that combines database management system functionality with information about location. In this way it is able to capture, manage, integrate, manipulate, analyze and display data that is spatially referenced to the earth's surface.

Giardia lamblia: Protozoan in the feces of humans and animals that can cause severe gastrointestinal Ailments. It is a common contaminant of surface waters. (See protozoa).

GIS: Geographical Information System

Global Positioning System (GPS): A GPS comprises a group of satellites orbiting the earth (24 are now maintained by the U.S. Government) and a receiver, which can be highly portable. The receiver can generate accurate coordinates for a point, including elevation, by calculating its own position relative to three or more satellites that are above the visible horizon at the time of measurement.

GPD: Gallons per Day

gpd/ft: gallons per day per foot

gpd/sq ft: gallons per day per square foot

GPS: Global Positioning System

Gradient: The rate of decrease (or increase) of one quantity with respect to another; for example, the rate of decrease of temperature with depth in a lake.

Groundwater: The supply of fresh water found beneath the earth's surface, usually in aquifers, which supply wells and springs. Because groundwater is a major source of drinking water, there is growing concern over contamination from leaching agricultural or industrial pollutants and leaking underground storage tanks.

H_2S: Hydrogen Sulfide

Habitat Conservation Plans (HCPs): As part of the Endangered Species Act, Habitat Conservation Plans are designed to protect a species while allowing development. HCP's give the U.S. Fish and Wildlife Service the authority to permit "taking" of endangered or threatened species as long as the impact is reduced by conservation measures. They allow a landowner to determine how best to meet the agreed-upon fish and wildlife goals.

Habitat: A place where the physical and biological elements of ecosystems provide an environment and elements of the food, cover and space resources needed for plant and animal survival.

Halocline: A vertical gradient in salinity.

HCP: Habitat Conservation Plan

Heavy Metals: Metallic elements with high atomic weights (e.g., mercury, chromium, cadmium, arsenic, and lead); can damage living things at low concentrations and tend to accumulate in the food chain.

High Rate Treatment (HRT): A traditional gravity settling process enhanced with flocculation and settling aids to increase loading rates and improve performance.

Holding Pond: A pond or reservoir, usually made of earth, built to store polluted runoff.

Holoplankton: An aggregate of passively floating, drifting or somewhat motile organisms throughout their entire life cycle; Hot spot locations in waterbodies or sediments where hazardous substances have accumulated to levels which may pose risks to aquatic life, wildlife, fisheries, or human health.

HRT: High Rate Treatment

Hydrogen Sulfide (H_2S): A flammable, toxic, colorless gas with an offensive odor (similar to rotten eggs) that is a byproduct of degradation in anaerobic conditions.

Hydrology: The study of the distribution, properties, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

Hypoxia: The condition of low dissolved oxygen in aquatic systems (typically with a dissolved oxygen concentration less than 3.0 mg/L).

Hypoxia/Hypoxic Waters: Waters with dissolved oxygen concentrations of less than 2 ppm, the level generally accepted as the minimum required for most marine life to survive and reproduce.

I/I: Inflow/Infiltration

Index of Biotic Integrity: A fish community assessment approach that incorporates the zoogeographic, ecosystem, community and population aspects of fisheries biology into a single ecologically-based index of the quality of a water resource.

IBI: Indices of Biological Integrity

IDNP: Illegal Dumping Notification Program

IEC: Interstate Environmental Commission

IFCP: Interim Floatables Containment Program

Illegal Dumping Notification Program (IDNP): New York City program wherein the NYCDEP field personnel report any observed evidence of illegal shoreline dumping to the Sanitation Police section of DSNY, who have the authority to arrest dumpers who, if convicted, are responsible for proper disposal of the material.

Impact: A change in the chemical, physical or biological quality or condition of a waterbody caused by external sources.

Impaired Waters: Waterbodies not fully supporting their designated uses.

Impairment: A detrimental effect on the biological integrity of a waterbody caused by an impact.

Impermeable: Impassable; not permitting the passage of a fluid through it.

In situ: Measurements taken in the natural environment.

in.: Abbreviation for "Inches".

Index Period: A sampling period, with selection based on temporal behavior of the indicator(s) and the practical considerations for sampling.

Indicator Organism: Organism used to indicate the potential presence of other (usually pathogenic) organisms. Indicator organisms are usually associated with the other organisms, but are usually more easily sampled and measured.

Indicator Taxa or Indicator Species: Those organisms whose presence (or absence) at a site is indicative of specific environmental conditions.

Indicator: Measurable quantity that can be used to evaluate the relationship between pollutant sources and their impact on water quality. Abiotic and biotic indicators can provide quantitative information on environmental conditions.

Indices of Biological Integrity (IBI): A usually dimensionless numeric combination of scores derived from biological measures called metrics.

Industrial Pretreatment Programs (IPP): Program mandated by USEPA to control toxic discharges to public sewers that are tributary to sewage treatment plants by regulating Significant Industrial Users (SIUs). NYCDEP enforces the IPP through Chapter 19 of Title 15 of the Rules of the City of New York (Use of Public Sewers).

Infauna: Animals living within submerged sediments. (See benthos.)

Infectivity: Ability to infect a host. Infiltration. 1. Water other than wastewater that enters a wastewater system and building sewers from the ground through such means as defective pipes, pipe joints, connections or manholes. (Infiltration does not include inflow.) 2. The gradual downward flow of water from the ground surfaces into the soil.

Infiltration: The penetration of water from the soil into sewer or other pipes through defective joints, connections, or manhole walls.

Infiltration/Inflow (I/I): The total quantity of water entering a sewer system from both infiltration and inflow.

Inflow: Water other than wastewater that enters a wastewater system and building sewer from sources such as roof leaders, cellar drains, yard drains, foundation drains, drains from springs and swampy areas, manhole covers, cross connections between storm drains and sanitary sewers, catch basins, cooling towers, stormwaters, surface runoff, street wash waters or drainage. (Inflow does not include infiltration.)

Influent: Water, wastewater, or other liquid flowing into a reservoir, basin, or treatment plant.

Initial Mixing Zone: Region immediately downstream of an outfall where effluent dilution processes occur. Because of the combined effects of the effluent buoyancy, ambient stratification, and current, the prediction of initial dilution can be involved.

Insolation: Exposure to the sun's rays.

Instream Flow: The amount of flow required to sustain stream values, including fish, wildlife, and recreation.

Interceptor Sewers: Large sewer lines that, in a combined system, collect and carry sewage flows from main and trunk sewers to the treatment plant for treatment and discharge. The sewer has no building sewer connections. During some storm events, their capacity is exceeded and regulator structures relieve excess flow to receiving waters to prevent flooding basements, businesses and streets.

Interim Floatables Containment Program (IFCP): A New York City Program that includes containment booms at 24 locations, end-of-pipe nets, skimmer vessels that pick up floatables and transports them to loading stations.

Interstate Environmental Commission (IEC): The Interstate Environmental Commission is a joint agency of the States of New York, New Jersey, and Connecticut. The IEC was established in 1936 under a Compact between New York and New Jersey and approved by Congress. The State of Connecticut joined the Commission in 1941. The mission of the IEC is to protect and enhance environmental quality through cooperation, regulation, coordination, and mutual dialogue between government and citizens in the tri-state region.

Intertidal: The area between the high- and low-tide lines.
IPP: Industrial Pretreatment Programs

Irrigation: Applying water or wastewater to land areas to supply the water and nutrient needs of plants.

JABERRT: Jamaica Bay Ecosystem Research and Restoration Team

Jamaica Bay Ecosystem Research and Restoration Team (JABERRT): Team established by the Army Corps of Engineers to conduct a detailed inventory and biogeochemical characterization of Jamaica Bay for the 2000-2001 period and to compile the most detailed literature search established.

Jamaica Eutrophication Model (JEM): Model developed for Jamaica Bay in 1996 as a result of a cost-sharing agreement between the NYCDEP and US Army Corps of Engineers.

JEM: Jamaica Eutrophication Model

Karst Geology: Solution cavities and closely-spaced sinkholes formed as a result of dissolution of carbonate bedrock.

Knee-off-the-Curve: The point where the incremental change in the cost of the control alternative per change in performance of the control alternative changes most rapidly.

Kurtosis: A measure of the departure of a frequency distribution from a normal distribution, in terms of its relative peakedness or flatness.

LA: Load Allocation

Land Application: Discharge of wastewater onto the ground for treatment or reuse. (See irrigation)

Land Use: How a certain area of land is utilized (examples: forestry, agriculture, urban, industry).

Landfill: A large, outdoor area for waste disposal; landfills where waste is exposed to the atmosphere (open dumps) are now illegal; in constructed landfills, waste is layered, covered with soil, and is built upon impermeable materials or barriers to prevent contamination of surroundings.

lb/day/cf: pounds per day per cubic foot

lbs/day: pounds per day

LC: Loading Capacity

Leachate: Water that collects contaminants as it trickles through wastes, pesticides, or fertilizers. Leaching can occur in farming areas, feedlots, and landfills and can result in hazardous substances entering surface water, groundwater, or soil.

Leaking Underground Storage Tank (LUST): An underground container used to store gasoline, diesel fuel, home heating oil, or other chemicals that is damaged in some way and is leaking its contents into the ground; may contaminate groundwater.

LID: Low Impact Development

LID-R: Low Impact Development - Retrofit

Limiting Factor: A factor whose absence exerts influence upon a population or organism and may be responsible for no growth, limited growth (decline) or rapid growth.

Littoral Zone: The intertidal zone of the estuarine or seashore; i.e., the shore zone between the highest and lowest tides.

Load Allocation (LA): The portion of a receiving water's loading capacity that is attributed either to one of its existing or future non-point sources of pollution or to natural background sources. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and non-point source loads should be distinguished. (40 CFR 130.2(g))

Load, Loading, Loading Rate: The total amount of material (pollutants) entering the system from one or multiple sources; measured as a rate in mass per unit time.

Loading Capacity (LC): The greatest amount of loading that a water can receive without violating water quality standards.

Long Term Control Plan (LTCP): A document developed by CSO communities to describe existing waterway conditions and various CSO abatement technologies that will be used to control overflows.

Low-Flow: Stream flow during time periods where no precipitation is contributing to runoff to the stream and contributions from groundwater recharge are low. Low flow results in less water available for dilution of pollutants in the stream. Due to the limited flow, direct discharges to the stream dominate during low flow periods. Exceedences of water quality standards during low flow conditions are likely to be caused by direct discharges such as point sources, illicit discharges, and livestock or wildlife in the stream.

Low Impact Development (LID): A sustainable storm water management strategy implemented in response to burgeoning infrastructural costs of new development and redevelopment projects, more rigorous environmental regulations, concerns about the urban heat island effect, and the impacts of natural resources due to growth and development. The LID strategy controls water at the source—both rainfall and storm water runoff—which is known as 'source-control' technology. It is a decentralized system that distributes storm water across a project site in order to replenish groundwater supplies rather than sending it into a system of storm drain pipes and channelized networks that control water downstream in a large storm water management facility. The LID approach promotes the use of various devices that filter water and infiltrate water into the ground. It promotes the use of roofs of buildings, parking lots, and other horizontal surfaces to convey water to either distribute it into the ground or collect it for reuse.

Low Impact Development – Retrofit (LID-R): Modification of an existing site to accomplish LID goals.

LTCP: Long-Term CSO Control Plan

LUST: leaking underground storage tank

Macrobenthos: Benthic organisms (animals or plants) whose shortest dimension is greater than or equal to 0.5 mm. (See benthos.)

Macrofauna: Animals of a size large enough to be seen by the unaided eye and which can be retained by a U.S. Standard No. 30 sieve (28 meshes/in, 0.595-mm openings).

Macro-invertebrate: Animals/organism without backbones (Invertebrate) that is too large to pass through a No. 40 Screen (0.417mm) but can be retained by a U.S. Standard No. 30 sieve (28 meshes/in, 0.595-mm openings). The organism size is of sufficient size for it to be seen by the unaided eye and which can be retained

Macrophytes: Large aquatic plants that may be rooted, non-rooted, vascular or algiform (such as kelp); including submerged aquatic vegetation, emergent aquatic vegetation, and floating aquatic vegetation.

Major Oil Storage Facilities (MOSF): Onshore facility with a total combined storage capacity of 400,000 gallons or more of petroleum and/or vessels involved in the transport of petroleum on the waters of New York State.

Margin of Safety (MOS): A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving waterbody (CWA section 303(d)(1)(C)). The MOS is normally incorporated into the conservative assumptions used to develop TMDLs (generally within the calculations or models) and approved by EPA either individually or in state/EPA agreements. If the MOS needs to be larger than that which is allowed through the conservative assumptions, additional MOS can be added as a separate component of the TMDL (in this case, quantitatively, a TMDL = LC = WLA + LA + MOS).

Marine Protection, Research and Sanctuaries Act of 1972, The Ocean Dumping Act: Legislation regulating the dumping of any material in the ocean that may adversely affect human health, marine environments or the economic potential of the ocean.

Mass Balance: A mathematical accounting of substances entering and leaving a system, such as a waterbody, from all sources. A mass balance model for a waterbody is useful to help understand the relationship between the loadings of a pollutant and the levels in the water, biota and sediments, as well as the amounts that can be safely assimilated by the waterbody.

Mass Loading: The quantity of a pollutant transported to a waterbody.

Mathematical Model: A system of mathematical expressions that describe the spatial and temporal distribution of water quality constituents resulting from fluid transport and the one, or more, individual processes and interactions within some prototype aquatic ecosystem. A mathematical water quality model is used as the basis for wasteload allocation evaluations.

Mean Low Water (MLW): A tidal level. The average of all low waters observed over a sufficiently long period.

Median Household Income (MHI): The median household income is one measure of average household income. It divides the household income distribution into two equal parts: one-half of the cases fall below the median household income, and one-half above it.

Meiofauna: Small interstitial; i.e., occurring between sediment particles, animals that pass through a 1-mm mesh sieve but are retained by a 0.1-mm mesh.

Memorandum of Understanding (MOU): An agreement between two or more public agencies defining the roles and responsibilities of each agency in relation to the other or others with respect to an issue over which the agencies have concurrent jurisdiction.

Meningitis: Inflammation of the meninges, especially as a result of infection by bacteria or viruses.

Meroplankton: Organisms that are planktonic only during the larval stage of their life history.

Mesohaline: The estuarine salinity zone with a salinity range of 5-18-ppt.

Metric: A calculated term or enumeration which represents some aspect of biological assemblage structure, function, or other measurable characteristic of the biota that changes in some predictable way in response to impacts to the waterbody.

mf/L: Million fibers per liter – A measure of concentration.

MG: Million Gallons – A measure of volume.

mg/L: Milligrams Per Liter – A measure of concentration.

MGD: Million Gallons Per Day – A measure of the rate of water flow.

MHI: Median Household Income

Microgram per liter (ug/L): A measure of concentration

Microorganisms: Organisms too small to be seen with the unaided eye, including bacteria, protozoans, yeasts, viruses and algae.

milligrams per liter (mg/L): This weight per volume designation is used in water and wastewater analysis. 1 mg/l=1 ppm.

milliliters (mL): A unit of length equal to one thousandth (10^{-3}) of a meter, or 0.0394 inch.

Million fibers per liter (mf/L): A measure of concentration.

million gallons (MG): A unit of measure used in water and wastewater to express volume. To visualize this volume, if a good-sized bath holds 50 gallons, so a million gallons would be equal to 20,000 baths.

million gallons per day (MGD): Term used to express water-use data. Denotes the volume of water utilized in a single day.

Mitigation: Actions taken to avoid, reduce, or compensate for the effects of environmental damage. Among the broad spectrum of possible actions are those which restore, enhance, create, or replace damaged ecosystems.

Mixing Zone: A portion of a waterbody where water quality criteria or rules are waived in order to allow for dilution of pollution. Mixing zones have been allowed by states in many NPDES permits when discharges were expected to have difficulty providing enough treatment to avoid violating standards for the receiving water at the point of discharge.

mL: milliliters

MLW: mean low water

Modeling: An investigative technique using a mathematical or physical representation of a system or theory, usually on a computer, that accounts for all or some of its known properties. Models are often used to test the effect of changes of system components on the overall performance of the system.

Monitoring: Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.

Monte Carlo Simulation: A stochastic modeling technique that involves the random selection of sets of input data for use in repetitive model runs. Probability distributions of receiving water quality concentrations are generated as the output of a Monte Carlo simulation.

MOS: Margin of Safety

MOSF: major oil storage facilities

MOU: Memorandum of Understanding

MOUSE: Computer model developed by the Danish Hydraulic Institute used to model the combined sewer system.

MS4: municipal separate storm sewer systems

Multimetric Approach: An analysis technique that uses a combination of several measurable characteristics of the biological assemblage to provide an assessment of the status of water resources.

Multivariate Community Analysis: Statistical methods (e.g., ordination or discriminant analysis) for analyzing physical and biological community data using multiple variables.

Municipal Separate Sewer Systems (MS4): A conveyance or system of conveyances (roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, storm drains) that is 1) Owned or operated by a state, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of sewage, industrial wastes, stormwater, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage districts, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the Clean Water Act that discharges to waters of the United States; 2) Designed or used for collecting or conveying stormwater; 3) Which is not a combined sewer; and 4) Which is not part of a publicly owned treatment works.

Municipal Sewage: Wastes (mostly liquid) originating from a community; may be composed of domestic wastewater and/or industrial discharges.

National Estuary Program: A program established under the Clean Water Act Amendments of 1987 to develop and implement conservation and management plans for protecting estuaries and restoring and maintaining their chemical, physical, and biological integrity, as well as controlling point and non-point pollution sources.

National Marine Fisheries Service (NMFS): A federal agency - with scientists, research vessels, and a data collection system - responsible for managing the nation's saltwater fish. It oversees the actions of the Councils under the Fishery Conservation and Management Act.

National Pollutant Discharge Elimination System (NPDES): The national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under Sections 307, 402, 318, and 405 of the Clean Water Act. The program imposes discharge limitations on point sources by basing them on the effluent limitation capabilities of a control technology or on local water quality standards. It prohibits discharge of pollutants into water of the United States unless a special permit is issued by EPA, a state, or, where delegated, a tribal government on an Indian reservation.

National Priorities List (NPL): EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under Superfund. The list is based primarily on the score a site receives from the Hazard Ranking System. EPA is required to update the NPL at least once a year. A site must be on the NPL to receive money from the Trust Fund for remedial action.

National Wetland Inventory (NWI): The National Wetlands Inventory (NWI) of the U.S. Fish & Wildlife Service produces information on the characteristics, extent, and status of the Nation's wetlands and deepwater habitats. The National Wetlands Inventory information is used by Federal, State, and local agencies, academic institutions, U.S. Congress, and the private sector. Congressional mandates in the Emergency Wetlands Resources Act requires the Service to map wetlands, and to digitize, archive and distribute the maps.

Natural Background Levels: Natural background levels represent the chemical, physical, and biological conditions that would result from natural geomorphological processes such as weathering or dissolution.

Natural Waters: Flowing water within a physical system that has developed without human intervention, in which natural processes continue to take place.

Navigable Waters: Traditionally, waters sufficiently deep and wide for navigation; such waters in the United States come under federal jurisdiction and are protected by the Clean Water Act.

New York City Department of City Planning (NYCDCP): New York City agency responsible for the city's physical and socioeconomic planning, including land use and environmental review; preparation of plans and policies; and provision of technical assistance and planning information to government agencies, public officials, and community boards.

New York City Department of Environmental Protection (NYCDEP): New York City agency responsible for addressing the environmental needs of the City's residents in areas including water, wastewater, air, noise and hazmat.

New York City Department of Parks and Recreation (NYCDPR): The New York City Department of Parks and Recreation is the branch of government of the City of New York responsible for maintaining the city's parks system, preserving and maintaining the ecological diversity of the city's natural areas, and furnishing recreational opportunities for city's residents.

New York City Department of Transportation (NYCDOT): New York City agency responsible for maintaining and improving New York City's transportation network.

New York City Economic Development Corporation (NYCEDC): City's primary vehicle for promoting economic growth in each of the five boroughs. NYCEDC works to stimulate investment in New York and broaden the City's tax and employment base, while meeting the needs of businesses large and small. To realize these objectives, NYCEDC uses its real estate and financing tools to help companies that are expanding or relocating anywhere within the city.

New York District (NYD): The local division of the United States Army Corps of Engineers,

New York State Code of Rules and Regulations (NYCRR): Official statement of the policy(ies) that implement or apply the Laws of New York.

New York State Department of Environmental Conservation (NYSDEC): New York State aagency that conserves, improves, and protects New York State's natural resources and environment, and controls water, land and air pollution, in order to enhance the health, safety and welfare of the people of the state and their overall economic and social well being.

New York State Department of State (NYSDOS): Known as the "keeper of records" for the State of New York. Composed of two main divisions including the Office of Business and Licensing Services and the Office of Local Government Services. The latter office includes the Division of Coastal Resources and Waterfront Revitalization.

NH_3: Ammonia

Nine Minimum Controls (NMC): Controls recommended by the USEPA to minimize CSO impacts. The controls include: (1) proper operation and maintenance for sewer systems and CSOs; (2) maximum use of the collection system for storage; (3) review pretreatment requirements to minimize CSO impacts; (4) maximize flow to treatment facility; (5) prohibit combines sewer discharge during dry weather; (6) control solid and floatable materials in CSOs; (7) pollution prevention; (8) public notification of CSO occurrences and impacts; and, (9) monitor CSOs to characterize impacts and efficacy of CSO controls.

NMC: nine minimum controls

NMFS: National Marine Fisheries Service

No./mL (or #/mL): number of bacteria organisms per milliliter – measure of concentration

Non-Compliance: Not obeying all promulgated regulations, policies or standards that apply.

Non-Permeable Surfaces: Surfaces which will not allow water to penetrate, such as sidewalks and parking lots.

Non-Point Source (NPS): Pollution that is not released through pipes but rather originates from multiple sources over a relatively large area (i.e., without a single point of origin or not introduced into a receiving stream from a specific outlet). The pollutants are generally carried off the land by storm water. Non-point sources can be divided into source activities related to either land or water use including failing septic tanks, improper animal-keeping practices, forest practices, and urban and rural runoff. Common non-point sources are agriculture, forestry, urban, mining, construction, dams, channels, land disposal, saltwater intrusion, and city streets.

NPDES: National Pollution Discharge Elimination System

NPL: National Priorities List

NPS: Non-Point Source

Numeric Targets: A measurable value determined for the pollutant of concern which is expected to result in the attainment of water quality standards in the listed waterbody.

Nutrient Pollution: Contamination of water resources by excessive inputs of nutrients. In surface waters, excess algal production as a result of nutrient pollution is a major concern.

Nutrient: Any substance assimilated by living things that promotes growth. The term is generally applied to nitrogen and phosphorus in wastewater, but is also applied to other essential and trace elements.

NWI: National Wetland Inventory

NYCDCP: New York City Department of City Planning

NYCDEP: New York City Department of Environmental Protection

NYCDOT: New York City Department of Transportation

NYCDPR: New York City Department of Parks and Recreation

NYCEDC: New York City Economic Development Corporation

NYCRR: New York State Code of Rules and Regulations

NYD: New York District

NYSDEC: New York State Department of Environmental Conservation

NYSDOS: New York State Department of State

O&M: Operation and Maintenance

Oligohaline: The estuarine salinity zone with a salinity range of 0.5-5-ppt.

ONRW: Outstanding National Resource Waters

Operation and Maintenance (O&M): Actions taken after construction to ensure that facilities constructed will be properly operated and maintained to achieve normative efficiency levels and prescribed effluent eliminations in an optimum manner.

Optimal: Most favorable point, degree, or amount of something for obtaining a given result; in ecology most natural or minimally disturbed sites.

Organic Chemicals/Compounds: Naturally occurring (animal or plant-produced or synthetic) substances containing mainly carbon, hydrogen, nitrogen, and oxygen.

Organic Material: Material derived from organic, or living, things; also, relating to or containing carbon compounds.

Organic Matter: Carbonaceous waste (organic fraction) that includes plant and animal residue at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population originating from domestic or industrial sources. It is commonly determined as the amount of organic material contained in a soil or water sample.

Organic: (1) Referring to other derived from living organisms. (2) In chemistry, any compound containing carbon.

Ortho P: Ortho Phosphorus

Ortho Phosphorus: Soluble reactive phosphorous readily available for uptake by plants. The amount found in a waterbody is an indicator of how much phosphorous is available for algae and plant growth. Since aquatic plant growth is typically limited by phosphorous, added phosphorous especially in the dissolved, bioavailable form can fuel plant growth and cause algae blooms.

Outfall: Point where water flows from a conduit, stream, or drain into a receiving water.

Outstanding National Resource Waters (ONRW): Outstanding national resource waters (ONRW) designations offer special protection (i.e., no degradation) for designated waters, including wetlands. These are areas of exceptional water quality or recreational/ecological significance. State antidegradation policies should provide special protection to wetlands designated as outstanding national resource waters in the same manner as other surface waters; see Section 131.12(a)(3) of the WQS regulation and EPA guidance (Water Quality Standards Handbook (USEPA 1983b), and Questions and Answers on: Antidegradation (USEPA 1985a)).

Overflow Rate: A measurement used in wastewater treatment calculations for determining solids settling. It is also used for CSO storage facility calculations and is defined as the flow through a storage basin divided by the surface area of the basin. It can be thought of as an average flow rate through the basin. Generally expressed as gallons per day per square foot (gpd/sq.ft.).

Oxidation Pond: A relatively shallow body of wastewater contained in an earthen basin; lagoon; stabilization pond.

Oxidation: The chemical union of oxygen with metals or organic compounds accompanied by a removal of hydrogen or another atom. It is an important factor for soil formation and permits the release of energy from cellular fuels.

Oxygen Demand: Measure of the dissolved oxygen used by a system (microorganisms) in the oxidation of organic matter. (See also biochemical oxygen demand)

Oxygen Depletion: The reduction of dissolved oxygen in a waterbody.

PAH: Polycyclic Aromatic Hydrocarbons

Partition Coefficients: Chemicals in solution are partitioned into dissolved and particulate adsorbed phase based on their corresponding sediment-to-water partitioning coefficient.

Parts per Million (ppm): The number of "parts" by weight of a substance per million parts of water. This unit is commonly used to represent pollutant concentrations. Large concentrations are expressed in percentages.

Pathogen: Disease-causing agent, especially microorganisms such as bacteria, protozoa, and viruses.

PCBs: Polychlorinated biphenyls

PCS: Permit Compliance System

PE: Primary Effluent

Peak Flow: The maximum flow that occurs over a specific length of time (e.g., daily, hourly, instantaneous).

Pelagic Zone: The area of open water beyond the littoral zone.

Pelagic: Pertaining to open waters or the organisms which inhabit those waters.

Percent Fines: In analysis of sediment grain size, the percent of fine (.062-mm) grained fraction of sediment in a sample.

Permit Compliance System (PCS): Computerized management information system which contains data on NPDES permit-holding facilities. PCS keeps extensive records on more than 65,000 active water-discharge permits on sites located throughout the nation. PCS tracks permit, compliance, and enforcement status of NPDES facilities.

Permit: An authorization, license, or equivalent control document issued by EPA or an approved federal, state, or local agency to implement the requirements of an environmental regulation; e.g., a permit to operate a wastewater treatment plant or to operate a facility that may generate harmful emissions.

Petit Ponar Grab Sampler: Dredge designed to take samples from all types of benthos sediments on all varieties of waterbody bottoms, except those of the hardest clay. When the jaws contact the bottom they obtain a good penetration with very little sample disturbance. Can be used in both fresh and salt water.

pH: An expression of the intensity of the basic or acid condition of a liquid. The pH may range from 0 to 14, where 0 is most acid, 14 most basic and 7 neutral. Natural waters usually have a pH between 6.5 and 8.5.

Phased Approach: Under the phased approach to TMDL development, load allocations (LAs) and wasteload allocations (WLAs) are calculated using the best available data and information recognizing the need for additional monitoring data to accurately characterize sources and loadings. The phased approach is typically employed when non-point sources dominate. It provides for the implementation of load reduction strategies while collecting additional data.

Photic Zone: The region in a waterbody extending from the surface to the depth of light penetration.

Photosynthesis: The process by which chlorophyll-containing plants make carbohydrates from water, and from carbon dioxide in the air, using energy derived from sunlight.

Phytoplankton: Free-floating or drifting microscopic algae with movements determined by the motion of the water.

Point Source: (1) A stationary location or fixed facility from which pollutant loads are discharged. (2) Any single identifiable source of pollutants including pipes, outfalls, and conveyance channels from either municipal wastewater treatment systems or industrial waste treatment facilities. (3) Point sources can also include pollutant loads contributed by tributaries to the main receiving water stream or river.

Pollutant: Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water. (CWA Section 502(6)).

Pollution: Generally, the presence of matter or energy whose nature, location, or quantity produces undesired environmental effects. Under the Clean Water Act, for example, the term is defined as the man-made or man-induced alteration of the physical, biological, chemical, and radiological integrity of water.

Polychaete: Marine worms of the class Polychaeta of the invertebrate worm order Annelida. Polychaete species dominate the marine benthos, with dozens of species present in natural marine environments. These worms are highly diversified, ranging from detritivores to predators, with some species serving as good indicators of environmental stress.

Polychlorinated Biphenyls (PCBs): A group of synthetic polychlorinated aromatic hydrocarbons formerly used for such purposes as insulation in transformers and capacitors and lubrication in gas pipeline systems. Production, sale and new use was banned by law in 1977 following passage of the Toxic Substances Control Act. PCBs have a strong tendency to bioaccumulate. They are quite stable, and therefore persist in the environment for long periods of time. They are classified by EPA as probable human carcinogens.

Polycyclic Aromatic Hydrocarbons (PAHs): A group of petroleum-derived hydrocarbon compounds, present in petroleum and related materials, and used in the manufacture of materials such as dyes, insecticides and solvents.

Population: An aggregate of interbreeding individuals of a biological species within a specified location.

POTW: Publicly Owned Treatment Plant

pounds per day per cubic foot: lb/day/cf

pounds per day: lbs/day; unit of measure

ppm: parts per million

Precipitation Event: An occurrence of rain, snow, sleet, hail, or other form of precipitation that is generally characterized by parameters of duration and intensity (inches or millimeters per unit of time).

Pretreatment: The treatment of wastewater from non-domestic sources using processes that reduce, eliminate, or alter contaminants in the wastewater before they are discharged into Publicly Owned Treatment Works (POTWs).

Primary Effluent (PE): Partially treated water (screened and undergoing settling) passing from the primary treatment processes a wastewater treatment plant.

Primary Treatment: A basic wastewater treatment method, typically the first step in treatment, that uses skimming, settling in tanks to remove most materials that float or will settle. Usually chlorination follows to remove pathogens from wastewater. Primary treatment typically removes about 35 percent of biochemical oxygen demand (BOD) and less than half of the metals and toxic organic substances.

Priority Pollutants: A list of 129 toxic pollutants including metals developed by the USEPA as a basis for defining toxics and is commonly referred to as “priority pollutants”.

Probable Total Project Cost (PTPC): Represents the realistic total of all hard costs, soft costs, and ancillary costs associated with a particular CSO abatement technology per the definitions provided in memorandum entitled “Comparative Cost Analysis for CSO Abatement Technologies – Costing Factors” (O’Brien & Gere, April 2006). All PTPCs shown in this report are adjusted to July 25 dollars (ENR CCI = 11667.99).

Protozoa: Single-celled organisms that reproduce by fission and occur primarily in the aquatic environment. Waterborne pathogenic protozoans of primary concern include Giardia lamblia and Cryptosporidium, both of which affect the gastrointestinal tract.

PS: Pump Station or Pumping Station

Pseudoreplication: The repeated measurement of a single experimental unit or sampling unit, with the treatment of the measurements as if they were independent replicates of the sampling unit.

PTPC: Probable Total Project Cost – represents the realistic total of all hard costs, soft costs, and ancillary costs associated with a particular CSO abatement technology per the definitions provided in O'Brien & Gere, April 2006. All PTPCs shown in this report are adjusted to July 2005 dollars (ENR CCI = 11667.99).

Public Comment Period: The time allowed for the public to express its views and concerns regarding action by USEPA or states (e.g., a Federal Register notice of a proposed rule-making, a public notice of a draft permit, or a Notice of Intent to Deny).

Publicly Owned Treatment Works (POTW): Any device or system used in the treatment (including recycling and reclamation) of municipal sewage or industrial wastes of a liquid nature that is owned by a state or municipality. This definition includes sewers, pipes, or other conveyances only if they convey wastewater to a POTW providing treatment.

Pump Station or Pumping Station: Sewer pipes are generally gravity driven. Wastewater flows slowly downhill until it reaches a certain low point. Then pump, or "lift," stations push the wastewater back uphill to a high point where gravity can once again take over the process.

Pycnocline: A zone of marked density gradient.

Q: Symbol for Flow (designation when used in equations)

R.L: Reporting Limit

Rainfall Duration: The length of time of a rainfall event.

Rainfall Intensity: The amount of rainfall occurring in a unit of time, usually expressed in inches per hour.

Raw Sewage: Untreated municipal sewage (wastewater) and its contents.

RCRAInfo: Resource Conservation and Recovery Act Information

Real-Time Control (RTC): A system of data gathering instrumentation used in conjunction with control components such as dams, gates and pumps to maximize storage in the existing sewer system.

Receiving Waters: Creeks, streams, rivers, lakes, estuaries, groundwater formations, or other bodies of water into which surface water and/or treated or untreated waste are discharged, either naturally or in man-made systems.

Red Tide: A reddish discoloration of coastal surface waters due to concentrations of certain toxin producing algae.

Reference Condition: The chemical, physical or biological quality or condition exhibited at either a single site or an aggregation of sites that represents the least impaired condition of a classification of waters to which the reference condition applies.

Reference Sites: Minimally impaired locations in similar waterbodies and habitat types at which data are collected for comparison with test sites. A separate set of reference sites are defined for each estuarine or coastal marine class.

Regional Environmental Monitoring and Assessment Program (REMAP): The Environmental Monitoring and Assessment Program (EMAP) is a research program to develop the tools necessary to monitor and assess the status and trends of national ecological resources. EMAP's goal is to develop the scientific understanding for translating environmental monitoring data from multiple spatial and temporal scales into assessments of current ecological condition and forecasts of future risks to our natural resources.

Regulator: A device in combined sewer systems for diverting wet weather flows which exceed downstream capacity to an overflow.

REMAP: Regional Environmental Monitoring and Assessment Program

Replicate: Taking more than one sample or performing more than one analysis.

Reporting Limit (RL): The lowest concentration at which a contaminant is reported.

Residence Time: Length of time that a pollutant remains within a section of a waterbody. The residence time is determined by the streamflow and the volume of the river reach or the average stream velocity and the length of the river reach.

Resource Conservation and Recovery Act Information (RCRAinfo): Database with information on existing hazardous materials sites. USEPA was authorized to develop a hazardous waste management system, including plans for the handling and storage of wastes and the licensing of treatment and disposal facilities. The states were required to implement the plans under authorized grants from the USEPA. The act generally encouraged "cradle to grave" management of certain products and emphasized the need for recycling and conservation.

Respiration: Biochemical process by means of which cellular fuels are oxidized with the aid of oxygen to permit the release of the energy required to sustain life; during respiration, oxygen is consumed and carbon dioxide is released.

Restoration: Return of an ecosystem to a close approximation of its condition prior to disturbance. Re-establishing the original character of an area such as a wetland or forest.

Riparian Zone: The border or banks of a stream. Although this term is sometimes used interchangeably with floodplain, the riparian zone is generally regarded as relatively narrow compared to a floodplain. The duration of flooding is generally much shorter, and the timing less predictable, in a riparian zone than in a river floodplain.

Ribonucleic acid (RNA): RNA is the generic term for polynucleotides, similar to DNA but containing ribose in place of deoxyribose and uracil in place of thymine. These molecules are involved in the transfer of information from DNA, programming protein synthesis and maintaining ribosome structure.

Riparian Habitat: Areas adjacent to rivers and streams with a differing density, diversity, and productivity of plant and animal species relative to nearby uplands.

Riparian: Relating to or living or located on the bank of a natural watercourse (as a river) or sometimes of a lake or a tidewater.

RNA: ribonucleic acid

RTC: Real-Time Control

Runoff: That part of precipitation, snow melt, or irrigation water that runs off the land into streams or other surface water. It can carry pollutants from the air and land into receiving waters.

Safe Drinking Water Act: The Safe Drinking Water Act authorizes EPA to set national health-based standards for drinking water to protect against both naturally occurring and man-made contaminants that may be found in drinking water. USEPA, states, and water systems then work together to make sure these standards are met.

Sanitary Sewer Overflow (SSO): When wastewater treatment systems overflow due to unforeseen pipe blockages or breaks, unforeseen structural, mechanical, or electrical failures, unusually wet weather conditions, insufficient system capacity, or a deteriorating system.

Sanitary Sewer: Underground pipes that transport only wastewaters from domestic residences and/or industries to a wastewater treatment plant. No stormwater is carried.

Saprobien System: An ecological classification of a polluted aquatic system that is undergoing self-purification. Classification is based on relative levels of pollution, oxygen concentration and types of indicator microorganisms; i.e., saprophagic microorganisms – feeding on dead or decaying organic matter.

SCADA: Supervisory Control and Data Acquisition

scfm: standard cubic feet per minute

Scoping Modeling: Involves simple, steady-state analytical solutions for a rough analysis of the problem.

Scour: To abrade and wear away. Used to describe the weathering away of a terrace or diversion channel or streambed. The clearing and digging action of flowing water, especially the downward erosion by stream water in sweeping away mud and silt on the outside of a meander or during flood events.

Secchi Disk: Measures the transparency of water. Transparency can be affected by the color of the water, algae and suspended sediments. Transparency decreases as color, suspended sediments or algal abundance increases.

Secondary Treatment: The second step in most publicly owned waste treatment systems in which bacteria consume the organic parts of the waste. It is accomplished by bringing together waste, bacteria, and oxygen in trickling filters or in the activated sludge process. This treatment removes floating and settleable solids and about 90 percent of the oxygen-demanding substances and suspended solids. Disinfection is the final stage of secondary treatment. (See primary, tertiary treatment.)

Sediment Oxygen Demand (SOD): A measure of the amount of oxygen consumed in the biological process that breaks down organic matter in the sediment.

Sediment: Insoluble organic or inorganic material often suspended in liquid that consists mainly of particles derived from rocks, soils, and organic materials that eventually settles to the bottom of a waterbody; a major non-point source pollutant to which other pollutants may attach.

Sedimentation: Deposition or settling of suspended solids settle out of water, wastewater or other liquids by gravity during treatment.

Sediments: Soil, sand, and minerals washed from land into water, usually after rain. They pile up in reservoirs, rivers and harbors, destroying fish and wildlife habitat, and clouding the water so that sunlight cannot reach aquatic plants. Careless farming, mining, and building activities will expose sediment materials, allowing them to wash off the land after rainfall.

Seiche: A wave that oscillates (for a period of a few minutes to hours) in lakes, bays, lagoons or gulfs as a result of seismic or atmospheric disturbances (e.g., "wind tides").

Sensitive Areas: Areas of particular environmental significance or sensitivity that could be adversely affected by discharges, including Outstanding National Resource Waters, National Marine Sanctuaries, waters with threatened or endangered species, waters with primary contact recreation, public drinking water intakes, shellfish beds, and other areas identified by State or Federal agencies.

Separate Sewer System: Sewer systems that receive domestic wastewater, commercial and industrial wastewaters, and other sources but do not have connections to surface runoff and are not directly influenced by rainfall events.

Separate Storm Water System (SSWS): A system of catch basin, pipes, and other components that carry only surface run off to receiving waters.

Septic System: An on-site system designed to treat and dispose of domestic sewage. A typical septic system consists of a tank that receives waste from a residence or business and a system of tile lines or a pit for disposal of the liquid effluent (sludge) that remains after decomposition of the solids by bacteria in the tank; must be pumped out periodically.

SEQRA: State Environmental Quality Review Act

Settleable Solids: Material heavy enough to sink to the bottom of a wastewater treatment tank.

Settling Tank: A vessel in which solids settle out of water by gravity during drinking and wastewater treatment processes.

Sewage: The waste and wastewater produced by residential and commercial sources and discharged into sewers.

Sewer Sludge: Sludge produced at a Publicly Owned Treatment Works (POTW), the disposal of which is regulated under the Clean Water Act.

Sewer: A channel or conduit that carries wastewater and storm-water runoff from the source to a treatment plant or receiving stream. "Sanitary" sewers carry household, industrial, and commercial waste. "Storm" sewers carry runoff from rain or snow. "Combined" sewers handle both.

Sewerage: The entire system of sewage collection, treatment, and disposal.

Sewershed: A defined area that is tributary to a single point along an interceptor pipe (a community connection to an interceptor) or is tributary to a single lift station. Community boundaries are also used to define sewer-shed boundaries.

SF: Square foot, unit of area.

Significant Industrial User (SIU): A Significant Industrial User is defined by the USEPA as an industrial user that discharges process wastewater into a publicly owned treatment works and meets at least one of the following: (1) All industrial users subject to *Categorical Pretreatment Standards* under the Code of Federal Regulations - Title 40 (40 CFR) Part 403.6, and CFR Title 40 Chapter I, Subchapter N-Effluent Guidelines and Standards; and (2) Any other industrial user that discharges an average of 25,000 gallons per day or more of process wastewater to the treatment plant (excluding sanitary, non-contact cooling and boiler blowdown wastewater); or contributes a process waste stream which makes up 5 percent or more of any design capacity of the treatment plant; or is designated as such by the municipal Industrial Waste Section on the basis that the industrial user has a reasonable potential for adversely affecting the treatment plants operation or for violating any pretreatment standard or requirement.

Siltation: The deposition of finely divided soil and rock particles upon the bottom of stream and river beds and reservoirs.

Simulation Models: Mathematical models (logical constructs following from first principles and assumptions), statistical models (built from observed relationships between variables), or a combination of the two.

Simulation: Refers to the use of mathematical models to approximate the observed behavior of a natural water system in response to a specific known set of input and forcing conditions. Models that have been validated, or verified, are then used to predict the response of a natural water system to changes in the input or forcing conditions.

Single Sample Maximum (SSM): A maximum allowable enterococci or E. Coli density for a single sample.

Site Spill Identifier List (SPIL): Federal database with information on existing Superfund Sites.

SIU: Significant Industrial User

Skewness: The degree of statistical asymmetry (or departure from symmetry) of a population. Positive or negative skewness indicates the presence of a long, thin tail on the right or left of a distribution respectively.

Slope: The degree of inclination to the horizontal. Usually expressed as a ratio, such as 1:25 or 1 on 25, indicating one unit vertical rise in 25 units of horizontal distance, or in a decimal fraction (0.04); degrees (2 degrees 18 minutes), or percent (4 percent).

Sludge: Organic and Inorganic solid matter that settles to the bottom of septic or wastewater treatment plant sedimentation tanks, must be disposed of by bacterial digestion or other methods or pumped out for land disposal, incineration or recycled for fertilizer application.

SNWA: Special Natural Waterfront Area

SOD: Sediment Oxygen Demand

SOP: Standard Operating Procedure

Sorption: The adherence of ions or molecules in a gas or liquid to the surface of a solid particle with which they are in contact.

SPDES: State Pollutant Discharge Elimination System

Special Natural Waterfront Area (SNWA): A large area with concentrations of important coastal ecosystem features such as wetlands, habitats and buffer areas, many of which are regulated under other programs.

SPIL: Site Spill Identifier List

SRF: State Revolving Fund

SSM: single sample maximum

SSO: Sanitary Sewer Overflow

SSWS: Separate Storm Water System

Stakeholder: One who is interested in or impacted by a project.

Standard Cubic Feet per Minute (SCFM): A standard measurement of airflow that indicates how many cubic feet of air pass by a stationary point in one minute. The higher the number, the more air is being forced through the system. The volumetric flow rate of a liquid or gas in cubic feet per minute. 1 CFM equals approximately 2 liters per second.

State Environmental Quality Review Act (SEQRA): New York State program requiring all local government agencies to consider environmental impacts equally with social and economic factors during discretionary decision-making. This means these agencies must assess the environmental significance of all actions they have discretion to approve, fund or directly undertake. SEQR requires the agencies to balance the environmental impacts with social and economic factors when deciding to approve or undertake an action.

Standard Operating Procedure (SOP): Document describing a procedure or set of procedures to perform a given operation or evolutions or in reaction to a given event.

State Pollutant Discharge Elimination System (SPDES): New York State has a state program which has been approved by the United States Environmental Protection Agency for the control of wastewater and stormwater discharges in accordance with the Clean Water Act. Under New York State law the program is known as the State Pollutant Discharge Elimination System (SPDES) and is broader in scope than that required by the Clean Water Act in that it controls point source discharges to groundwaters as well as surface waters.

State Revolving Fund (SRF): Revolving funds are financial institutions that make loans for specific water pollution control purposes and use loan repayment, including interest, to make new loans for additional water pollution control activities. The SRF program is based on the 1987 Amendments to the Clean Water Act, which established the SRF program as the CWA's original Construction Grants Program was phased out.

Steady-State Model: Mathematical model of fate and transport that uses constant values of input variables to predict constant values of receiving water quality concentrations.

Storage: Treatment holding of waste pending treatment or disposal, as in containers, tanks, waste piles, and surface impoundments.

STORET: U.S. Environmental Protection Agency (EPA) national water quality database for STORage and RETrieval (STORET). Mainframe water quality database that includes physical, chemical, and biological data measured in waterbodies throughout the United States.

Storm Runoff: Stormwater runoff, snowmelt runoff, and surface runoff and drainage; rainfall that does not evaporate or infiltrate the ground because of impervious land surfaces or a soil infiltration rate lower than rainfall intensity, but instead flows onto adjacent land or waterbodies or is routed into a drain or sewer system.

Storm Sewer: A system of pipes (separate from sanitary sewers) that carries waste runoff from buildings and land surfaces.

Storm Sewer: Pipes (separate from sanitary sewers) that carry water runoff from buildings and land surfaces.

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, channels or pipes into a defined surface water channel, or a constructed infiltration facility.

Stormwater Management Models (SWMM): USEPA mathematical model that simulates the hydraulic operation of the combined sewer system and storm drainage sewershed.

Stormwater Protection Plan (SWPP): A plan to describe a process whereby a facility thoroughly evaluates potential pollutant sources at a site and selects and implements appropriate measures designed to prevent or control the discharge of pollutants in stormwater runoff.

Stratification (of waterbody): Formation of water layers each with specific physical, chemical, and biological characteristics. As the density of water decreases due to surface heating, a stable situation develops with lighter water overlaying heavier and denser water.

Stressor: Any physical, chemical, or biological entity that can induce an adverse response.

Subaqueous Burrow Pit: An underwater depression left after the mining of large volumes of sand and gravel for projects ranging from landfilling and highway construction to beach nourishment.

Substrate: The substance acted upon by an enzyme or a fermenter, such as yeast, mold or bacteria.

Subtidal: The portion of a tidal-flat environment that lies below the level of mean low water for spring tides. Normally it is covered by water at all stages of the tide.

Supervisory Control and Data Acquisition (SCADA): System for controlling and collecting and recording data on certain elements of WASA combined sewer system.

Surcharge Flow: Flow in which the water level is above the crown of the pipe causing pressurized flow in pipe segments.

Surface Runoff: Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of non-point source pollutants in rivers, streams, and lakes.

Surface Water: All water naturally open to the atmosphere (rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other groundwater collectors directly influenced by surface water.

Surficial Geology: Geology relating to surface layers, such as soil, exposed bedrock, or glacial deposits.

Suspended Loads: Specific sediment particles maintained in the water column by turbulence and carried with the flow of water.

Suspended Solids or Load: Organic and inorganic particles (sediment) suspended in and carried by a fluid (water). The suspension is governed by the upward components of turbulence, currents, or colloidal suspension. Suspended sediment usually consists of particles <0.1 mm, although size may vary according to current hydrological conditions. Particles between 0.1 mm and 1 mm may move as suspended or bedload. It is a standard measure of the concentration of particulate matter in wastewater, expressed in mg/L. Technology-Based Standards. Minimum pollutant control standards for numerous categories of industrial discharges, sewage discharges and for a growing number of other types of discharges. In each industrial category, they represent levels of technology and pollution control performance that the EPA expects all discharges in that category to employ.

SWEM: System-wide Eutrophication Model

SWMM: Stormwater Management Model

SWPP: Stormwater Protection Plan

System-wide Eutrophication Model (SWEM): Comprehensive hydrodynamic model developed for the New York/New Jersey Harbor System.

Taxa:

TC: Total coliform

TDS: Total Dissolved Solids

Technical and Operational Guidance Series (TOGS): Memorandums that provide information on determining compliance with a standard.

Tertiary Treatment: Advanced cleaning of wastewater that goes beyond the secondary or biological stage, removing nutrients such as phosphorus, nitrogen, and most biochemical oxygen demand (BOD) and suspended solids.

Test Sites: Those sites being tested for biological impairment.

Threatened Waters: Water whose quality supports beneficial uses now but may not in the future unless action is taken.

Three-Dimensional Model (3-D): Mathematical model defined along three spatial coordinates where the water quality constituents are considered to vary over all three spatial coordinates of length, width, and depth.

TKN: Total Kjeldahl Nitrogen

TMDL: Total Maximum Daily Loads

TOC: Total Organic Carbon

TOGS: Technical and Operational Guidance Series

Topography: The physical features of a surface area including relative elevations and the position of natural and man-made features.

Total Coliform Bacteria: A particular group of bacteria, found in the feces of warm-blooded animals, that are used as indicators of possible sewage pollution. They are characterized as aerobic or facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria which ferment lactose with gas formation within 48 hours at 35°. Note that many common soil bacteria are also total coliforms, but do not indicate fecal contamination. (See also fecal coliform bacteria)

Total Coliform (TC): The coliform bacteria group consists of several genera of bacteria belonging to the family *enterobacteriaceae*. These mostly harmless bacteria live in soil, water, and the digestive system of animals. Fecal coliform bacteria, which belong to this group, are present in large numbers in the feces and intestinal tracts of humans and other warm-blooded animals, and can enter water bodies from human and animal waste. If a large number of fecal coliform bacteria (over 200 colonies/100 milliliters (ml) of water sample) are found in water, it is possible that pathogenic (disease- or illness-causing) organisms are also present in the water. Swimming in waters with high levels of fecal coliform bacteria increases the chance of developing illness (fever, nausea or stomach cramps) from pathogens entering the body through the mouth, nose, ears, or cuts in the skin.

Total Dissolved Solids (TDS): Solids that pass through a filter with a pore size of 2.0 micron or smaller. They are said to be non-filterable. After filtration the filtrate (liquid) is dried and the remaining residue is weighed and calculated as mg/L of Total Dissolved Solids.

Total Kjeldahl Nitrogen (TKN): The sum of organic nitrogen and ammonia nitrogen.

Total Maximum Daily Load (TMDL): The sum of the individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for non-point sources and natural background, and a margin of safety (MOS). TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standard.

Total Organic Carbon (TOC): A measure of the concentration of organic carbon in water, determined by oxidation of the organic matter into carbon dioxide (CO2). TOC includes all the carbon atoms covalently bonded in organic molecules. Most of the organic carbon in drinking water supplies is dissolved organic carbon, with the remainder referred to as particulate organic carbon. In natural waters, total organic carbon is composed primarily of nonspecific humic materials.

Total P: Total Phosphorus

Total Phosphorus (Total P): A nutrient essential to the growth of organisms, and is commonly the limiting factor in the primary productivity of surface water bodies. Total phosphorus includes the amount of phosphorus in solution (reactive) and in particle form. Agricultural drainage, wastewater, and certain industrial discharges are typical sources of phosphorus, and can contribute to the eutrophication of surface water bodies. Measured in milligrams per liter (mg/L).

Total Suspended Solids (TSS): See Suspended Solids Toxic Substances. Those chemical substances which can potentially cause adverse effects on living organisms. Toxic substances include pesticides, plastics, heavy metals, detergent, solvent, or any other materials that are poisonous, carcinogenic, or otherwise directly harmful to human health and the environment as a result of dose or exposure concentration and exposure time. The toxicity of toxic substances is modified by variables such as temperature, chemical form, and availability.

Total Volatile Suspended Solids (VSS): Volatile solids are those solids lost on ignition (heating to 550 degrees C.) They are useful to the treatment plant operator because they give a rough approximation of the amount of organic matter present in the solid fraction of wastewater, activated sludge and industrial wastes.

Toxic Pollutants: Materials that cause death, disease, or birth defects in organisms that ingests or absorbs them. The quantities and exposures necessary to cause these effects can vary widely.

Toxicity: The degree to which a substance or mixture of substances can harm humans or animals. Acute toxicity involves harmful effects in an organism through a single or short-term exposure. Chronic toxicity is the ability of a substance or mixture of substances to cause harmful effects over an extended period, usually upon repeated or continuous exposure sometimes lasting for the entire life of the exposed organism.

Treated Wastewater: Wastewater that has been subjected to one or more physical, chemical, and biological processes to reduce its potential of being a health hazard.

Treatment Plant: Facility for cleaning and treating freshwater for drinking, or cleaning and treating wastewater before discharging into a water body.

Treatment: (1) Any method, technique, or process designed to remove solids and/or pollutants from solid waste, waste-streams, effluents, and air emissions. (2) Methods used to change the biological character or composition of any regulated medical waste so as to substantially reduce or eliminate its potential for causing disease.

Tributary: A lower order stream compared to a receiving waterbody. "Tributary to" indicates the largest stream into which the reported stream or tributary flows.

Trophic Level: The functional classification of organisms in an ecological community based on feeding relationships. The first trophic level includes green plants; the second trophic level includes herbivores; and so on.

TSS: Total Suspended Solids

Turbidity: The cloudy or muddy appearance of a naturally clear liquid caused by the suspension of particulate matter. It can be measured by the amount of light that is scattered or absorbed by a fluid.

Two-Dimensional Model (2-D): Mathematical model defined along two spatial coordinates where the water quality constituents are considered averaged over the third remaining spatial coordinate. Examples of 2-D models include descriptions of the variability of water quality properties along: (a) the length and width of a river that incorporates vertical averaging or (b) length and depth of a river that incorporates lateral averaging across the width of the waterbody.

U.S. Army Corps of Engineers (USACE): The United States Army Corps of Engineers, or USACE, is made up of some 34,600 civilian and 650 military men and women. The Corps' mission is to provide engineering services to the United States, including: Planning, designing, building and operating dams and other civil engineering projects ; Designing and managing the construction of military facilities for the Army and Air Force; and, Providing design and construction management support for other Defense and federal agencies

United States Environmental Protection Agency (USEPA): The Environmental Protection Agency (EPA or sometimes USEPA) is an agency of the United States federal government charged with protecting human health and with safeguarding the natural environment: air, water, and land. The USEPA began operation on December 2, 1970. It is led by its Administrator, who is appointed by the President of the United States. The USEPA is not a cabinet agency, but the Administrator is normally given cabinet rank.

U.S. Fish and Wildlife Service (USFWS): The United States Fish and Wildlife Service is a unit of the United States Department of the Interior that is dedicated to managing and preserving wildlife. It began as the U.S. Commission on Fish and Fisheries in the United States Department of Commerce and the Division of Economic Ornithology and Mammalogy in the United States Department of Agriculture and took its present form in 1939.

U.S. Geological Survey (USGS): The USGS serves the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

UAA: Use Attainability Analysis

ug/L: Microgram per liter – A measure of concentration

Ultraviolet Light (UV): Similar to light produced by the sun; produced in treatment processes by special lamps. As organisms are exposed to this light, they are damaged or killed.

ULURP: Uniform Land Use Review Procedure

Underground Storage Tanks (UST): Buried storage tank systems that store petroleum or hazardous substances that can harm the environment and human health if the USTs release their stored contents.

Uniform Land Use Review Procedure (ULURP): New York City program wherein a standardized program would be used to publicly review and approve applications affecting the land use of the city would be publicly reviewed. The program also includes mandated time frames within which application review must take place.

Unstratified: Indicates a vertically uniform or well-mixed condition in a waterbody. (See also Stratification)

Urban Runoff: Storm water from city streets and adjacent domestic or commercial properties that carries pollutants of various kinds into the sewer systems and receiving waters.

Urban Runoff: Water containing pollutants like oil and grease from leaking cars and trucks; heavy metals from vehicle exhaust; soaps and grease removers; pesticides from gardens; domestic animal waste; and street debris, which washes into storm drains and enters receiving waters.

USA: Use and Standards Attainability Project

USACE: United States Army Corps of Engineers

Use and Standards Attainability Project (USA): A DEP program that supplements existing Harbor water quality achievements. The program involves the development of a four-year, expanded, comprehensive plan (the Use and Standards Attainment or "USA" Project) that is to be directed towards increasing water quality improvements in 26 specific bodies of water located throughout the entire City. These waterbodies were selected by DEP based on the City's drainage patterns and on New York State Department of Environmental Conservation (NYSDEC) waterbody classification standards.

Use Attainability Analysis (UAA): An evaluation that provides the scientific and economic basis for a determination that the designated use of a water body is not attainable based on one or more factors (physical, chemical, biological, and economic) proscribed in federal regulations.

Use Designations: Predominant uses each State determines appropriate for a particular estuary, region, or area within the class.

USEPA: United States Environmental Protection Agency

USFWS: U.S. Fish and Wildlife Service

USGS: United States Geological Survey

UST: underground storage tanks

UV: ultraviolet light

Validation (of a model): Process of determining how well the mathematical representation of the physical processes of the model code describes the actual system behavior.

Verification (of a model): Testing the accuracy and predictive capabilities of the calibrated model on a data set independent of the data set used for calibration.

Viewsheds: The major segments of the natural terrain which are visible above the natural vegetation from designated scenic viewpoints.

Virus: Submicroscopic pathogen consisting of a nucleic acid core surrounded by a protein coat. Requires a host in which to replicate (reproduce).

VSS: Total Volatile Suspended Solids

Wasteload Allocation (WLA): The portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality-based effluent limitation (40 CFR 130.2(h)).

Wastewater Treatment Plant (WWTP): A facility that receives wastewaters (and sometimes runoff) from domestic and/or industrial sources, and by a combination of physical, chemical, and biological processes reduces (treats) the wastewaters to less harmful byproducts; known by the acronyms, STP (sewage treatment plant), POTW (publicly owned treatment works), WPCP (water pollution control plant) and WWTP.

Wastewater Treatment: Chemical, biological, and mechanical procedures applied to an industrial or municipal discharge or to any other sources of contaminated water in order to remove, reduce, or neutralize contaminants.

Wastewater: The used water and solids from a community (including used water from industrial processes) that flows to a treatment plant. Stormwater, surface water and groundwater infiltration also may be included in the wastewater that enters a wastewater treatment plant. The term sewage usually refers to household wastes, but this word is being replaced by the term wastewater.

Water Pollution Control Plant (WPCP): A facility that receives wastewaters (and sometimes runoff) from domestic and/or industrial sources, and by a combination of physical, chemical, and biological processes reduces (treats) the wastewaters to less harmful byproducts; known by the acronyms, STP (sewage treatment plant), POTW (publicly owned treatment works), WWTP (wastewater treatment) and WPCP.

Water Pollution: The presence in water of enough harmful or objectionable material to damage the water's quality.

Water Quality Criteria: Levels of water quality expected to render a body of water suitable for its designated use. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes.

Water Quality Standard (WQS): State or federal law or regulation consisting of a designated use or uses for the waters of the United States, water quality criteria for such waters based upon such uses, and an antidegradation policy and implementation procedures. Water quality standards protect the public health or welfare, enhance the quality of water and serve the purposes of the Clean Water Act. Water Quality Standards may include numerical or narrative criteria.

Water Quality: The biological, chemical, and physical conditions of a waterbody. It is a measure of a waterbody's ability to support beneficial uses.

Water Quality-Based Limitations: Effluent limitations applied to discharges when mere technology-based limitations would cause violations of water quality standards.

Water Quality-Based Permit: A permit with an effluent limit more stringent than technology based standards. Such limits may be necessary to protect the designated uses of receiving waters (e.g., recreation, aquatic life protection).

Waterbody Inventory/Priority Waterbody List (WI/PWL): The WI/PWL incorporates monitoring data, information from state and local communities and public participation. The Waterbody Inventory portion refers to the listing of all waters, identified as specific individual waterbodies, within the state that are assessed. The Priority Waterbodies List is the subset of waters in the Waterbody Inventory that have documented water quality impacts, impairments or threats.

Waterbody Segmentation: Implementation of a more systematic approach to defining the bounds of individual waterbodies using waterbody type, stream classification, hydrologic drainage, waterbody length/size and homogeneity of land use and watershed character as criteria.

Waterfront Revitalization Program (WRP): New York City's principal coastal zone management tool. As originally adopted in 1982 and revised in 1999, it establishes the city's policies for development and use of the waterfront and provides the framework for evaluating the consistency of all discretionary actions in the coastal zone with those policies. When a proposed project is located within the coastal zone and it requires a local, state, or federal discretionary action, a determination of the project's consistency with the policies and intent of the WRP must be made before the project can move forward.

Watershed Approach: A coordinated framework for environmental management that focuses public and private efforts on the highest priority problems within hydrologically-defined geographic area taking into consideration both ground and surface water flow.

Watershed: A drainage area or basin that drains or flows toward a central collector such as a stream, river, estuary or bay: the watershed for a major river may encompass a number of smaller watersheds that ultimately combined at a common point.

Weir: (1) A wall or plate placed in an open channel to measure the flow of water. (2) A wall or obstruction used to control flow from settling tanks and clarifiers to ensure a uniform flow rate and avoid short-circuiting.

Wet Weather Flow: Hydraulic flow conditions within a combined sewer system resulting from a precipitation event. Flow within a combined sewer system under these conditions may include street runoff, domestic sewage, ground water infiltration, commercial and industrial wastewaters, and any other non-precipitation event related flows. In a separately sewered system, this type of flow could result from dry weather flow being combined with inflow.

Wet Weather Operating Plan (WWOP): Document required by a permit holder's SPDES permit that optimizes the plant's wet weather performance.

Wetlands: An area that is constantly or seasonally saturated by surface water or groundwater with vegetation adapted for life under those soil conditions, as in swamps, bogs, fens, marshes, and estuaries. Wetlands form an interface between terrestrial (land-based) and aquatic environments; include freshwater marshes around ponds and channels (rivers and streams), brackish and salt marshes.

WI/PWL: Waterbody Inventory/Priority Waterbody List

WLA: Waste Load Allocation

WPCP: Water Pollution Control Plant

WQS: Water Quality Standards

WRP: Waterfront Revitalization Program

WWOP: Wet Weather Operating Plan

WWTP: Wastewater Treatment Plant

Zooplankton: Free-floating or drifting animals with movements determined by the motion of the water.

APPENDIX A

WET WEATHER OPERATING PLANS
RED HOOK WPCP, OWLS HEAD WPCP

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

Wet Weather Operating Plan
Owls Head Water Pollution Control Plant

Prepared by:
The New York City Department of Environmental Protection
Bureau of Wastewater Treatment

December 2007

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1.0 INTRODUCTION

One effective strategy to abate pollution resulting from Combined Sewer Overflows (CSOs) is to maximize the delivery of flows during wet weather to a wastewater treatment plant for processing. Delivering these flows would maximize the use of available wastewater treatment plant capacity for wet weather flows and would ensure that combined sewer overflow would receive at least primary treatment prior to discharge. To implement this goal, New York State Department of Environmental Conservation (NYSDEC) requires the development of a Wet Weather Operating Plan (WWOP) for collection systems that include combined sewers. This requirement is one of 13 Best Management Practices (BMPs) that New York includes in the SPDES permit requirements of plants with Combined Sewer Overflows (CSOs). This particular provision has been included in consideration of the Federal CSO policy that mandates maximization of flow to Publicly Owned Treatment Works (POTWs). In addition, the Nitrogen Control Consent Order for the Upper East River WPCPs includes milestone dates for submitting a WWOP describing procedures to maximize treatment during wet weather events while each WPCP is under construction. The WWOPs will establish process control procedures and set-points to maintain the stability and efficiency of the Biological Nitrogen Removal (BNR) process. Upon completion of construction, the WWOPs will be revised to reflect the operation of the fully upgraded facility.

This document provides an evaluation and specific guidance for the Owls Head WPCP. The implementation of these plans will help The City to improve treatment of sewage during wet weather events, and will allow them to demonstrate compliance with the State and Federal BMP requirements.

1.1 BACKGROUND OF EXISTING SYSTEM

The Owls Head Water Pollution Control Plant (WPCP) is located in the Bay Ridge section of the Borough of Brooklyn, City of New York, on the southwestern tip of the Owls Head Park. The Owls Head WPCP treats wastewater from a combined sewage collection system, which serves a population of approximately 780,000 and which drains storm water flow from an area of almost 13,664 acres.

The Owls Head plant began operation in 1952. Originally, the plant was designed to remove 80 percent suspended solids (SS) and 75 percent of the biochemical oxygen demand (BOD) from an average wastewater flow of 160 MGD. In 1979, the engineering firm of Metcalf and Eddy of New York Inc. was engaged to prepare the plans and contract drawings for updating the Owls Head plant to meet more stringent Federal standards requirements. Normal operation of the plant provides treatment for up to 120 MGD. The upgraded plant was designed to provide primary treatment and chlorination to wet weather peak flow of twice design average dry weather flow (240 MGD), and secondary treatment to 1.5 times average dry weather flow.

In 1997, DEP's Office of Environmental Planning and Assessment (OEPA) developed water demand and wastewater flow projections for each of the City WPCPs. The high-end projected flow to the Owls Head WPCP in the year 2020 is estimated to be 134 MGD. Maximum design wet weather flow to the plant is 240 MGD. The design maximum flow to secondary treatment is 1.5 times average flow, or 180 MGD.

1.2 Drainage Area

The Owls Head regulation system is comprised of ten regulator stations (eight of which incorporate tide gate chambers). Nine of the regulators have outfall sewers discharging into the Bay. A typical regulator consists of one or more float controlled sluice gates, which regulate the flow to the interceptors.

During dry weather the regulators will be in the open position and all flow will be directed to the plant. During times of storms when it is necessary to limit flow to the plant, regulators should always be used in preference to throttling the inlet gates. Throttling at the inlet gates surcharges the interceptor, which in turn may cause deposition behind the gates or produce damaging velocities through the inlet gates and into the screen units located just downstream.

There are four sanitary pumping stations located in the Owls Head drainage area. In addition, the Prospect Expressway "storm water" pumping station is also located in the Owls Head drainage area. The following Table 1-1 lists the regulators and outfalls for the Owls Head WWTP drainage area.

1.3 Wastewater Treatment Plant Description

Wastewater treatment at the plant consists of screening, primary settling, step aeration activated sludge, final settling and chlorination with sodium hypochlorite.

1.4 Effluent Permit Limits

The Owls Head WPCP is currently operating under SPDES Permit No. 0026166. Under this SPDES Permit, the plant is rated at 120 MGD dry weather flow and 240 MGD wet weather flow. The current effluent flow, CBOD, TSS, and fecal coliform limits and monitoring requirements from the permit are summarized in Table 1-2 below.

Table 1-1: Owls Head WPCP
Conventional Effluent Limitations and Monitoring Requirements

PARAMETER	Limit	Monitoring Requirement
PLANT FLOW	120 MGD	(30 day mean)
$CBOD_5$ (1)	25 mg/l (2)	(30 day mean)
	40 mg/l	(7 day mean)
	50 mg/l (3)	6 consecutive hour avg.
TSS (1)	30 mg/l (2)	(30 day mean)
	45 mg/l	(7 day mean)
	50 mg/l	Daily maximum
	50 mg/l (3)	6 consecutive hour avg.
FECAL COLIFORM	Not exceed 200/100 ml	(30 day geom. mean)
	Not exceed 400/100 ml	(7 day geom. mean)
	Not exceed 800/100 ml	6 hour geom. mean
TOTAL CHLORINE RESIDUAL	2 mg/l (4)	Daily maximum
PH	6.0 – 9.0 SU	Range

(1) Frequency: 1/day; Sample Type: 24-hour composite
(2) Effluent values shall not exceed 15% of influent values.
(3) During periods of wet weather influence, it is recognized that permittee may not be able to meet CBOD5 and suspended solids limits for effluent concentrations and mass loadings. Relief from these requirements shall be granted if permittee can demonstrate that treatment is being maximized while up to maximum treatable flow is being accepted.
(4) During periods of wet weather influence, in order to achieve proper fecal coliform kill it may be necessary to exceed the effluent chlorine residual limit. Relief shall be granted, if permittee can demonstrate that such exceedances are necessary in order to provide optimum disinfection

1.5 WET WEATHER FLOW CONTROL

Original design of the collection system assumed that when it was necessary to limit flow to the plant, the regulators should be used in preference to throttling the plant inlet gates. Throttling at the inlet gates surcharges the interceptors, which in turn may cause deposition behind the gates or produce damaging velocities through the inlet gates and into the screen units located just downstream.

1.6 PERFORMANCE GOALS FOR WET WEATHER EVENTS

The goal of this Wet Weather Operating Plan is to maximize treatment of wet weather flows at the Owls Head WPCP and, in doing so, reduce the volume of untreated CSO being discharged in the Upper Bay and its tributaries.

There are three primary objectives in maximizing treatment for wet weather flows:

- Consistently achieve primary treatment and disinfection for wet weather flows up to 240 MGD before CSOs occur. In doing so the plant will satisfy the SPDES requirement of providing this level of treatment for 2xDDWF.

- Consistently provide secondary treatment for wet weather flows up to 180 MGD before bypassing the secondary treatment system. In doing so this plant will provide a secondary level of treatment for 1.5xDDWF

- Do not appreciably diminish the effluent quality or destabilize treatment upon return to dry weather operations.

1.7 PURPOSE OF THIS MANUAL

The purpose of this manual is to provide a set of operating guidelines to assist the Owls Head WPCP staff in making operational decisions which will best meet their performance goals and the requirements of the NPDES discharge permit. During a wet weather event, numerous operational decisions must be made to effectively manage and optimize treatment of wet weather flows. Plant flow is normally controlled through influent pump operations and adjustment of influent gates. Flow rates at which the secondary bypass is used are dependant upon a complex set of factors, including conditions within specific treatment processes (such as sludge settling characteristics) and anticipated storm intensity and duration. Each storm event produces a unique combination of flow patterns and plant conditions. No manual can describe the decision making process for every possible wet weather scenario which will be encountered at the Owls Head WPCP. This manual can, however, serve as a useful reference, which both new and experienced operators can utilize during wet weather events. The manual can be useful in preparing for a coming wet weather event, a source of ideas for controlling specific processes during the storm, and a checklist to avoid missing critical steps in monitoring and controlling processes during wet weather.

1.8 USING THE MANUAL

This manual is designed to allow use as a reference during wet weather events. It is broken down into sections that cover major unit processes at the Owls Head WPCP. Each protocol for the unit processes includes the following information:

- List of unit processes and equipment covered in the section
- Steps to take before a wet weather event and who is responsible for these steps
- Steps to take during a wet weather event and who is responsible for these steps
- Steps to take after a wet weather event and who is responsible for these steps
- Discussion of why the recommended control steps are performed
- Identification of specific circumstances that trigger the recommended changes
- Identification of things that can go wrong with the process

This manual is a living document. Users of the manual are encouraged to identify new steps, procedures, and recommendations to further the objectives of the manual. Modifications, which improve upon the manual's procedures to maximize treatment of wet weather, are encouraged. With continued input from the plant's experienced operations staff this manual will become a useful and effective tool.

1.9 REVISIONS TO THIS MANUAL

In additions to revisions based on plant operating experience, this manual will also be revised as modifications and stabilizations are made to the collection system and the Owls Head WPCP that affect the plants ability to receive and treat wet weather flows. Applicable changes are listed as follows:

- **Regulator Automation**- Under DEP's SCADA system project, automatic control of the regulators will be provided to plant operators. Control strategies for these regulators should be incorporated into this manual after automation is complete.
- **Throttling Gate Automation**- The Forebay throttling gate will eventually be actuated by a hydraulic cylinder operator. The objective of the Forebay throttling gate system is to automatically throttle flow into the plant to no more than 240 MGD during wet weather conditions, and to prevent the level in the Afterbay channel from exceeding Elevation **(-)1.00.** The revisions to the operating procedure for the gate should be incorporated into this manual after automation is complete.

- **Future Construction Phases**- Future construction phases may impact the operation of the plant and may require revisions to this manual.

❖❖❖end of section❖❖❖

Owls Head Drainage Area Outfalls

Outfall No.	Location	Size	Receiving Waterbody
001	Owls Head WPCP		Upper New York Bay
002	64th Street (Reg #6, 6A, B, C)	3BL 15' x 7'6"	Upper New York Bay
003	49th Street (Reg #7, 7A, B, C)	11' x 8'	Upper New York Bay
004	43rd Street (Reg # 7D)	6' x 4'	Upper New York Bay
005	5' s/o Carroll St. Bridge	42" DIA	Gowanus Canal
006	19th Street (North side)	36" DIA	Gowanus Creek (E)
007	e/o 2nd Avenue	78" DIA	Gowanus Canal
008	E. 9th Street	12" DIA	Gowanus Canal
009	5th Street	78" DIA	Gowanus Canal
015	17th Avenue (Reg #9A, B, C)	4 BL 14'6" x 10'	Gravesend Bay
017	92nd Street (Reg #1)	3BL 7'4" x 7'4"	Upper New York Bay
018	79th Street (Reg #2, 3)	90" DIA	Upper New York Bay
019	71st Street (Reg #8, 8A, 8B, 4)	48" DIA	Upper New York Bay
020	Bay Ridge Avenue (Reg #5)	3' x 3'	Upper New York Bay
021	West 15th Street (Reg #10, 11)	3BL 15' x 10'	Coney Island Creek (N)
022	32nd St. (Bush Terminal Complex)	6' x 4'	Gowanus Bay
023	28th St. (N side) (Bush Terminal Complex)	10" DIA	Gowanus Bay

Table 1-2: Owls Head WPCP

2.0 EXISTING FACILITY - WET WEATHER OPERATING PROCEDURES AND GUIDELINES

This section presents equipment summaries and wet weather operating protocols for each major unit operation of the plant. The protocols are divided into steps to be followed before, during and after a wet weather event that address the rational trigger mechanisms and potential problem areas for wet weather operations. Table **2-1** located at the end of this Section outlines a summary of unit operation capacities.

2.1 THROTTLING GATE

2.1.1 Equipment for Influent Gate System

EQUIPMENT	NUMBER
Influent Sluice Gate	4
Effluent Sluice Gate	4
26 Cubic Yard (cy) Container	1
Backup 10 cy Container	3

2.1.2 Wet Weather Operating Protocol

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
Senior Sewage Treatment Worker (SSTW)	Sewage Treatment Worker (STW)	• Forebay gates should be in full open position during dry weather and prior to wet weather. • Check gate operation.
During Wet Weather Event		
SSTW	STW	• Leave gates in full open position until: 1. Plant flow approaches capacity of pumps in service or 2. Screen channel level exceeds acceptable level with maximum pumping, or 3. Bar screens become overloaded with screenings or 4. Grit removal exceeds the plant's grit handling capacity • Set the gates to maintain acceptable wet well water level

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
		• Record forebay gate adjustments on the Screening Chamber Log. Forebay gate adjustments are also automatically archived on Bailey system. • As wet weather event subsides open the forebay gates to maintain the wet well water level until the gates are completely open.
After Wet Weather Event		
SSTW	STW	• Make sure the forebay gates are in the full open position. • Conduct maintenance or repair of the forebay gates as necessary.
Why Do We Do This?		
To regulate flow to the WWTP and prevent excessive flows from destabilizing plant performance.		
What Triggers The Change?		
High water levels in the wet well or other unacceptable plant conditions related to high flows.		
What Can Go Wrong?		
If the forebay gates are not operated when necessary, or fail to operate, high water levels in the wet well may result. Flooding of the screen chamber may occur. If the forebay gates fail to operate, flow to the plant should be manually throttled with the screen channel influent gates.		

❖❖❖end of section❖❖❖

2.2 WASTEWATER SCREENING

Screenings are accomplished at Owls Head by means of a double row of bar screens consisting of eight climber screens, two per channel, one coarse screen followed by one fine screen, in series with each other.

2.2.1 Equipment

Screens	
Primary Screens	
Number of Units	4 units
Bar Openings	Coarse 11/4" - Fine 3/4"
Screen Channel Width (nominal)	6' - 9"
Screen Channel Invert Elevation @ Screen	-16.0'
Operating Lower Floor Elevation	4-'0"
Operating Higher Floor Elevation	12.5'

2.2.2 Wet Weather Operating Protocol

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
Stationary Engineer Electrical (SEE)	SSTW/STW	• During normal dry weather operations, operating experience will dictate the number of screens required based on parameters such as grit settling problems, and quantity of screenable material. General guide for number of primary screens in service for various flow ranges: **Up to 150 MGD - 2 Primary Screens** **150 to 240 MGD - 3 Primary Screens** • Rotate screen operation to ensure that all available screens are in working order. Make sure empty screenings containers are available.
During Wet Weather Event		
SEE	SSTW/STW	• Put a third primary screen into operation. • Set all screen rakes to continuous operation.

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
		• Regulate the plant flow with the forebay gates if the screens become overwhelmed or the water elevation in the screen channel exceeds -1.0 (OH WPCP uses submersible screens). • Remove and replace screenings containers as necessary.
After Wet Weather Event		
SEE	SSTW/STW	• Take extra screen out of operation. Return to two screens online. • Remove screenings for disposal.
Why Do We Do This?		
Two primary screens can accommodate flow of 150 MGD. Three primary screens are required to handle flows between 150 MGD and 240 MGD. This leaves the fourth screen on standby in case of a screen failure or excessive loadings.		
What Triggers The Change?		
Flows in excess of 150 MGD will require a third primary screen to be put online. Screen rakes will operate on time mode or if the head differential across the screens exceeds 2 to 4 inches.		
What Can Go Wrong?		
If an insufficient number of screens are online the screen channel may surcharge above acceptable levels (-1.0).		

❖❖❖end of section❖❖❖

2.3 MAIN SEWAGE PUMPS

2.3.1 Equipment

EQUIPMENT	NUMBER
Influent Wet Wells	Total 1
Main Sewage Pumps (MSPs)	Total 5

2.3.2 Wet Weather Operating Protocol

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• Monitor wet well elevation. • Number and speed of pumps in service are selected and automatically adjusted by the sonic control system in the pump control room. The pumps are activated manually. • Adjustments made based on maintaining the level in the screen chamber wet well at a nominally constant level • Check that wet well level monitor is functional.
During Wet Weather Event		
SEE	SSTW/STW	• Monitor wet well elevation. • As wet well level rises put off-line pumps in service and increase speed of variable speed pumps as necessary • Pump to maximum capacity during wet weather events always leaving one pump out of service as standby • Pumps are controlled automatically using the sonic control system, which is based on maintaining wet well levels within a desired operating range. Pumps are activated manually.

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
After Wet Weather Event		
SEE	SSTW/STW	• Maintain pumping rate as required to keep wet well level in operating range. • If the forebay gates have been throttled, maintain maximum pumping rate until forebay gates are returned to fully open position. • Reduce pump speeds and number in service to maintain wet well level and return to dry weather operation.
Why Do We Do This?		
Maximize flow to treatment plant, and minimize need for flow storage in collection system and associated overflow from collection system into receiving water body.		
What Triggers The Change?		
High flows, and the subsequent increase in the level of the screen channels and wet well.		
What Can Go Wrong?		
Pump fails to start. Pump fails while running. Screens blind, necessitating pump speed reduction or slowdown. Subsequent flooding of wet well and bar screen equipment.		

❖❖❖end of section❖❖❖

2.4 PRIMARY SETTLING TANKS

The primary settling tanks are designed to treat a maximum flow of approximately 111 MGD for each tank. When primary tanks are taken out of service, the primary settling effluent quality should be checked to avoid overloading and degradation of the secondary treatment process. Below table lists maximum primary tank flow rates.

2.4.1 Equipment

EQUIPMENT	NUMBER
Primary Settling Tanks (PSTs)	Total 4 4 Passes/PST
Longitudinal Collectors	4/PST
Cross Collector	1/PST
Grease Pit	1
Skimmings Dipping Weir w/ Trough	16
6 Cubic Yard (cy) Container	1
Primary Sludge Pump Stations (PSPS)	1
Primary Sludge Pumps (PSPs)	6
Cyclone Degritters	Total 6 4 in service
Classifiers	Total 3 2 in service

Number of Primary Settling Tanks in Service	2 Units East Side	2 Units West Side	Maximum Sustainable Flow Rate (Approx.)
4	2	2	240 MGD
3	2	1	240 MGD
3	1	2	240 MGD
2	1	1	200 MGD
2	2	0	120 MGD
2	0	2	120 MGD
1	1	0	111 MGD
1	0	1	111 MGD

2.4.2 Wet Weather Operating Protocol

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• Under normal operations all available primary tanks should be in service.

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
		• Check the flow balance to all tanks in service by looking at the effluent weirs. • Check the sludge collector operation and inspect tanks for broken flights. • Check for floating sludge or bubbles on the tank surface as an indication of sludge collector problems. • Check sludge pump operation. • Repair any malfunctions or equipment out of service.
During Wet Weather Event		
SEE	SSTW/STW	• Make sure four primary sludge pumps are on-line. • Watch water surface elevations at the weirs for flooding and flow imbalances. • Check the collector and drive operation. • Make sure grit flushers are operating. • Assign additional operators to grit handling if necessary. • Repair equipment failures as needed. • Reduce flow (sewage pumps and throttle forebay gates) if: 1. Sludge cannot be withdrawn quick enough from the primaries, 2. Grit accumulation exceeds the plants ability to handle it. 3. A primary tank must be taken out of service.
After Wet Weather Event		

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	**IMPLEMENTATION**	
SEE	SSTW/STW	• Take tanks out of service for repair or maintenance if necessary. • Remove floating debris and scum on the tanks. • Repair any failures. • Clean the effluent weirs if needed.

❖❖❖end of section❖❖❖

2.5 BYPASS CHANNEL

2.5.1 Equipment

EXISTING	
Bypass Channel	2 Bypass Control Sluice Gates
Location of Sluice Gates	End of bypass channels - East of Primary tanks

That portion of the primary settling tank flow, which is in excess of the secondary treatment process capacity, must be bypassed around secondary treatment. The bypass gates will automatically open to limit flow to secondary treatment to a minimum of 180 MGD (1.5 times DDWF). (Automatic function)

2.5.2 Wet Weather Operating Protocol

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• Conduct routine bypass gate preventative maintenance. • Check the secondary flow meter operation.
During Wet Weather Event		
SEE	SSTW/STW	• Bypass gate automatically open or close to maintain secondary flow at 180 MGD or greater. • Repair failures as necessary.
After Wet Weather Event		
SEE	SSTW/STW	• As the secondary flow drops below 180 MGD, bypass gate automatically closes.
Why Do We Do This?		
To relieve flow to the aeration system and avoid excessive loss of biological solids. To relieve primary clarifier flooding.		

What Triggers The Change?
Secondary flow in excess of 185 MGD. Bailey system is programmed to maintain flows between 180 MGD and 190 MGD.
What Can Go Wrong?
If the bypass gate does not open, secondary clarifier washout could occur and discharge large amount of biological solids. Bypass gate can open too much and cause flows less than 180 MGD to be passed through the secondary system.

❖❖❖end of section❖❖❖

2.6 AERATION TANKS

2.6.1 Equipment

Aeration Tanks		
Number of Tanks	2 Units - West Side	2 Units - East Side
Unit Dimensions (Ft)	West Side	East Side
Length	392'-8"	392'-8"
Width	100'	100'
Number of Passes Per Tanks	4	4
Sidewater Depth	17.3"	17.3"
Diffuser System	Ceramic Dome Diffusers	

2.6.2 Wet Weather Operating Protocol

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• During normal dry weather operations, at least 4 aeration tanks should be in operation. • The plant operates in a Step feed mode with Inlets at the Head of Passes B, C, and D. • Monitor Filamentous Growth
During Wet Weather Event		
SEE	SSTW/STW	• Monitor the dissolved oxygen and adjust the airflow to maintain proper dissolved oxygen levels. • During wet weather operations, at least 4 aeration tanks should be in operation.
After Wet Weather Event		
SEE	SSTW/STW	• Monitor the dissolved oxygen and adjust the air flow to maintain proper dissolved oxygen levels • Monitor Filamentous Growth
Why Do We Do This?		
Limiting the secondary treatment flow to 1.5 x DDWF with the balance being bypassed.		
What Triggers The Change?		
Secondary flows above 180 MGD.		
What Can Go Wrong?		
Potential impacts of wet weather events on the activated sludge process include: • Loss of biomass from the aeration tanks and secondary clarifiers		

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	

- Overloading of the aeration system resulting from high CBOD loadings caused by solids washout from the sewer system and solids washout from the primary clarifiers
- Decreased CBOD removal efficiency due to shortened hydraulic retention time in the aeration tanks.
- The operator must maintain proper dissolved oxygen levels in the aerators to avoid filamentous organisms.

❖❖❖end of section❖❖❖

2.7 FINAL SETTLING TANKS

2.7.1 Equipment

EQUIPMENT	NUMBER
Final Settling Tanks (FSTs)	16
Flight & Chain Sludge Collection System	6/FST
Skimmings Concentration Pit	2
Skimmings Trough	4
6 Cubic Yard (cy) Container	1

2.7.2 Wet Weather Operating Protocol

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• During normal dry weather operation all available final clarifiers should be in service. • Check the telescoping valves for plugging. Free any plugged valves. • Skim tanks as necessary. • Check the flow balance to all tanks in service by looking at effluent weirs. • Normal operation is to set the RAS rates to maintain a minimal sludge blanket.
During Wet Weather Event		
SEE	SSTW/STW	• Balance flows to the tanks. • Observe the clarity of the effluent and watch for solids loss. • Open the secondary bypass if secondary treatment flow exceeds 180 MGD (automatic function).
After Wet Weather Event		
SEE	SSTW/STW	• Modify the sludge wasting based on MLSS levels. • Close the secondary bypass when secondary flow drops below 180

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
		MGD. • Observe the effluent clarity. • Skim the clarifiers if necessary.

Why Do We Do This?
High flows will substantially increase solids loadings to the clarifiers and result in high effluent TSS. These conditions can lead to loss of biological solids, which can destabilize treatment efficiency when the plant returns to dry weather flow conditions.
What Triggers The Change?
Twice design dry weather flow.
What Can Go Wrong?
Excessive loss of TSS will reduce the biomass inventory of the plant, which will adversely affect secondary treatment efficiency when the plant returns to dry weather flow conditions.

❖❖❖end of section❖❖❖

2.8 CHLORINATION

Proper chlorine disinfection relies on required exposure time to adequately disinfect secondary effluent. During periods of extreme wet weather, there may be insufficient exposure time in the chlorine contact tank to adequately disinfect the effluent. In addition, excessive solids in secondary effluent resulting from high flows can hinder disinfection as well. In spite of the potential for reduced effectiveness, it is preferable to send as much flow through the disinfection units as possible to achieve some level of disinfection. Recommendations for maximizing chlorine disinfection efficiency during high flows include:

- Experiment with chlorine dosage at high flows. Adequate kills may be achievable at detention times of less than 15 minutes with the proper chlorine dosage.
- Optimize chlorine mixing. Poor mixing will greatly reduce chlorination effectiveness.

Chlorine tanks can be modified with the addition of longitudinal baffles extending the plug flow pattern with less short-circuiting and more effective chlorine contact volume.

EQUIPMENT	NUMBER
Chlorine Contact Tanks (CCTs)	2
Sodium Hypochlorite Storage Tanks	3
Sodium Hypochlorite Roto-Dip	3
Dilution Water Pumps	3
- Automatic Strainer	3
- Manual Strainers	3
Skimmings Trough w/ Weir	1/Tank
Sump Pit	2
Hydraulic Actuated Slide Gate	2

Chlorination System		
Number of Tanks	2	
Number of Bays Per Tank	3	
Hypochlorite Storage Tanks	3	
Total Capacity Hypochlorite Tanks	10000 x 3	(30,000 gallons total)
Detention Time - Minutes	2 Tanks in Service	1 Tank in Service
Design Average Flow, 120mgd	30	15
Dry Weather Maximum, 180mgd	20	10
Peak Weather Maximum, 240mgd	15	7

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	**IMPLEMENTATION**	
Before Wet Weather Event		
SEE	SSTW/STW	• Maintain adequate hypochlorite in storage tanks. • Make sure there are sufficient chlorine residual test kit supplies. • Report problems within a 2-hour window. • Perform preventative maintenance on equipment if necessary. • When the disinfection system is in automatic mode, the hypo feed rate is controlled by flow pacing and is proportional to the plant influent flow. The hypo feed rate is also trimmed or fine tuned by the ORP set point (Oxidation Reduction Potential). • When the system is on manual, the operator determines the hypo feed rate based on titrations for chlorine residual, the change from the last reading, and the change in flow conditions. When the chlorine residual is on target, the operator checks the residual every hour. When the chlorine residual is out of the target range, the operator checks the residual every half hour.

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
During Wet Weather Event		
SEE	SSTW/STW	• Check, adjust and maintain the hypochlorite feed rates to provide proper chlorine residual for adequate fecal kill. • When the disinfection system is in automatic mode, the hypo feed rate is controlled by flow pacing and is proportional to the plant influent flow. The hypo feed rate is also trimmed or fine tuned by the ORP set point (Oxidation Reduction Potential). • When the system is on manual, the operator determines the hypo feed rate based on titrations for chlorine residual, the change from the last reading, and the change in flow conditions. When the chlorine residual is on target, the operator checks the residual every hour. When the chlorine residual is out of the target range, the operator checks the residual every half hour. • Check and maintain the Hypochlorite tank levels.

<table>
<tr><th colspan="2">WHO DOES IT?</th><th rowspan="2">WHAT DO WE DO?</th></tr>
<tr><th>SUPERVISORY</th><th>IMPLEMENTATION</th></tr>
<tr><td colspan="3">After Wet Weather Event</td></tr>
<tr><td>SEE</td><td>SSTW/STW</td><td>Drop the Hypochlorite feed rates as needed to maintain the chlorine residual.
When the disinfection system is in automatic mode, the hypo feed rate is controlled by flow pacing and is proportional to the plant influent flow. The hypo feed rate is also trimmed or fine tuned by the ORP set point (Oxidation Reduction Potential).
When the system is on manual, the operator determines the hypo feed rate based on titrations for chlorine residual, the change from the last reading, and the change in flow conditions. When the chlorine residual is on target, the operator checks the residual every hour. When the chlorine residual is out of the target range, the operator checks the residual every half hour.
Maintain the Hypochlorite tank levels.
Repair equipment as necessary.</td></tr>
<tr><td colspan="3">Why Do We Do This?</td></tr>
<tr><td colspan="3">Hypochlorite demand will increase as flow rises and secondary bypasses occur. Increase the Hypochlorite feed rates to maintain the target chlorine residual.</td></tr>
<tr><td colspan="3">What Triggers The Change?</td></tr>
<tr><td colspan="3">High flows and secondary bypasses will increase Hypochlorite demand and usage.</td></tr>
<tr><td colspan="3">What Can Go Wrong?</td></tr>
<tr><td colspan="3">Chlorination system is on automatic mode most of the time. However, manual chlorination control with rapid flow changes and effluent quality changes can cause the chlorine residual to increase or decrease dramatically. Effluent chlorine residual must be monitored closely to maintain the target residual.</td></tr>
</table>

❖❖❖end of section❖❖❖

2.9 Sludge Thickening, Digestion and Storage

2.9.1 Equipment

EQUIPMENT	NUMBER
Waste Activated Sludge (WAS) Wet Well	1
WAS Pumps	3
Polymer Pumps	1

Sludge Thickening Digestion and Storage	
Design Condition	
Sludge Thickeners	
Installed	4
Operating	4
Anaerobic Sludge Digesters	
No. Of Units	6
No. Of Units Operating	6
Sludge Storage	
No. Of Storage Tanks	2
Storage Capacity (Days)	1

2.9.2 Wet Weather Operating Protocol

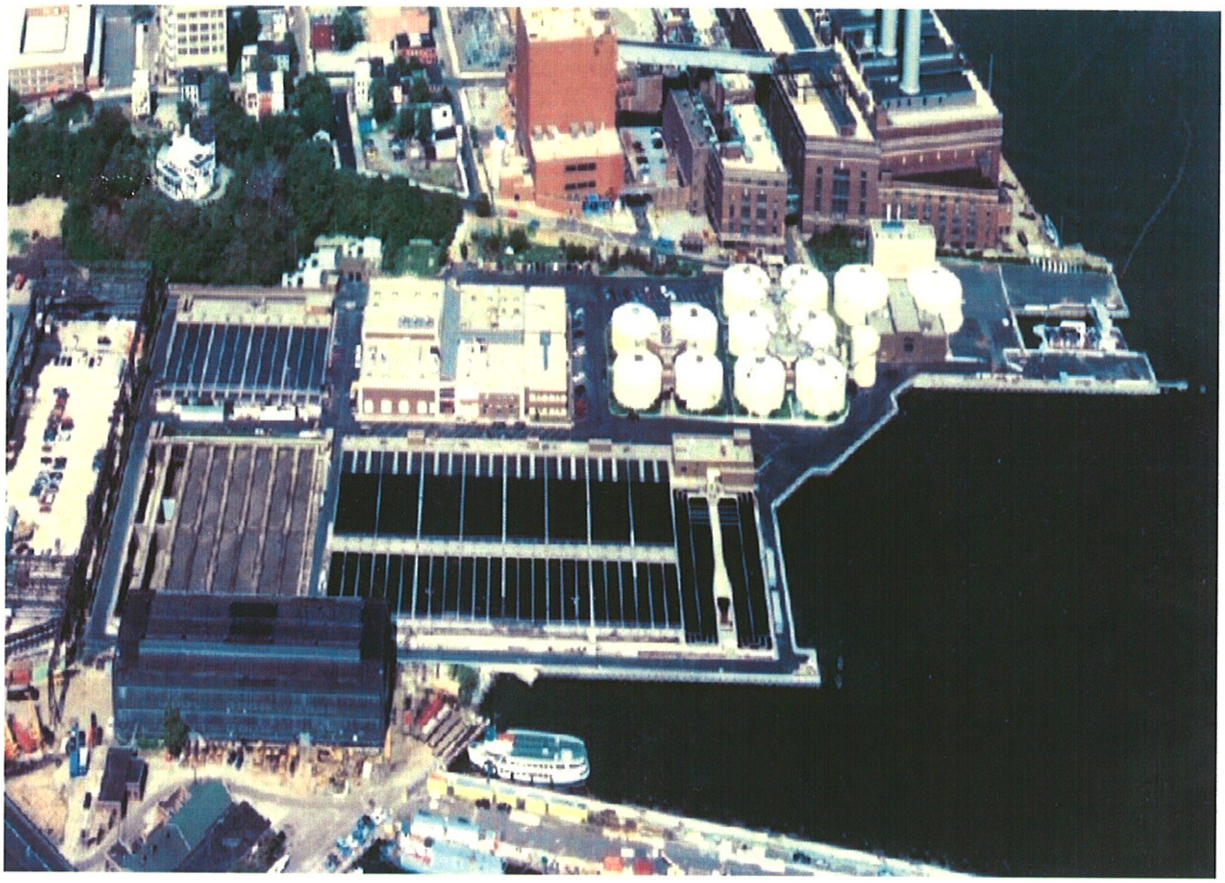
WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	SUPERVISORY	
During Wet Weather Event		
SEE	SSTW/STW	• Sludge handling activities should proceed, as they normally would during dry weather flow.

Table 2-1. Rated Minimum Capacity for Equipment in Service				
Process Equipment	Number of Units Installed	Number of Units in Service	Minimum Plant Influent Flow	Minimum Secondary Treatment Flow
Screens	4	3 2 1	240 150 80 or less	
Main Sewage Pump	5	4 3 2 1	240 180 120 60 or less	
Primary Settling Tanks	4	4 3 2	240 180 120	
Aeration Tanks	4	4 3 2		180 135 90
Final Settling Tanks	16	16 15 14 13		180 170 160 150
Chlorine Contract Tanks	2	2 1	240 120 or less	

❖❖❖end of section❖❖❖

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

Wet Weather Operating Plan
Red Hook Wastewater Pollution Control Plant



Prepared by:
The New York City Department of Environmental Protection
Bureau of Wastewater Treatment

February 2005
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SECTION 1.

INTRODUCTION

1.1 BACKGROUND

The Red Hook Water Pollution Control Plant (WPCP) is located in western Brooklyn (Figure 1-1). The plant services a system of combined sewers, regulators, and interceptors that convey a combination of both storm water and wastewater to the WPCP.

The Red Hook WPCP is designed to treat an average flow of 60 MGD with a peak primary treatment capacity of 120 MGD and a peak secondary treatment capacity of 90 MGD. The total capacity of the secondary treatment bypass channel is **120 MGD.** The maximum capacity of the bypass flume is 35 MGD. The maximum outfall capacity is 250 MGD at mean high water (MHW). The maximum capacity of the interceptor is 360 MGD.

During dry weather conditions wastewater is collected by the combined sewers and diverted by the regulators to the WPCP via the interceptors for treatment and subsequent discharge into the East River. During wet weather storm water runoff combines with the wastewater in the combined collection system, which produces a significant increase in flow. The Red Hook WPCP is designed, and required by its SPDES permit, to be physically capable of receiving a minimum of 120 MGD through the plant head works during wet weather. Flow in excess of the plant's capacity is discharged through combined sewer outfalls (CSO) at the regulators. The amount of flow discharged through the CSOs is dictated by: the regulators; WPCP operations and rainfall characteristics (intensity, duration and location).

While the WPCP has a maximum capacity of 120 MGD, the plant operators can control the amount of flow received by the plant through use of the plant's throttling gate. The plant operators use the throttling gate to maintain reliable plant performance during and after a wet weather event. In recent years the Red Hook WPCP has increased wet weather capture. The objective of this Wet Weather Operating Plan is to establish an operating procedure that will maximize treatment of wet weather flows, and if possible, consistently achieve or exceed 2xDDWF.

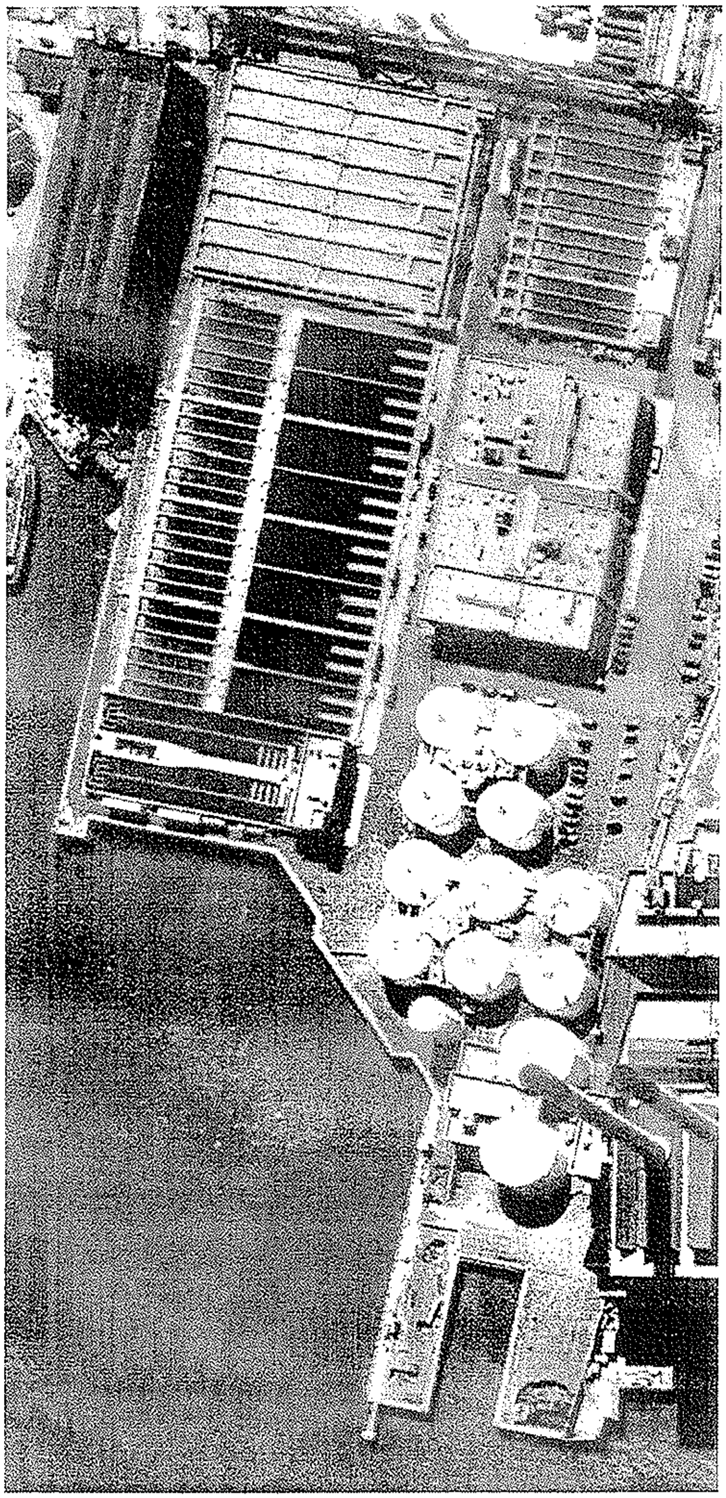

Figure 1-1. Aerial View of Red Hook WPCP

1.1.1 Drainage Area

The Red Hook WPCP is located in the northwest corner of the Brooklyn and serves a drainage area covering approximately 3,000 acres of western Brooklyn and Governors Island. The majority of the drainage system is a combined system composed of two interceptors, five pump stations and 28 regulators. One pump station (Nevins Street Pump Station) pumps only sanitary sewage, and two pump stations (Hamilton Avenue and Kane Street pump stations) only handle storm water. Figure 1-2 presents the plant location, drainage area and locations of major elements of the collection system.

Flow within the Red Hook WPCP drainage area is controlled by the 28 regulators shown in Table 1-1. Thirteen of the regulators are hydraulic, seven are manual, and eight are diversion chambers In addition, there are four cut-outs that discharge overflows into Gowanus Canal which are designated as CSO 1 through CSO 4 in Table 1-1.

Three large regulators (RH-003, RH004 and PH-028) will be automated and 18 hydraulic regulators will be converted to fixed orifices. Final design, bidding, and construction for all regulator improvements is due to be completed by 2007.

1.1.2 Throttling Gate

The Red Hook WPCP was designed with a hydraulically operated throttling gate, gate 1302 in Figure 1-3, located upstream of the screening chamber and downstream of the influent chamber. It is used to control flow to the plant and provide some in-line storage by surcharging the interceptor. When equipped with computer controls, this facility will induce about 4 MG of in-line storage in the interceptor. Final design, bidding and construction for automation is expected to be completed by 2007. Downstream of the throttling gate is the Main Gate (1301). This gate can be used to throttle flow if the throttling gate fails.

1.1.3 Wastewater Treatment Plant Description

The Red Hook WPCP provides influent screening, primary and secondary treatment and effluent chlorination with sodium hypochlorite. Secondary treatment is provided by an activated sludge system operated in a step aeration mode. Primary sludge is degritted by a cyclone degritter.

Figure 1-2 - Red Hook WPCP Location, Drainage Area and Locations of Major Elements of the Collection System.

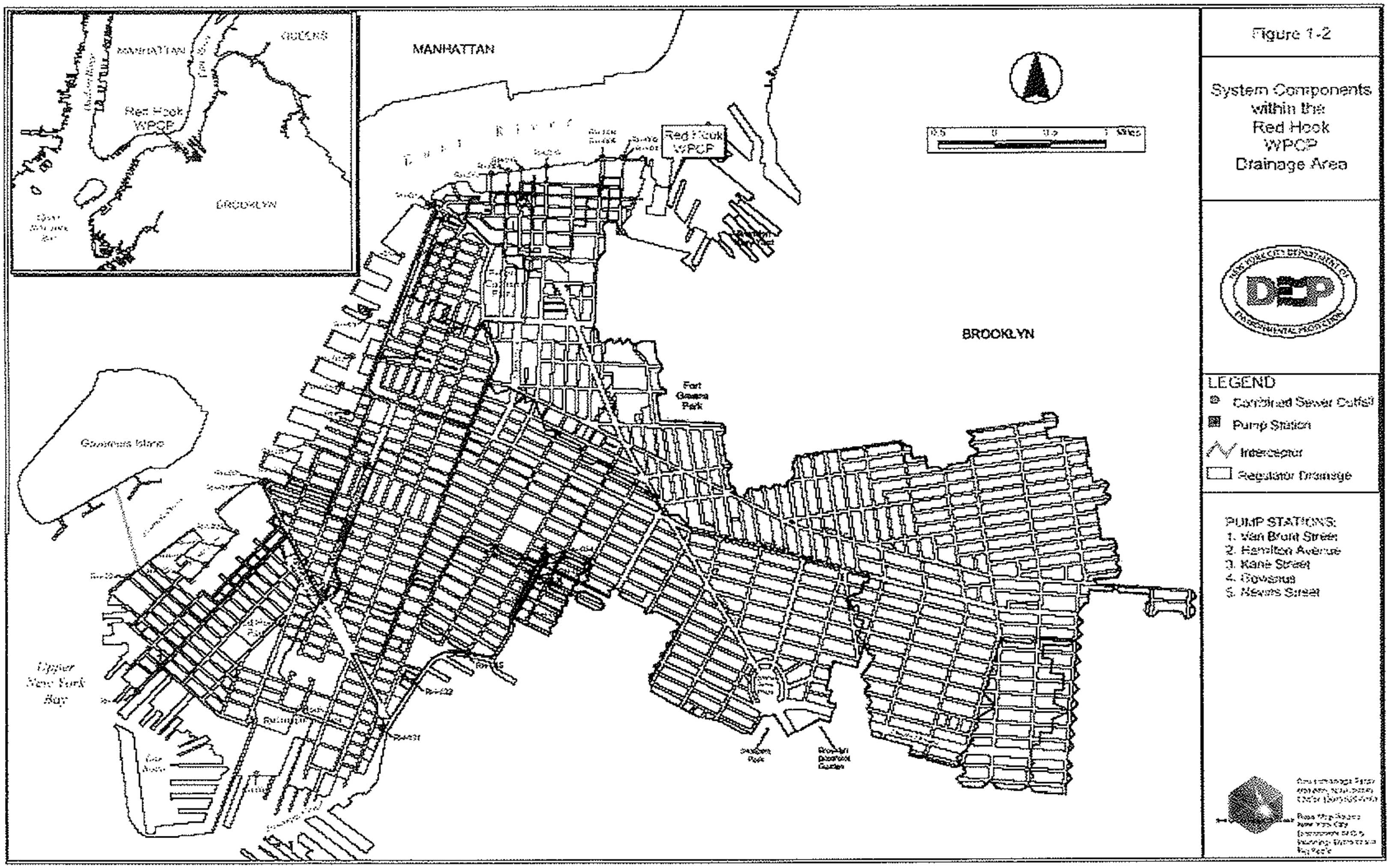

Table 1-1. Red Hook WPCP Drainage Area
Location of Regulators and Outfalls

Regulator	Outfall	Outfall Location	Outfall Size (W x H)	Regulator Location
1	RH-029	Van Brunt St. & Upper New York Bay	30" Dia.	Van Brunt St. south of Reed St.
2[(1)]	RH-028	Wolcott St. & Buttermilk Channel	72" Dia.	Wolcott St. & Conover St.
5	RH-025	Conover St. & Atlantic Basin	2'4" x 2'6"	Pioneer St. & Conover St.
6	RH-024	Verona St. & Atlantic Basin	24" Dia.	Verona St. west of Imlay St.
7	RH-023	Commerce St. & Atlantic Basin	24" Dia.	Commerce St. west of Imlay St.
8	RH-022	Bowne St. & Atlantic Basin	24" Dia.	Bowne St. west of Imlay St.
9	RH-019	Hamilton Av. & Buttermilk Channel	8'6" x 6'0"	Hamilton Av. & Ferry Pl.
9A	RH-021	Sackett St. & Buttermilk Channel	48" Dia.	Sackett St. & Ferry Pl.
10	RH-020	Degraw St. & Buttermilk Channel	18' Dia.	Degraw St. & Van Brunt St.
11	RH-018	Kane St. & East River	3'9" x 5'7"	Kane St. & Van Brunt St.
12	RH-016	Amity St. & East River	8'6" x 8'6"	Amity St. & Columbia St.
13	RH-014	Atlantic Av. & East River	36" Dia.	Atlantic Av. west of Columbia St.
14	RH-013	Joralemon St. & East River	18" Dia.	Joralemon St. west of Furman St.
15	RH-011	Montague St. & East River	4'0" x 4'0"	Montague St. west of Furman St.
16	RH-010	Orange St. & East River	18" Dia.	Furman St. & Orange St.
17	RH-012	Cadman Plaza & East River	6'0" x 6'0"	Fulton St & Furman St.

Table 1-1. Red Hook WPCP Drainage Area
Location of Regulators and Outfalls

Regulator	Outfall	Outfall Location	Outfall Size (W x H)	Regulator Location
18	RH-009	Main St. & East River	36' Dia.	Main St. & Plymouth St.
18A	RH-008	Washington St. & East River	36' Dia.	Washington St & Plymouth St.
19	RH-007	Adams St. & East River	15" Dia.	Adams St. & John St.
19A	RH-006	Pearl St. & East River	36" Dia.	Pearl St. & John St.
20[1]	RH-004	Gold St. & East River	168" Dia.	Gold St & Plymouth St.
20A	RH-005	Gold St. & East River	168" Dia.	Gold St & Plymouth St.
21[1]	RH-003	Hudson Av. & East River	4'6" x 7'3"	Hudson Av. & Plymouth St.
22	RH-036	President St. & Gowanus Canal	18" Dia.	Nevins St. & President St.
23	RH-037	Sackett St. & Gowanus Canal	18" Dia.	Nevins St. & Sackett St.
24	RH-038	Degraw St. & Gowanus Canal	12'0" x 5'21/2"	Nevins St. & Degraw St.
25	RH-033	Douglass St. & Gowanus Canal	3'2" x 3'8"	Nevins St. & Douglass St.
CSO1	RH-039	Douglass St. & Gowanus Canal (W)	3'2" x 3'8"	NA
CSO2	RH-035	Bond St. & Gowanus Canal	DBL 24" Dia.	NA
CSO3	RH-031	Creamer St. & Gowanus Canal	6'0" x 5'0"	NA
CSO4	RH-030	Hicks St. & Gowanus Canal	42" Dia.	NA
Gowanus PS	RH-034	Head of Gowanus Canal	4BL 8'0" x 8'0"	Gowanus PS: Butler St. & Gowanus Canal

(1) Targeted for automation under the NYCDEP Supervisory Control and data Acquisition (SCADA) System

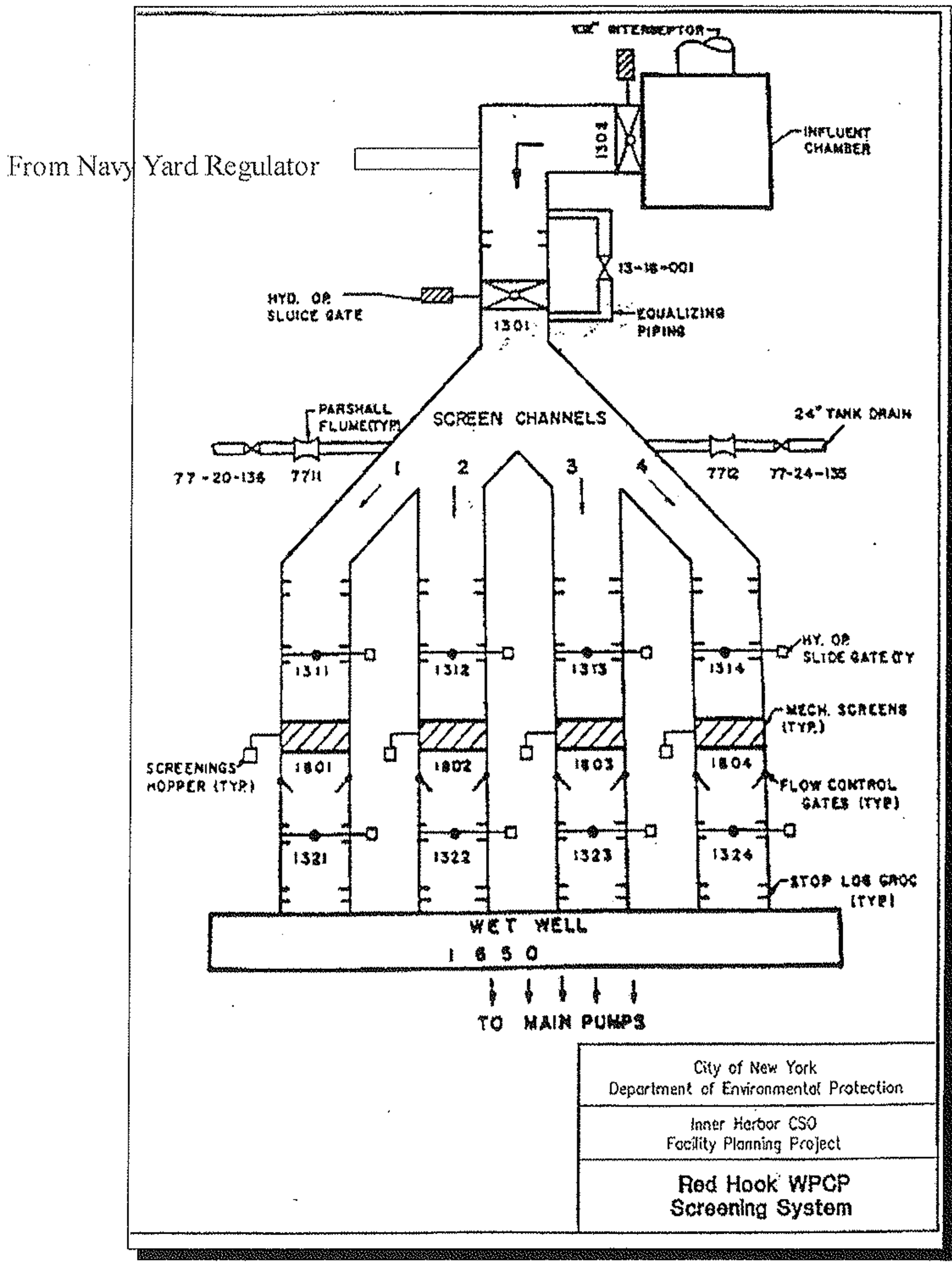

Figure 1-3. Red Hook Influent Changer, Throttling Gate and Screening Facility

Primary and waste activated sludges are combined, thickened, anaerobically digested and then stored and dewatered through two centrifuges. A process flow schematic of the plant is presented in Figure 1-4 and a site plan of the plant is presented in Figure 1-5.

The Red Hook WPCP is designed to treat an average flow of 60 MGD. The plant has a peak primary treatment capacity of 120 MGD, and a peak secondary treatment capacity of 90 MGD. When the total flow through the WPCP exceeds 90 MGD, the difference is diverted through the bypass flume and into the bypass channel from the primary settling tank effluent channels and receives disinfection prior to discharge through the outfall. If the flow exceeds the capacity of the bypass flume, the bypass gate downstream of the Parshall flume can be opened.

The Red Hook WPCP is a step aeration facility using 22 foot deep aeration tanks with fine bubble dome diffusers. The plant is a conventional open facility with enclosed screenings, grit handling, and sludge facilities.

1.2 PERFORMANCE GOALS FOR WET WEATHER EVENTS

The goal of this Wet Weather Operating Plan is to maximize treatment of wet weather flows at the Red Hook WPCP and, in doing so, reduce the volume of CSO released to the East River, Upper New York Bay, and Gowanus Canal.

There are three primary objectives in maximizing treatment of wet weather flows:

1. Consistently achieve primary treatment and disinfection for wet weather flows of at least 120 MGD before a CSO event occurs. In doing this the plant will satisfy the SPDES requirement of providing this level of treatment for 2xDDWF
2. Consistently provide secondary treatment for wet weather flows up to 90 MGD before bypassing the secondary treatment system. In doing this the plant will satisfy the SPDES requirement of providing this level of treatment for 1.5Xddwf
3. Do not appreciably diminish effluent quality or destabilize treatment upon return to dry weather operation.

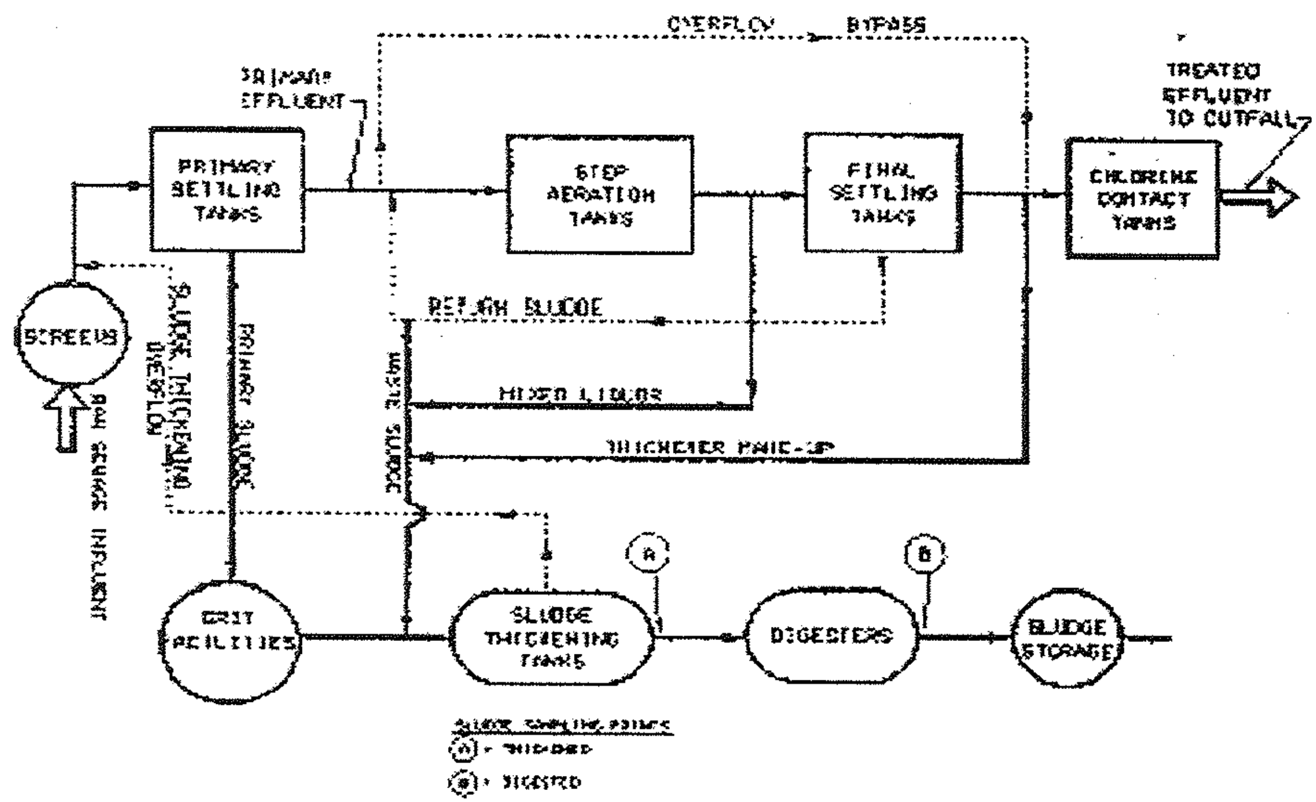

Figure 1-4. Red Hook WPCP Process Flow Diagram

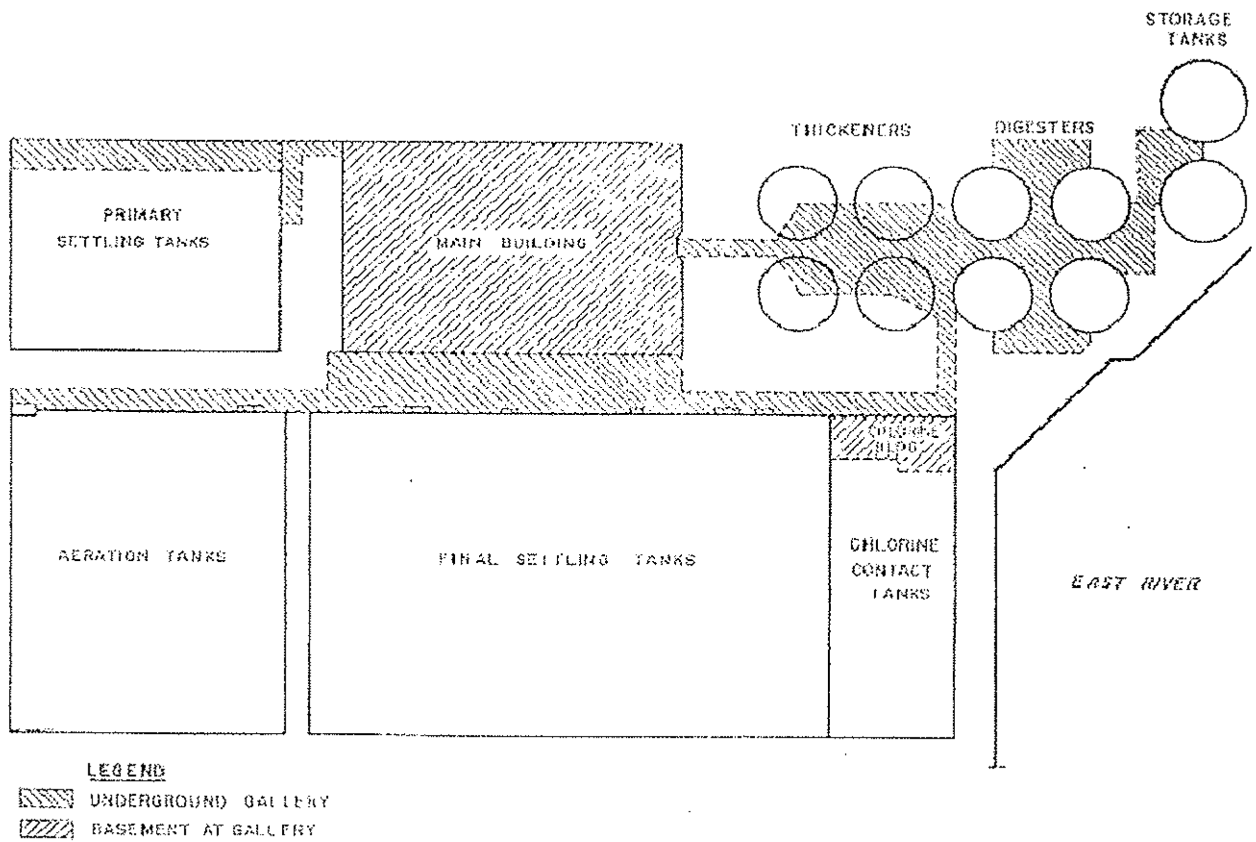

Figure 1-5. Red Hook WPCP Site Plan

This requires operator sensitivity and awareness to symptoms of destabilization of the treatment system. These symptoms range from the obvious such as flooding of channels and weirs, to the subtle such as overburdened sludge collectors and total suspended solids carry-over in the primary clarifiers and increasing sludge blanket height in the secondary clarifiers. Recognition of these symptoms comes with experience in plant operations.

1.3 PURPOSE OF THIS MANUAL

The purpose of this manual is to provide a set of operating guidelines to assist Red Hook WPCP staff in making operational decisions, which will best meet the performance goals stated in Section 1.2, and the requirements of the NPDES discharge permit. During a wet weather event, numerous operational decisions must be made to effectively manage and optimize treatment of wet weather flows. Plant flow is controlled through influent pump operations and adjustment of the throttling gates. Flows processed by the plant during wet weather are dependant upon a complex set of factors, including conditions within specific treatment processes and anticipated storm intensity and duration. Each storm event produces a unique combination of flow patterns and plant conditions. No manual can describe the decision making process for every possible wet weather scenario which will be encountered at the Red Hook WPCP. This manual can, however, serve as a useful reference which both new and experienced operators can utilize during wet weather events. The manual can be useful in preparing for a coming wet weather event, a source of ideas for controlling specific processes during the storm, and a checklist to avoid missing critical steps in monitoring and controlling processes during wet weather.

1.4 USING THE MANUAL

This manual was designed to be used as a quick reference during wet weather events. It is broken down into sections that cover major unit processes at the Red Hook WPCP. Each protocol for the unit processes includes the following information:

- list of unit processes and equipment covered in the section
- steps normally taken <u>before</u> a wet weather event together with the associated sequential action items
- steps normally taken <u>during</u> a wet weather event together with the associated sequential action items
- steps normally taken <u>after</u> a wet weather event together with the associated sequential action items
- discussion of why the recommended control steps are performed
- identification of specific circumstances that trigger the recommended changes
- identification of things that can go wrong with the process

This manual is a living document. Users of the manual are encouraged to identify new steps, procedures, and recommendations to further the objectives of the manual. Modifications, which improve upon the manual's procedures, are encouraged. With continued input from the plant's experienced operations staff this manual will become a useful and effective tool.

1.5 REVISIONS TO THIS MANUAL

In additions to revisions based on plant operating experience, this manual will also be revised as modifications and stabilizations are made to the collection system and the WPCP that affect the plants ability to receive and treat wet weather flows. Three such modifications are:

1. **Regulator Automation**
   Under DEP's Supervisory Control and Data Acquisition (SCADA) system project three regulators in the Red Hook drainage area are scheduled for automation. This will provide remote and automatic control of these regulators to the Red Hook operators. The finalized control strategies for these regulators will be incorporated into this manual as points of information once automation is completed.

2. **Throttling Gate Automation**
   The existing throttling gate is manually operated to regulate flow to the plant during wet weather periods. This gate is scheduled for automation and will be controlled by water surface elevations in the wet well. The revisions to the operating procedure for the gate would be incorporated into this manual after automation is complete.

3. **Inflatable Dam Operation**
   An inflatable dam for in-line storage is planned for regulator RH-020 in the Red Hook drainage area. Protocols for operation of this facility should be included in this manual when the facility is complete. This protocol should include procedures and specifications for draining stored wastewater to the Red Hook WPCP.

SECTION 2.

UNIT PROCESS OPERATIONS

This section presents equipment summaries and wet weather operating protocols for each major unit operation of the plant The protocols are divided into steps to be followed before, during and after a wet weather event. The protocols also address the rational for the protocol, events or observations that trigger the protocol and a discussion of what can go wrong.

Under certain conditions, such as during upgrade related construction, not all of the units of major equipment will be available for service. Table 2-1 shows the maximum hydraulic capacities for major equipment in service and plant capacities with units out of service. The capacities shown are for all of the required equipment in service during peak wet weather flows and for reduced numbers of operating units. The capacities with reduced numbers of operating units reflect the hydraulic limits of the particular treatment process with units out of service. The reduced hydraulic capacities indicate the flow limits for the processes in order to meet their design operating parameters under peak flow conditions.

2.1 THROTTLING GATE

The hydraulic sluice gate is shown schematically on Figure 1-3.

Unit Processes	Equipment
Throttling Gate	108" x 72" Hydraulic Sluice Gate

Table 2-1. Rated Capacity for Equipment in Service

Process Equipment	Number of Units Installed	Number of Units in Service	Minimum Plant Influent Flow	Minimum Secondary Treatment Flow
Screens	4	3 2 1	120 90 45	
Main Sewage Pump	5	5 4 3	120 96 72	
Primary Settling Tanks	4	4 3 2	120 90 60	
Aeration Tanks	4	4 3 2		90 67 45
Final Settling Tanks	8	8 7 6 5		90 78 67 56
Chlorine Contract Tanks	2	2 1	120 60	

<table>
<tr><th colspan="2">WHO DOES IT?</th><th rowspan="2">WHAT DO WE DO?</th></tr>
<tr><th>SUPERVISORY</th><th>IMPLEMENTATION</th></tr>
<tr><td colspan="3">Before Wet Weather Event</td></tr>
<tr><td>SEE</td><td>SSTW/STW</td><td>Gate should be in normal dry weather operating position during dry weather and prior to wet weather.
Check gate operation.
Optimal wet well operation levels, during dry weather, range from elevation -19.0 to -28.0 ft.</td></tr>
<tr><td colspan="3">During Wet Weather Event</td></tr>
<tr><td>SEE</td><td>SSTW/STW</td><td>Leave gate in normal dry weather operating position until:<ol type="a">
plant flow approaches 120 mgd or
wet well level exceeds an acceptable level which is customarily in the region of elevation -19.0 ft. or higher, with five pumps running or
bar screens become overloaded with screenings or
water level in screen channel exceeds elevation -17.5 ft.
grit removal exceeds the plants grit handling capacity.
When the gate is operated set its position to maintain acceptable wet well water level (between elevation -18.0 and -24.0 ft.). A range is delineated due to the turbulent nature of the wet-well levels during rain events. The Throttling Gate is adjusted in order to maintain an acceptable wet well level .
As wet weather event subsides open the gate to maintain the wet well water level and a pumping rate of 120MGD until the gate is completely open.</td></tr>
</table>

After Wet Weather Event		
SEE	SSTW/STW	• Make sure the throttling gate is in the normal dry weather operating position. • Conduct maintenance or repair of the throttling gate as necessary.

Why Do We Do This?

- To regulate flow to the treatment plant and prevent excessive flows from destabilizing plant performance.

What Triggers The Change?

High water levels in the wet well or other unacceptable plant conditions related to high flows.

What Can Go Wrong?

- If the throttling gate is operated before necessary, CSOs may occur before 2xDDWF is achieved.
- If the throttling gate is not operated when necessary, or fails to operate, high water levels in the wet well may result.
- The Main Gate (1301) can be used to throttle flow in the event of a throttling gate failure.

2.2 WASTEWATER SCREENING

Unit Processes	Equipment
Screening	4 Climber Bar Screens with 3/4" bar spacing 8 Screen Isolation Sluice Gates Auto/Manual Screen Rakes 2 Cubic Yard Screenings Containers Located At Each Screen 20 Cubic Yard Disposal Container

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• During normal dry weather operations two screens should be in service. • Rotate screen operation to ensure that all available screens are in working order. • Make sure screenings containers are available.

During Wet Weather Event		
SEE	SSTW/STW	• If necessary activate additional screens. • Regulate the plant flow with the throttling gate if the screens become overwhelmed or the water elevation in the screen channel exceeds an elevation in the range of -17.5 ft. • Remove and replace screenings containers as necessary.

After Wet Weather Event		
SEE	SSTW/STW	• Take extra screens out of operation. • Remove screenings for disposal.
Why Do We Do This?		
Two screens can accommodate the plant design dry flow of 60 MGD. Three screens are required to handle up to 120 MGD. This leaves the fourth screen on standby in case of a screen failure or excessive loadings.		
What Triggers The Change?		
Flows in excess of 90 mgd will require additional screen(s) to be put online. Screen rakes will operate on time mode or if the head differential across the screens exceeds 2 to 4 inches.		
What Can Go Wrong?		
If an insufficient number of screens are online the screen channel may surcharge above acceptable levels (greater than elevation –17.5 ft.).		

2.3 WASTEWATER PUMPING

Unit Processes	Equipment
Main Sewage Pumping	5 Worthington Dresser variable speed centrifugal pumps (30 mgd, 400 hp, 585 rpm) 5 variable speed controllers (5 steps) 10 pump isolation valves (30") 5 cone check valves 66" diameter raw sewage line Venturi flowmeter 2 wet well continuous level monitors (one primary, one secondary)

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• During dry weather two pumps are generally in service with two spares and one offline for repair or maintenance. • Pumps are generally cycled to ensure all available pumps are in working order. • Check that wet well level monitors are functional.
During Wet Weather Event		
SEE	SSTW/STW	• Bring a third, fourth and fifth pump on line respectively, based on wet well water levels. • Operate pumps optimally to maintain wet well levels.

After Wet Weather Event		
SEE	SSTW/STW	• The throttling gate should be in the full open position before any pumping changes are made. • As the wet weather flows subside and after the throttling gate is fully open, reduce pump speeds to maintain an acceptable wet well level. • Reduce pump operations to normal or as required as the plant returns to dry weather flow conditions.
Why Do We Do This?		
The pump operating strategy during dry or wet weather is to maintain a safe water level in the wet well typically in the range of elevation -19.0 to -28.0 ft. This is accomplished through a combination of throttling gate and pump operations. Pumps brought up together through the variable speed steps will avoid possible variable discharge pressures across the pumps in service.		
What Triggers The Change?		
The number of pumps online and their speeds are controlled by the wet well water level.		
What Can Go Wrong?		
If the throttling gate and pumps are not operated in a synchronized manner (operations of both are based on wet well water levels) water levels in the wet well will vary significantly and flooding could occur.		

2.4 PRIMARY TANKS

Unit Processes	Equipment
Primary Tanks	1 flow distribution box 4 tanks 8 sludge collectors and 4 cross collectors
Sludge Handling and Distribution	6 primary sludge pumps 6 grit suspension pumps 8 cyclone degritters 6 1 1/4-cubic yard grit containers 4 grit washers

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• Under normal operations all four primary tanks should be in service. • Check the sludge collector operation and inspect tanks for broken flights. • Check for floating sludge or bubbles on the tank surface as an indication of sludge collector problems. • Check sludge pump operation. • Repair any malfunctions or equipment out of service.

During Wet Weather Event		
SEE	SSTW/STW	• Make sure four primary sludge pumps are pumping, back-flush when necessary. • Watch water surface elevations at the weirs for flooding and flow imbalances • Check the collector and drive operation. • Make sure grit flushers are operating. • Assign additional operators to grit handling if necessary. • Repair equipment failures as needed. • Reduce flow (sewage pumps and throttling gate) if: a. Grit accumulation exceeds the plants ability to handle it, b. Loss of equipment warrants reduction, as per Table 2-1.
After Wet Weather Event		
SEE	SSTW/STW	• Take tanks out of service for repair or maintenance if necessary. • Remove floating debris and scum on the tanks. • Repair any failures. • If warranted clean the effluent weirs.

Why Do We Do This?
Flows need to be balanced to the primary tanks for the following reasons: 1. maximize suspended solids and CBOD removal, 2. prevent premature weir flooding, 3. prevent short circuiting, 4. prevent excessive sludge and grit accumulation in individual clarifiers, 5. maximize scum removal. Sludge blankets need to be kept to minimum levels to avoid excessive torque on the collectors. Normal operation practices are intended to keep sludge blankets at minimum levels.
What Triggers The Change?
Primary tank wet weather operations are very similar to dry weather operations. Excessive grit accumulation from the sludge degritters will be an indication of severe first flush loads that may require throttling.
What Can Go Wrong?
During wet weather the plant may experience high grit loads related to collection system and interceptor sediment being scoured into the plant. Operators must manage flow distribution, and sludge and grit collection equipment to prevent primary tank and grit clarifier failure.

2.5 BYPASS CHANNEL

Unit Processes	Equipment
Bypass Channel	2 sluice gates (before and after flume) Parshall flume calibrated to 35 MGD

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• Conduct routine bypass gate preventative maintenance. • Check the bypass flow meter operation.
During Wet Weather Event		
SEE	SSTW/STW	• Open the bypass gate to Parshall flume when the plant influent flow exceeds 90 MGD. • Open the bypass gate if the primary clarifier weirs flood when less than 3 primaries are in service (refer to Table 2-1). • Open the bypass gate to protect final clarifier blanket levels from going overboard. • Open bypass gate downstream of Parshall flume when required • Repair failures as necessary.

After Wet Weather Event		
SEE	SSTW/STW	• Close bypass downstream of Parshall Flume after storm event. • As the plant flow drops and stays below 90 mgd (no bypass flow), close the bypass gate to the Parshall flume. • These action levels should be reduced if less than three primary tanks are in service.

Why Do We Do This?
• To relieve flow to the aeration system and avoid excessive loss of biological solids. • To relieve primary clarifier flooding.

What Triggers The Change?
A flow trigger of 90 MGD.

What Can Go Wrong?
If the bypass gate is not used properly the primary clarifier may flood and the secondary clarifier sludge blankets could rise and discharge large amounts of biological solids.

2.6 AERATION TANKS

Unit Processes	Equipment
Aeration Tanks	2 Channel Air Blowers 4 Process Air Blowers 4 tanks, 4 passes per tank Continuous dissolved oxygen analyzer (located in D pass of each tank)

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• During normal dry weather operations all necessary aeration tanks should be in operation. • The plant usually operates in a step feed mode, which requires even air distribution to each pass. • Check the dissolved oxygen levels and control the airflow to maintain greater than 2 mg/L in the aeration tanks.

During Wet Weather Event		
SEE	SSTW/STW	• Maintain step feed mode. • Monitor the dissolved oxygen.

After Wet Weather Event		
SEE	SSTW/STW	• Maintain greater than 2 mg/L dissolved oxygen. • Monitor the dissolved oxygen
Why Do We Do This?		
Wet weather operation of the aeration tanks is identical to dry weather operations.		
What Triggers The Change?		
There are no significant changes to the aeration tank operation during wet weather.		
What Can Go Wrong?		
The operator must be careful not to let the dissolved oxygen levels drop much below 2.0 mg/l because this can affect secondary treatment efficiency.		

2.7 FINAL CLARIFIERS AND DISTRIBUTION

Unit Processes	Equipment
Final Clarifiers	8 tanks, 3 bays per tank 4 Return sludge pumps 3 Waste sludge pumps

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• During normal dry weather operation necessary final clarifiers should be in service. • Check the telescoping valves for plugging. Free any plugged valves. • Observe tank surface. • Skim tanks as necessary. • Check the flow balance to all tanks in service by looking at effluent weirs. • Normal operation is to set the RAS rates to maintain low sludge blanket levels.

During Wet Weather Event		
SEE	SSTW/STW	• Observe the clarity of the effluent and watch for solids loss. • If necessary, increase the RAS rate to maintain low blanket levels. • Open the secondary bypass if secondary treatment flow exceeds 90 mgd.

<table>
<tr><th colspan="3">After Wet Weather Event</th></tr>
<tr><td>SEE</td><td>SSTW/STW</td><td>• Modify the sludge wasting based on MLSS levels when applicable.
• Close the secondary bypass when the flow drops below 90 mgd.
• Monitor effluent clarity.
• Skim the clarifiers if needed.</td></tr>
<tr><th colspan="3">Why Do We Do This?</th></tr>
<tr><td colspan="3">High flows will substantially increase hydraulic loadings to the clarifiers, which may result in higher levels of effluent suspended solids. These conditions can lead to loss of biological solids, which can destabilize treatment efficiency when the plant returns to dry weather flow conditions.</td></tr>
<tr><th colspan="3">What Triggers The Change?</th></tr>
<tr><td colspan="3">Washout of solids.</td></tr>
<tr><th colspan="3">What Can Go Wrong?</th></tr>
<tr><td colspan="3">Excessive loss of suspended solids will reduce the biomass inventory of the plant, which will adversely affect secondary treatment efficiency when the plant returns to dry weather flow conditions.</td></tr>
</table>

2.8 SLUDGE THICKENING, DIGESTION AND STORAGE

Unit Processes	Equipment
Sludge Thickeners	4 Gravity thickeners 8 Thickened sludge pumps
Anaerobic digestion	6 Anaerobic digesters 12 Digester mixing pumps 36 sludge heaters 4 Hot Loop Sludge pumps 4 sludge transfer pumps 1 Gas holder
Sludge Storage	2 Sludge storage tanks 2 Variable speed, Centrifugal sludge transfer pumps
Sludge Dewatering	2 Centrifuges

During Wet Weather Event		
SEE	SSTW/STW	• Sludge handling activities should proceed as they do during dry weather. The major plant return stream is thickener overflow. This cannot be reduced unless sludge wasting is also reduced. • Balance water flow to the thickeners can be reduced before any changes in sludge wasting.

2.9 CHLORINATION

Unit Processes	Equipment
Chlorination	2 Contact tanks, 2 passes each 2 Hypochlorite pumps 3 10,000 gallon storage tanks 4 Positive displacement Hypochlorite metering pumps

HO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• Make sure both chlorination tanks are in service. • Normal operation is to maintain full Hypochlorite tanks. • Make sure there are sufficient chlorine residual test kit supplies. • Perform preventative maintenance on equipment as necessary.

During Wet Weather Event		
SEE	SSTW/STW	• Check, adjust and maintain the Hypochlorite feed rates to provide chlorine residual at determined target of less than 2 mg/l. • Increase the chlorine residual measurements as necessary. • Check the Hypochlorite Tank levels in service and switch as necessary.

After Wet Weather Event		
SEE	SSTW/STW	• Drop the Hypochlorite feed rates as needed to maintain the chlorine residual. • Repair equipment as necessary.
Why Do We Do This?		
Hypochlorite demand will increase as flow rises and secondary bypasses occur. Increase the Hypochlorite feed rates to maintain the target chlorine residual.		
What Triggers The Change?		
High flows and secondary bypasses will increase Hypochlorite demand and usage.		
What Can Go Wrong?		
Manual chlorination control with rapid flow changes and effluent quality changes can cause the chlorine residual to increase or decrease dramatically. Effluent chlorine residual must be monitored closely to maintain the target residual.		

APPENDIX B

BIOLOGICAL EXHIBITS

Exhibit B-1. Taxa Collected During Subtidal Benthos Sampling, Years 2000-2002

		East River	Jamaica Bay	All Waterbodies
Acteocina Canaliculata	Channeled Barrel-bubble Snail	x		x
Ampelisca Abdita	Small Four-eyed Amphipod	x	x	x
Ampelisca Vadorum	Long-antennaed Four-eyed Amphipod	x	x	x
Ampharetidae	Ampharetidae		x	x
Anemone	Anemone		x	x
Aoridae	Aoridae		x	x
Arabella Iricolor	Opal Worm	x		x
Arcidae	Arcidae		x	x
Aricidea	Aricidea		x	x
Asteroidea	Starfishes	x		x
Cabira Incerta	Cabira Incerta		x	x
Capitella Capitata	Capitella Capitata	x	x	x
Caprellidae	Caprellidae		x	x
Cirratulidae	Cirratulidae		x	x
Clymenella Torquata	Common Bamboo Worm		x	x
Corophium	Corophium	x	x	x
Crangon Septemspinosa	Sand Shrimp	x	x	x
Crepidula Fornicata	Common Atlantic Slippersnail	x	x	x
Cyathura Polita	Slender Isopod		x	x
Elasmopus Laevis	Elasmopus Laevis		x	x
Ericthonius	Ericthonius		x	x
Eteone	Eteone	x	x	x
Eulalia	Eulalia	x	x	x
Gammarus Mucronatus	Spine-backed Scud		x	x
Glycera	Bloodworms	x	x	x
Haploscoloplos	Haploscoloplos	x	x	x
Harmothoe Extenuata	Harmothoe Extenuata		x	x
Hydroida	Medusae		x	x
Insecta	Insects	x	x	x
Jassa Falcata	Mottled Tube-builder Amphipod	x		x
Limulus Polyphemus	Atlantic Horseshoe Crab		x	x
Lumbrineris	Lumbrineris	x		x
Lysianopsis Alba	Lysianopsis Alba	x	x	x
Melampus Bidentatus	Eastern Melampus	x		x
Melita Nitida	Melita Nitida		x	x
Mercenaria Mercenaria	Northern Quahog		x	x
Microdeutopus Gryllotalpa	Microdeutopus Gryllotalpa	x	x	x
Mulinia Lateralis	Dwarf Surfclam	x		x
Mya Arenaria	Softshell Clam	x	x	x
Mysidacea	Opossom Shrimp	x		x
Nassarius Obsoletus	Eroded Basket Shell	x	x	x
Nassarius Trivittatus	New England Nassa	x	x	x
Nematoda	Threadworms	x	x	x
Nephtys Incisa	Nephtys Incisa	x		x
Nereis Succinea	Common Clamworm	x	x	x
Nucula Proxima	Atlantic Nutclam		x	x

Exhibit B-1. Taxa Collected During Subtidal Benthos Sampling, Years 2000-2002 (Continued)

		East River	Jamaica Bay	All Waterbodies
Nudibranchia	Nudibranchs		x	x
Oligochaeta	Oligochaetes	x	x	x
Orbiniidae	Orbiniidae	x	x	x
Ovalipes Ocellatus	Lady Crab		x	x
Ovatella Myosotis	Mouse Ear Marsh Snail	x		x
Pagurus	Hermit Crabs	x	x	x
Palaemonetes	Grass Shrimps		x	x
Pandora Gouldiana	Gould Pandora	x		x
Paraphoxus Epistomus	Paraphoxus Epistomus	x		x
Pectinaria Gouldi	Trumpet Worm	x	x	x
Phyllodocidae	Phyllodocidae	x	x	x
Platyhelminthes	Flatworms		x	x
Podarke Obscura	Podarke Obscura		x	x
Polydora	Whip Mud Worm	x	x	x
Polygordius Triestinus	Polygordius Triestinus	x		x
Polynoidae	Polynoidae		x	x
Sabella Microphthalma	Fan Worm	x	x	x
Sabellaria Vulgaris	Sandbuilder Worm		x	x
Scolecolepides Viridis	Red-grilled Mud Worm	x	x	x
Scoloplos	Scoloplos	x		x
Serpulidae	Serpulidae		x	x
Sesarma	Sesarma	x		x
Spionidae	Spionidae	x	x	x
Spisula Solidissima	Atlantic Surfclam	x		x
Stauronereis Rudolphi	Stauronereis Rudolphi		x	x
Streblospio Benedicti	Barred-gilled Mud Worm	x	x	x
Syllidae	Syllidae		x	x
Tellina Agilis	Northern Dward Tellin	x		x
Tharyx	Tharyx	x	x	x
Trichophoxus Epistomus	Trichophoxus Epistomus		x	x
Unciola	Unciola		x	x
Xanthidae	Mud Crabs		x	x
Yoldia	Yoldia	x		x
Taxa Total		**48**	**61**	**79**

Exhibit B-2. Taxa Collected During Artificial Substrate Sampling Years 2000-2002

		East River	Jamaica Bay	Other Waterbodies	All Waterbodies
Ampliscidae	Ampeliscidae		x		x
Amphitrite Ornata	Ornat Worm		x		x
Ampithoidae	Ampithoidae	x		x	x
Anadara Ovalis				x	x
Anas Acuta	Northern Pintail		x	x	x
Balanus Eburneus	Ivory Barnacle	x	x	x	x
Botryllus Schlosseri	Golden Star Tunicate	x		x	x
Bugula				x	x
Campanularia	Hydroid		x	x	x
Caprellidae	Caprellidae		x	x	x
Carcinus Maenas	Green Crab		x	x	x
Crangon Septemspinosa	Sand Shrimp	x	x	x	x
Crepidula Convexa	Convex Slippersnail		x	x	x
Crepidula Fornicata	Common Atlantic Slippersnail		x	x	x
Crepidula Plana	Eastern White Slippersnail	x	x	x	x
Diadumene Lineata	Orangestriped Green Anenome	x	x	x	x
Dyspanopeus Sayi	Say Mud Crab	x	x	x	x
Elasmopus Laevis	Elasmopus Laevis	x		x	x
Eumida Sanguinea	Eumida Sanguinea	x	x	x	x
Euspira Heros	Northern Moonsnail		x	x	x
Fistularia Tabacaria				x	x
Gammaridea	Gammarid Amphipods	x	x	x	x
Gammarus Oceanicus	Gammarus Oceanicus	x	x	x	x
Gastropoda				x	x
Geukensia Demissa	Ribbed Mussel	x		x	x
Gobiidae	True Gobies	x	x	x	x
Hemigrapsus Sanguineus	Pacific Grapsid Shore Crab		x	x	x
Hydroida	Medusae		x	x	x
Hydroides Dianthus	Limy Tube Worm	x	x	x	x
Hypsoblennius Hentzi	Feather Blenny		x	x	x
IlYanassa Obsoleta	Eastern Mudsnail	x	x	x	x
Isopoda	Sowbugs	x		x	x
Jassa Falcata	Mottled Tube-builder Amphipod	x	x	x	x
Jassa Marmorata	Jassa Marmorata		x	x	x
Lepidonotus		x		x	x
Leptocheirus Pinguis	Leptocheirus Pinguis	x	x	x	x
Libinia Emarginata				x	x
Membranipora Tenuis	Coffin Box Bryozoan		x	x	x
Mercenaria Mercenaria	Northern Quahog		x	x	x
Microdeutopus Gryllotalpa	Microdeutopus Gryllotalpa	x		x	x
Molgula Manhattensis	Sea Grapes (Sea Squirt)	x	x	x	x
Mya Arenaria	Softshell Clam	x	x	x	x
Mytilus Edulis	Edible Blue Mussel	x	x	x	x
Nereis Succinea	Common Clamworm	x	x	x	x
Nereis Virens	Nereis Virens	x	x	x	x
Nudibranchia				x	x
Onchidorididae	Dorid Nudibranchs	x	x	x	x

Exhibit B-2. Taxa Collected During Artificial Substrate Sampling
Years 2000-2002
(Continued)

		East River	Jamaica Bay	Other Waterbodies	All Waterbodies
Palaemonetes Pugio	Daggerblade Grass Shrimp	x	x	x	x
Palaemonetes Vulgaris	Marsh Shrimp	x	x	x	x
Panopeus Herbstii	Atlantic Mud Crab	x	x	x	x
Pinnotheres Maculatus	Squatter Pea Crab	x		x	x
Pleustidae	Pleustidae	x	x	x	x
Polychaeta	Polycheates	x	x	x	x
Polynoidae	Polynoidae	x	x	x	x
Rhithropaopeus Harrisii	Harris Mud Crab	x	x	x	x
Sabella Microphthalma	Fan Worm	x	x	x	x
Sabellaria Vulgaris	Sandbuilder Worm		x	x	x
Spionidae	Spionidae	x	x	x	x
Spirorbis Borealis	Spirorbis Borealis		x	x	x
Stenothoidae	Stenothoidae		x	x	x
Styela Paritta	Atlantic Rough Sea Squirt		x	x	x
Suberites Ficus	Suberites Ficus		x	x	x
Tautogolabrus Adspersus	Cunner	x	x	x	x
Tubularia	Tubularia	x		x	x
Urosalpinx Cinerea	Atlantic Oyster Drill	x	x	x	x
Xanthidae	Mud Crabs	x	x	x	x
Taxa Total		40	50	64	66

Exhibit B-3. Taxa Collected During Harbor-Wide Ichthyoplankton Sampling, Years 2000-2002

		East River	Jamaica Bay	Other Waterbodies	All Waterbodies
Ammodytes Americanus	American Sand Lance	x	x	x	x
Anchoa Mitchelli	Bay Anchovy	x	x	x	x
Anguilla Rostrata	American Eel		x	x	x
Blenniidae	Blennies	x	x		x
Brevoortia Tyrannus	Atlantic Menhaden	x	x	x	x
Clupea Harengus	Atlantic Herring		x	x	x
Clupeidae	Herrings	x			x
Cynoscion Regalis	Weakfish	x	x		x
Enchelyopus Cimbrius	Fourbeard Rockling	x	x	x	x
Fundulus Diaphanus	Banded Killfish		x		x
Fundulus Majalis	Striped Killfish		x		x
Gasterosteus Aculeatus	Threespine Stickleback	x			x
Gobiidae	Ttue Gobies	x			x
Gobiosoma Bosc	Naked Goby		x	x	x
Gobiosoma Ginsburgi	Seaboard Goby		x	x	x
Hippocampus Erectus	Spotted Seahorse		x	x	x
Hypsoblennius Hentzi	Feather Blenny	x	x	x	x
Menidia Menidia	Atlantic Silverside	x	x	x	x
Microgadus Tomcod				x	x
Myoxocephalus	Myoxocephalus	x	x	x	x
Paralichthys Dentat	Summer Flounder		x	x	x
Paralichthys Oblongus	Fourspot Flounder		x		x
Peprilus Triacanthus	Butterfish		x	x	x
Pholis Gunnellus	Rock Gunnel		x	x	x
Prionotus	North American Searobins	x	x	x	x
Pseudopleuronectes Americanus	Winter Flounder	x	x	x	x
Scomber Scombrus	Atlantic Mackerel		x		x
Scophthalmus Aquosus	Windowpane	x	x	x	x
Sphoeroides Maculatus	Northern Puffer		x	x	x
Sphoeroides Nephelus	Southern Puffer	x			x
Stenotomus Chrysops	Scup	x	x	x	x
Syngnathus Fuscus	Northern Pipefish	x	x	x	x
Tautoga Onitis	Tautog	x	x	x	x
Trinectes Maculatus					x
Tautogolabrus Adspersus	Cunner	x	x	x	x
Taxa Total		**20**	**29**	**24**	**35**

Exhibit B-4. Ichthyoplankton Species Ranked by Total Numbers Collected in Harbor-Wide 2001 Samples

Species Name	S (# Eggs/100m^3)	S (# Larvae/100m^3)	Eggs+ Larvae	Frequency of Occurrence*	
				Eggs	Larvae
TAUTOGOLABRUS ADSPERSUS	13983.03	15.37	13998.41	149	17
ANCHOA MITCHELLI	12884.00	215.25	13099.25	129	42
CLUPEIDAE	11988.04	671.05	12659.09	62	97
BREVOORTIA TYRANNUS	6547.18	390.59	6937.76	50	31
TAUTOGA ONITIS	4944.24	15.11	4959.35	133	14
SCOPHTHALMUS AQUOSUS	3250.71	305.92	3556.63	87	84
ENCHELYOPUS CIMBRIUS	2860.68	18.98	2879.65	49	20
PSEUDOPLEURONECTES AMERICANUS	52.46	2824.56	2877.01	27	207
LABRIDAE	1758.65	23.19	1781.84	36	14
PRIONOTUS	1744.93	0.00	1744.93	85	0
GOBIIDAE	0.00	896.82	896.82	0	113
MYOXOCEPHALUS	0.00	439.50	439.50	0	134
STENOTOMUS CHRYSOPS	425.07	1.85	426.92	15	2
MICROGADUS TOMCOD	0.00	111.57	111.57	0	5
AMMODYTES AMERICANUS	0.00	104.88	104.88	0	73
ANCHOA	1.29	68.81	70.10	2	40
SYNGNATHUS FUSCUS	0.00	67.16	67.16	0	42
MENIDIA MENIDIA	0.00	60.25	60.25	0	35
GOBIOSOMA BOSC	0.00	59.61	59.61	0	6
CLUPEA HARENGUS HARENGUS	0.00	18.61	18.61	0	13
HIPPOCAMPUS ERECTUS	0.00	11.46	11.46	0	11
HYPSOBLENNIUS HENTZI	0.00	10.66	10.66	0	12
PHOLIS GUNNELLUS	0.00	8.72	8.72	0	13
CYNOSCION REGALIS	0.00	6.25	6.25	0	8
FUNDULUS DIAPHANUS	0.00	5.10	5.10	0	1
BLENNIIDAE	0.00	3.12	3.12	0	2
PARALICHTHYS DENTATUS	0.00	2.71	2.71	0	3
SPHOEROIDES MACULATUS	0.00	2.26	2.26	0	3
MENIDIA	0.00	2.21	2.21	0	1
GASTEROSTEUS ACULEATUS	0.00	2.12	2.12	0	2
TRINECTES MACULATUS	0.00	2.06	2.06	0	4
FUNDULUS MAJALIS	0.00	1.23	1.23	0	1
ANGUILLA ROSTRATA	0.00	0.75	0.75	0	2
PARALICHTHYS OBLONGUS	0.00	0.65	0.65	0	3
GOBIOSOMA GINSBURGI	0.00	0.64	0.64	0	0
SPHOEROIDES NEPHELUS	0.00	0.55	0.55	0	0
SCOMBER SCOMBRUS	0.54	0.00	0.54	1	0
PEPRILUS TRIACANTHUS	0.49	0.00	0.49	1	0
CLUPEA HARENGUS	0.00	0.26	0.26	0	0

*Out of 300 samples

Exhibit B-5. Fish Taxa Collected During Harbor-Wide Fisheries Sampling Years 2000-2002

Taxa		East River	Jamaica Bay	All Waterbodies
Alosa Aestivalis	Blueback Herring	x	x	x
Anchoa Mitchelli	Bay Anchovy	x	x	x
Anguilla Rostrata		x		x
Astroscopus Guttatus	Northern Stargazer		x	x
Brevoortia Smithi	Yellowfin Menhaden	x		x
Brevoortia Tyrannus	Atlantaic Menhaden	x	x	x
Brosme Brosme	Cusk	x		x
Caranx Hippos	Crevalle Jack	x		x
Centropristis Striata	Black Sea Bass	x	x	x
Clupea Harangus	Atlantic Herring	x		x
Clupeidae	Herrings	x		x
Cynoscion Regalis	Weakfish	x	x	x
Dorosoma Cepedianum	Gizzard Shad		x	x
Enchelyopus Cimbrius	Fourbeard Rockling		x	x
Etropus Microstomus	Smallmouth Flounder		x	x
Ffunulus Heteroclitus	Mummichog		x	x
Gobiosoma Bosc	Naked Goby	x	x	x
Lepophidium Profundorum	Fawn Cusk-eel		x	x
Liparis	Snailfishes		x	x
Menidia Menidia	Atlantaic Silverside	x	x	x
Morone Saxatilus	Striped Bass	x	x	x
Mustelus Canis	Smooth Dogfish		x	x
Odontaspis Taurus	Sand Tiger		x	x
Opsanus Pardus	Leopard Toadfish	x		x
Paralichthys Dentatus	Summer Flounder	x	x	x
Peprilus Triacanthus	Butterfish	x	x	x
Pomatomus Saltatrix	Bluefish	x	x	x
Prionotus Carolinus	Northern Searobin	x	x	x
Prionotus Evolans	Striped Searobin	x	x	x
Pseudopleuronectes Americanus	Winter Flounder	x	x	x
Scophthalmus Aquosus	Windowpane	x	x	x
Selene VomerR	Lookdown		x	x
Sphoeroides Maculatus	Northern Puffer	x		x
Stenotomus Chrysops	Scup	x	x	x
Syngnathus Fuscus	Northern Pipefish	x	x	x
Tautoga Onitis	Tautog	x	x	x
Tautogolabrus Adspersus	Cunner	x	x	x
Triglidae	Searobins	x	x	x
Urophycis Regia	Spotted Hake		x	x
Taxa Total		28	31	39

Exhibit B-6. Other Taxa Collected During Harbor-Wide Fisheries Sampling Years 2000-2002

Taxa	East River	Jamaica Bay	All Waterbodies
Abacola Holothuriae		x	x
Ablabesmyia	x	x	x
Ampelisca Abdita		x	x
Amphipoda	x	x	x
Anemone	x	x	x
Asterias Forbesi	x		x
Asteridae	x		x
Aurelia Aurita		x	x
Balanus		x	x
Calcareous Worm Tubes		x	x
Callinectes Sapidus	x	x	x
Cancer Irroratus	x	x	x
Carcinus Maenas	x	x	x
Cnidaria		x	x
Crangon Septemspinosa	x	x	x
Crepidula Fornicata	x	x	x
Crepidula Plana		x	x
Ctenophora	x	x	x
Dyspanopeus Sayi	x	x	x
Eurypanopeus Depressus		x	x
Euspira Heros		x	x
Hydrioda		x	x
Hydroides Dianthus		x	x
Illex Illecebrosus		x	x
Ilyanassa Obsoleta	x	x	x
Libinia Emarginata	x	x	x
Limulus Polyphemus	x	x	x
Malaclemys Terrapin	x	x	x
Mercenaria Mercenaria	x	x	x
Microciona Prolifera	x	x	x
Modiolus Demissus		x	x
Molgula Manhattensis	x	x	x
Mytilus Edulis	x		x
Nassarius Obsoletus	x	x	x
Nassarius Trivittatus		x	x
Neopanope Texana		x	x
Nereidae		x	x
Ovalipes Ocellatus		x	x
Pagurus Acadianus	x	x	x
Pagurus Longicarpus	x	x	x
Pagurus Pollicaris		x	x
Palaemonetes Pugio	x	x	x
Palaemonetes Vulgaris		x	x
Panopeus Herbstii	x	x	x
Pelecypoda	x		x
Penaeus Aztecus	x		x
Polychaeta	x	x	x
Porifera	x	x	x
Rhithropanopeus Harrisii		x	x
Rhodophycota		x	x
Sciaenidae		x	x
Ulva Lactuca		x	x
Urochordata	x	x	x
Worm Tubes		x	x
Xanthidae	x		x
Taxa Total	31	49	55

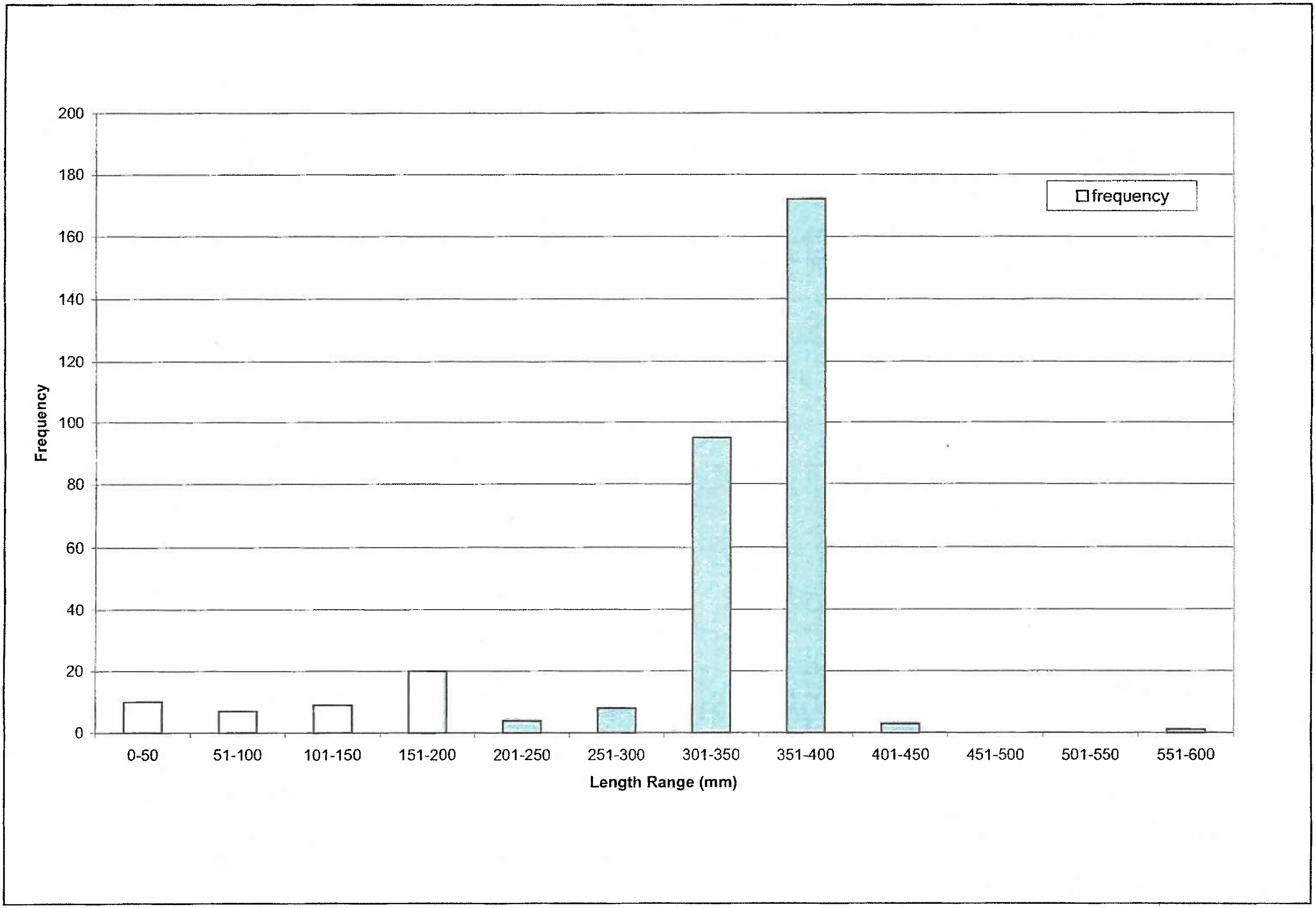

Exhibit B-7
Length of Atlantic Menhaden Collected During USA Project Fish Sampling Surveys
Years 2000-2002

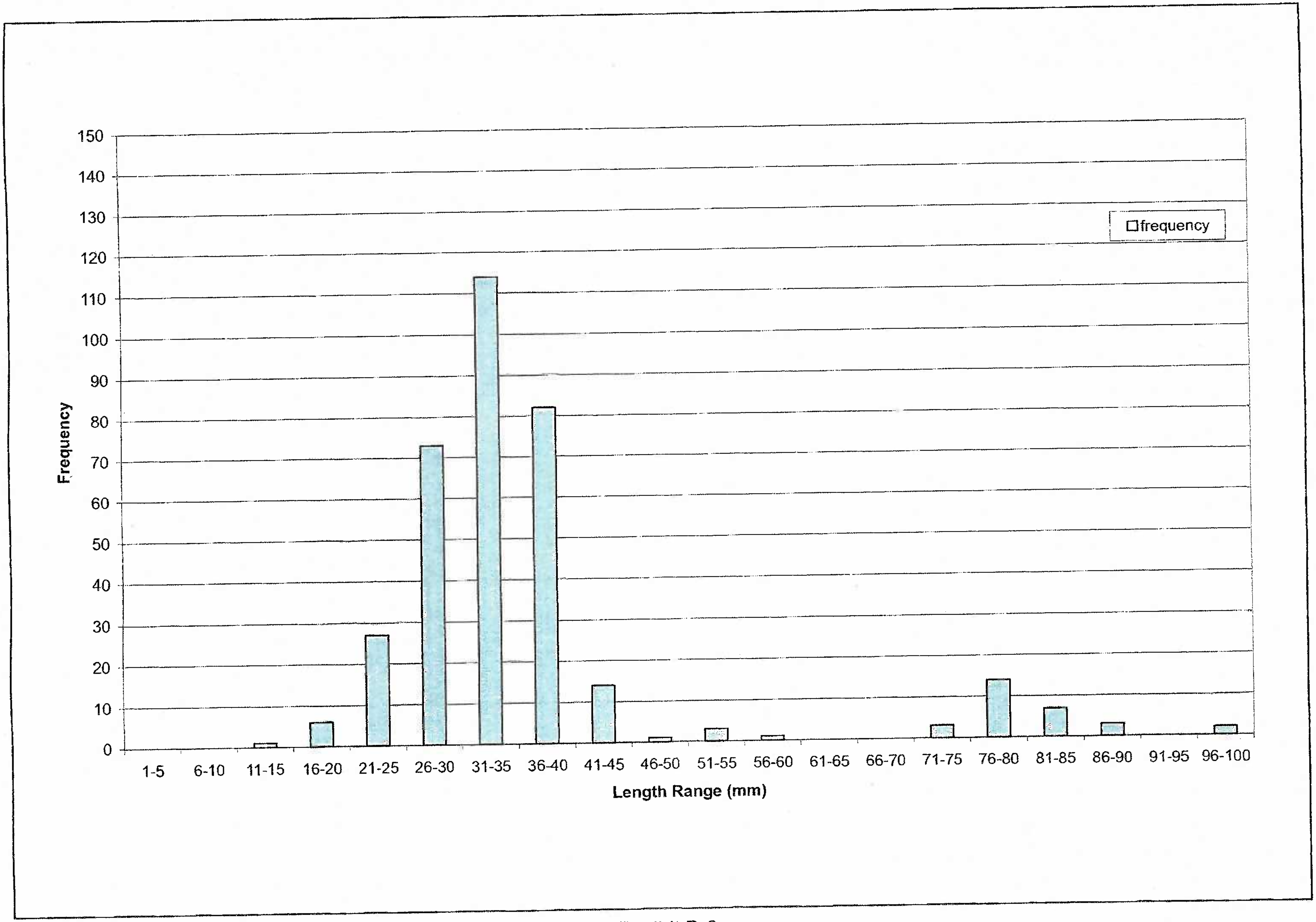

Exhibit B-8
Length of Bay Anchovy Collected During USA Project Fish Sampling Surveys
Years 2000-2002

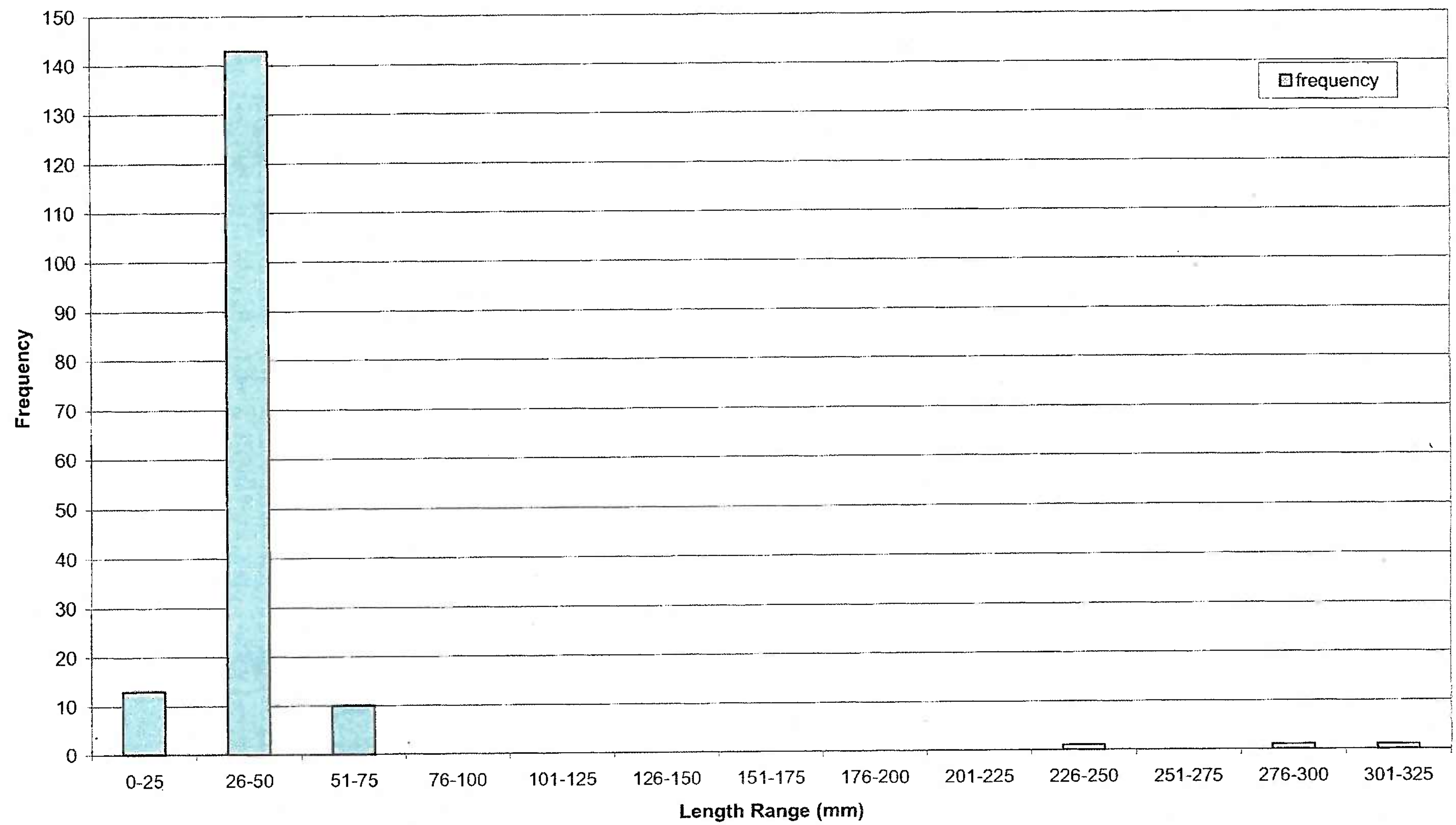

Exhibit B-9
Length of Blueback Herring Collected During USA Project Fish Sampling Surveys
Years 2000-2002

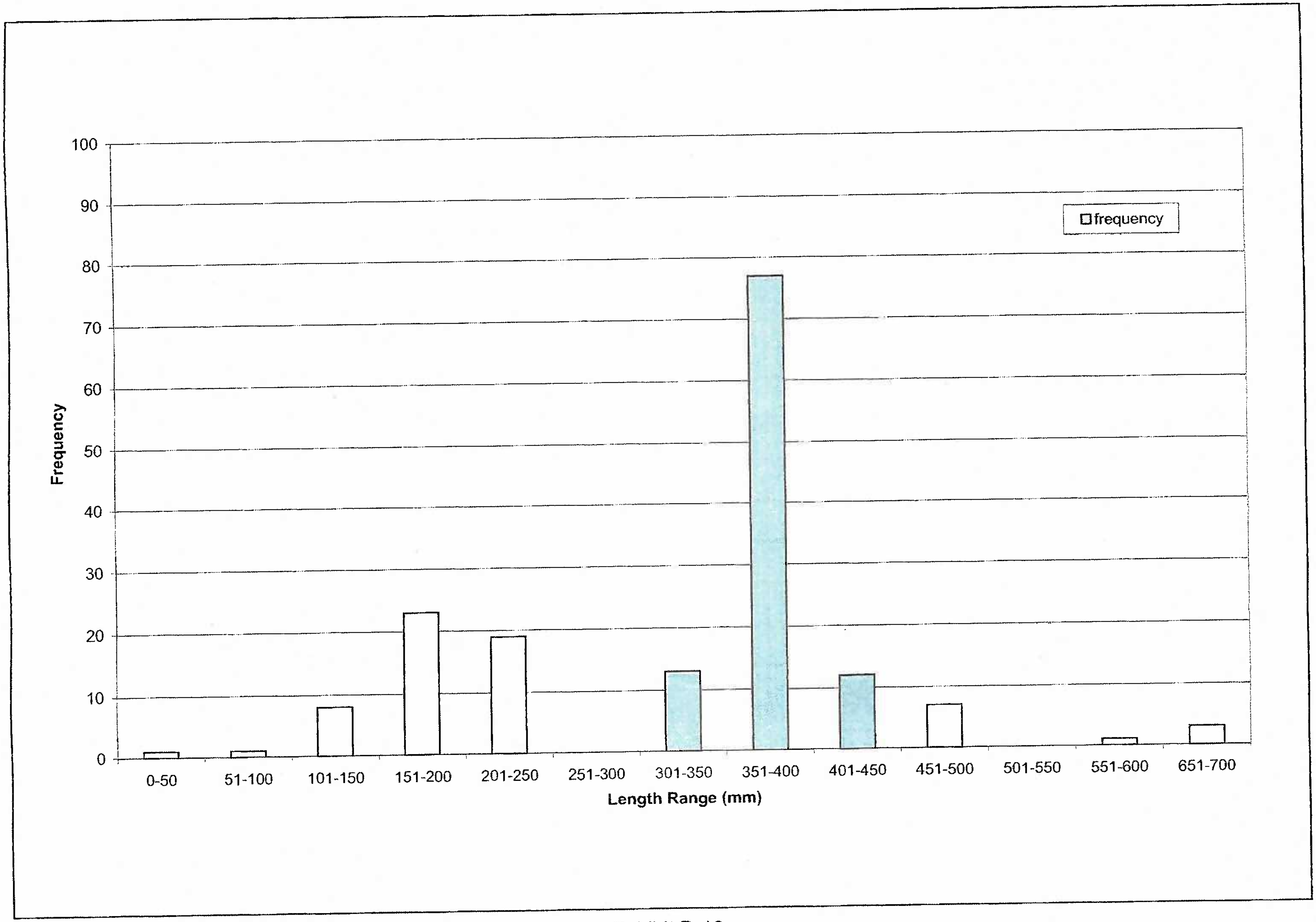

Exhibit B-10
Length of Bluefish Collected During USA Project Fish Sampling Surveys
Years 2000-2002

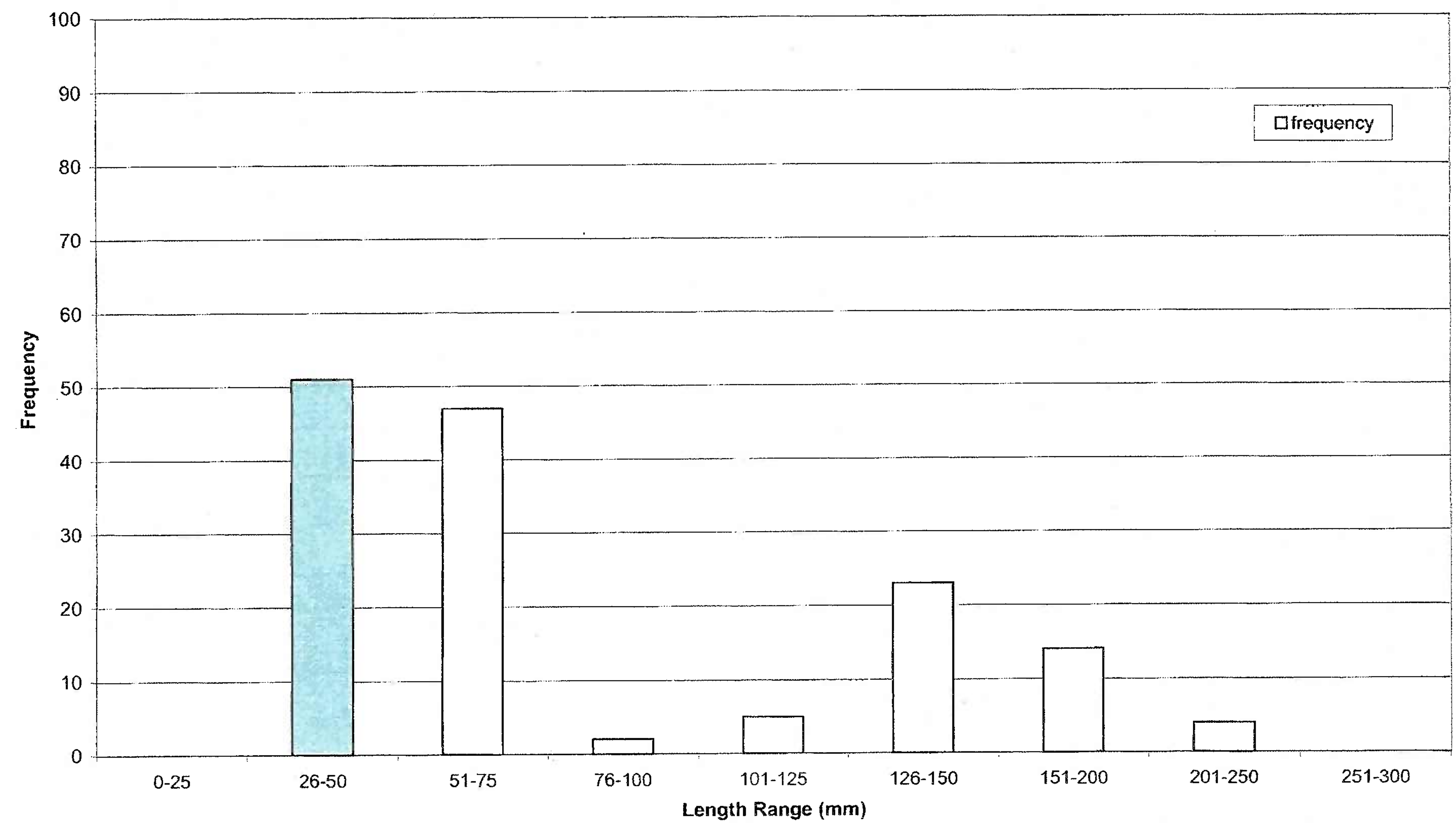

Exhibit B-11
Length of Scup Collected During USA Project Fish Sampling Surveys
Years 2000-2002

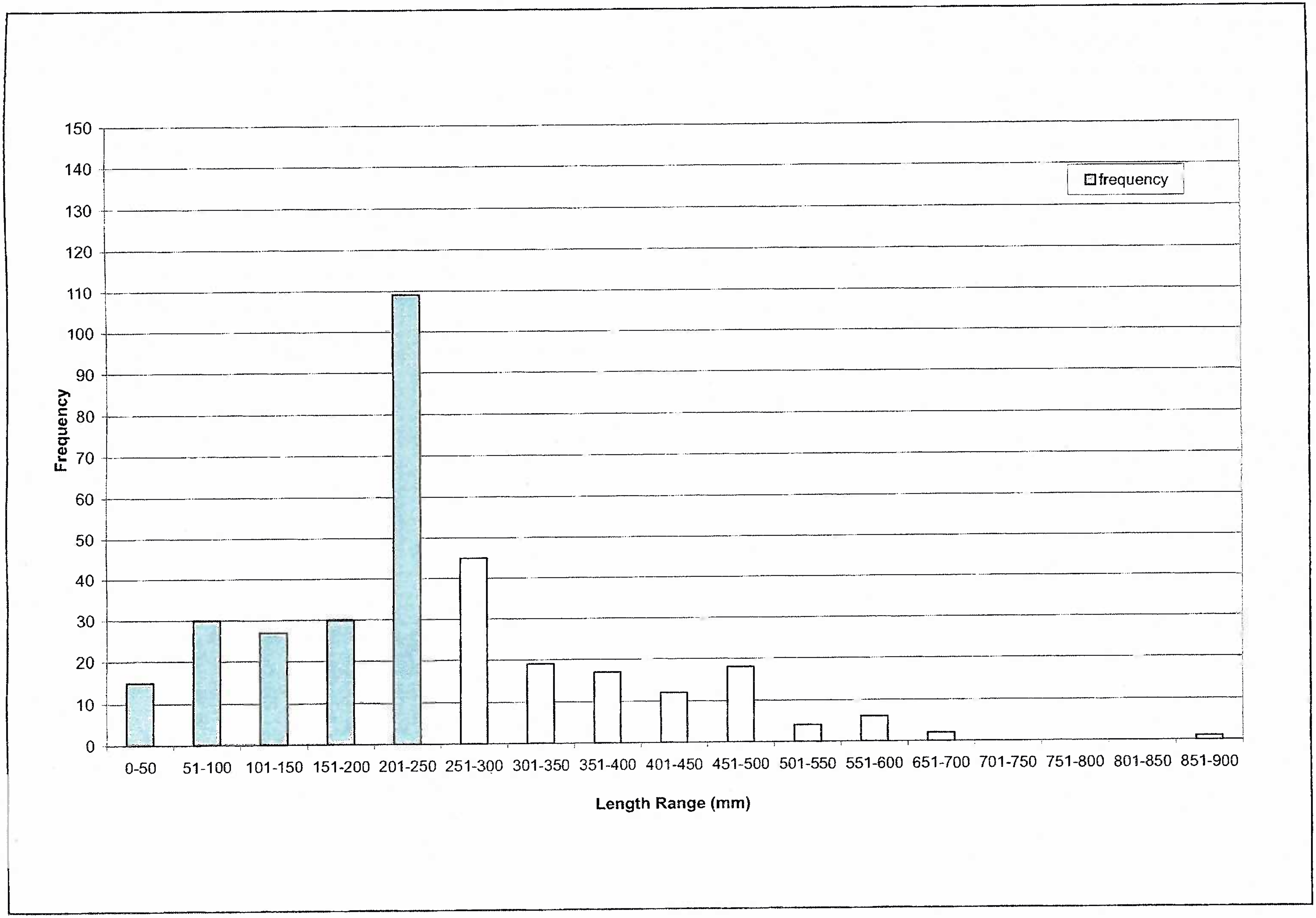

Exhibit B-12
Length of Striped Bass Collected During USA Project Fish Sampling Surveys
Years 2000-2002

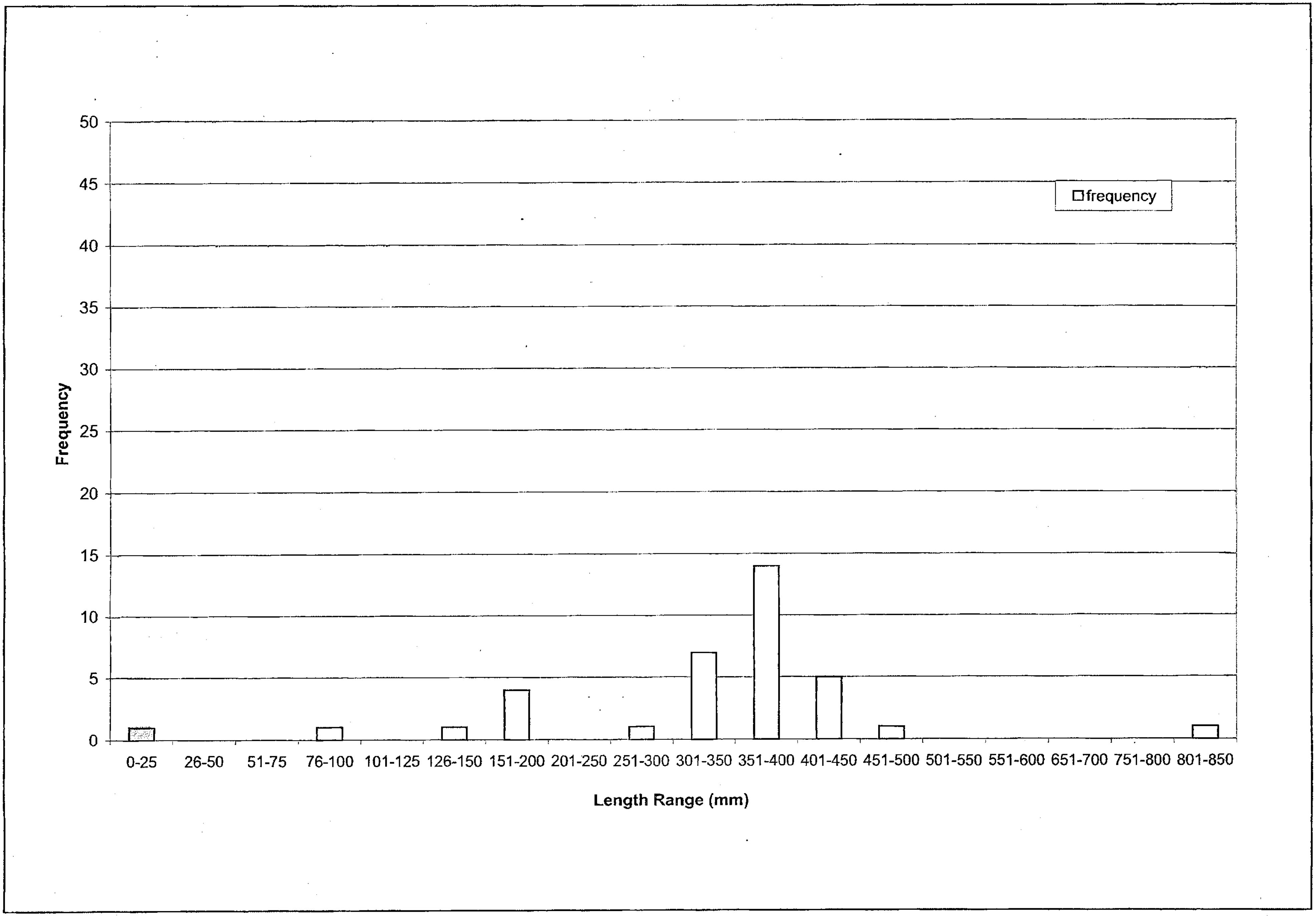

Exhibit B-13
Length of Summer Flounder Collected During USA Project Fish Sampling Surveys
Years 2000-2002

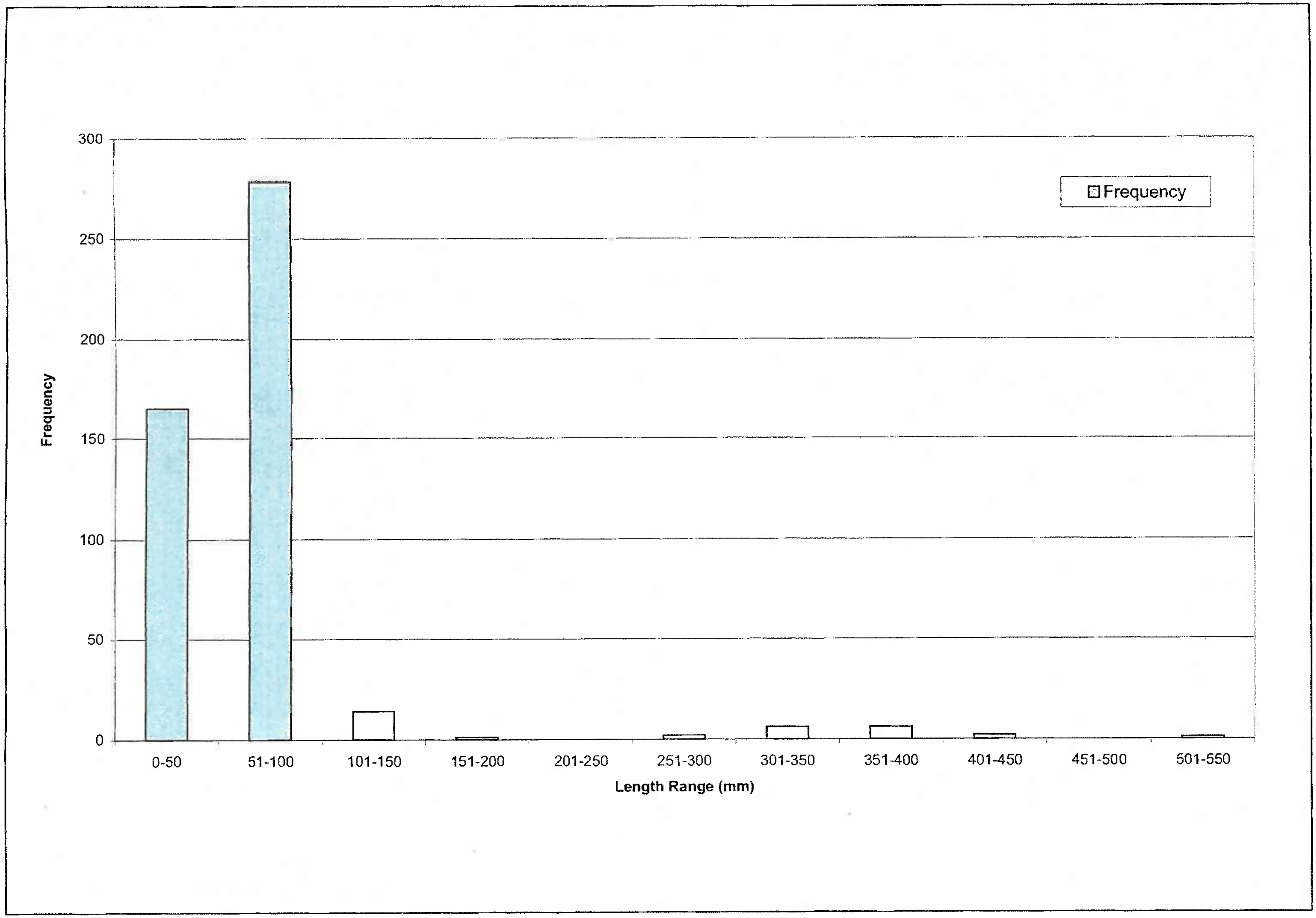

Exhibit B-14
Length of Weakfish Collected During USA Project Fish Sampling Surveys
Years 2000-2002

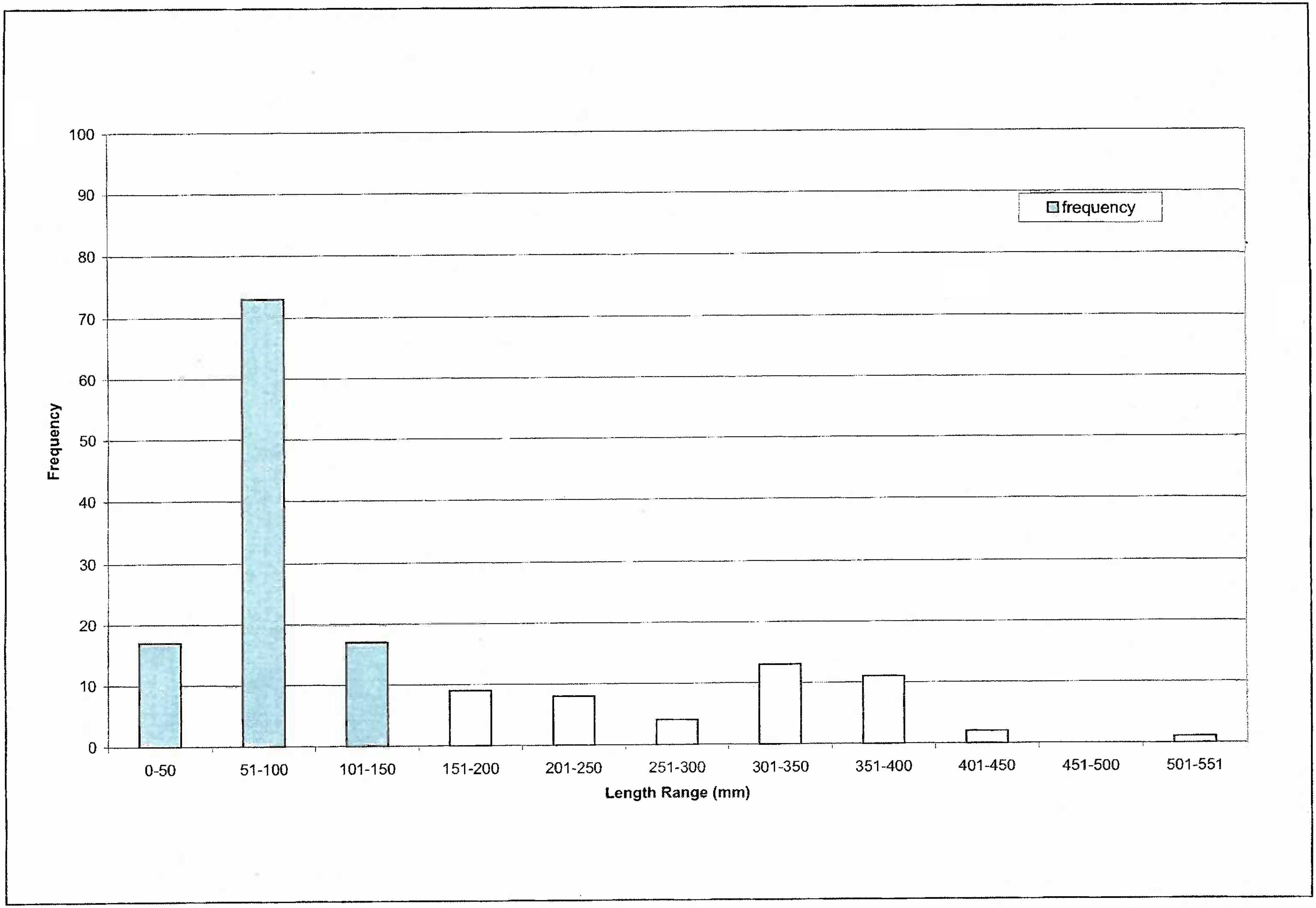

Exhibit B-15
Length of Winter Flounder Collected During USA Project Fish Sampling Surveys
Years 2000-2002

Exhibit B-16. Species of Fish Eggs Caught in Ichthyoplankton Samples in 2001

Latin Name (Common Name)	BRNXI01	BRNXI02	HUCHI01	HUCHI02	WESTI01	PAERI01	FRSHI01	HECRI01	JAMBI01	ALLYI01	ARTHI01	ARTHI02	ARTHI03	BERGI01	CONEI01	EASTI01	EASTI02	EASTI03	EASTI04	FLSHI01	FLSHI02	GOWCI01	GOWCI02	HARLI01	HEBAI01	HUDRI01	HUDRI02	HUDRI03	JAMBI02	JAMBI03	JAMBI04	JAMBI05	KVNKI01	KVNKI02	LBAYI01	LBAYI02	LOBEI01	MABAI01	MILLI01	MILLI02	NEWTI01	NEWTI02	NOBAI01	RARII01	RARII02	SHLLI01	SPCRI01	THURI01	UBAYI01	UBAYI02
Anchoa Mitchelli (Bay Anchovy)		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P					P		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	
Brevoortia Tyrannus (Atlantic Menhaden)		P	P	P				P	P		P	P		P				P		P	P	P		P		P								P	P								P							P
Clupeidae (Herrings)	P	P		P	P	P			P	P		P	P		P	P		P	P		P					P	P	P	P	P			P	P	P			P				P	P	P	P		P	P	P	P
Enchelyopus Cimbrius (Fourbeard Rockling)	P	P	P	P	P					P				P		P	P	P	P	P	P							P			P				P		P	P						P					P	P
Labridae (Wrasses)					P		P		P		P	P			P	P	P	P						P	P	P	P				P	P	P		P		P				P	P	P		P					
Peprilus Triacanthus (Butterfish)																																	P																P	
Prionotus (Searobins)		P		P	P	P	P	P	P			P	P	P	P	P	P	P	P	P					P		P	P		P	P	P		P	P	P	P		P	P			P	P		P	P	P	P	P
Pseudopleuronectes Americanus (Winter Flounder)											P												P								P				P		P						P						P	
Scomber Scombrus (Atlantic Mackerel)																																														P				
Scophthalmus Aquosus (Windowpane)	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P			P			P		P	P	P	P	P	P		P	P	P	P			P	P	P	P	P	P	P	P
Stenotomus Chrysops (Scup)		P							P					P														P		P	P	P											P	P	P				P	P
Tautoga Onitis (Tautog)	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P	P	P	P	P			P	P	P	P		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Tautogolabrus Adspersus (Cunner)	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		P	P	P	P	P			P			P		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Total Number of Taxa	**5**	**9**	**6**	**8**	**8**	**6**	**6**	**6**	**9**	**6**	**7**	**8**	**6**	**8**	**7**	**8**	**5**	**8**	**6**	**6**	**5**	**5**	**1**	**3**	**6**	**5**	**5**	**8**	**2**	**7**	**9**	**7**	**7**	**7**	**10**	**4**	**8**	**6**	**5**	**5**	**4**	**5**	**10**	**8**	**7**	**6**	**6**	**6**	**10**	**8**

APPENDIX C

PUBLIC OPINION SURVEYS

New York City Waterways Study

Gowanus Canal

Fall 2003

Purpose and Objectives

Gowanus Canal Assessment Area

The overall purpose of the study was to measure New York City residents' use of and attitudes toward the water resources in their community and elsewhere. The research covered many different areas relevant to this overall purpose. Among the key topics included were:

- New Yorkers' awareness of the major New York City waterways;
- Their use of the water and the land areas alongside the water for recreational use for various waterways;
- The recreational activities they have participated in and how enjoyable they found these activities;
- If they have not used the various waterways for recreational purposes, the reasons why not;
- Their attitudes toward New York City waterways on a variety of aspects;
- The improvements they have seen in New York City waterways and their desired future improvements.

Method

Gowanus Canal Assessment Area

Interviews were conducted via CATI (Computer Assisted Telephone Interviews) among 18+ year old residents of the five boroughs of New York City.

The sample design for the study was as follows:

- HydroQual selected 26 New York City "primary waterways" to be studied. The specific waterways respondents were asked about were determined by their zip code.
- The sample size for each waterway was to be 300.
- However, because some zip codes are proximate to more than one primary waterway, respondents in those zip codes were asked about two and sometimes three primary waterways. As a result, the number of responses for some individual waterways is greater than 300. In turn, a total of 7,424 interviews were conducted which yielded a total of 8,031 responses to questions about primary waterways.

Method (cont'd)

Gowanus Canal Assessment Area

- Of the total of 7,424 interviews, 5,488 interviews (74%) were conducted using a RDD (random digit dial) sample of the five boroughs.
- The balance of 1,936 interviews was conducted using listed sample specific to the zip codes for those waterways with remaining sample assignments, (i.e., for those assessment areas where an RDD method would have been dispro-portionately expensive due to the relatively low incidence of people living in the areas.)
- Within each household, whether from the RDD or the listed sample, the specific individual interviewed was selected at random from all 18+ year old residents at home.

A list of the 26 primary waterways studied is provided in Appendix A.

Method (cont'd)

Gowanus Canal Assessment Area

As a first step in the questionnaire development process a series of 5 focus groups was conducted among residents of the five boroughs (one in each borough) to ensure that the questionnaire for the telephone survey covered all the relevant issues, and did so in a way that would be clear to respondents.

The questionnaire was then designed in close consultation with HydroQual and NYC DEP senior personnel. A copy is appended at the end of this report.

The interviews, which averaged about 18 minutes in length, were conducted as follows:

- Written instructions regarding the correct administration of the questionnaire were provided and all field supervisors and interviewers were briefed on the study prior to conducting any interviews.
- A pre-test was conducted prior to the full field to ensure that the questionnaire would be clearly understood by respondents.
- The full fieldwork was conducted from late June until early September. Interviewing hours throughout the period were weekday evenings and during both the day and evening on the weekend.

Method (cont'd)

Gowanus Canal Assessment Area

The data were edited and cleaned prior to tabulation. In addition, "other specify" responses to all pre-coded answer list questions were examined and where a sufficient number of responses clustered around a general theme (at least 2% of responses), a code for those responses was added to the pre-coded list in tabulating the data

The final data were weighted as follows:

- Weights were applied to correct for:
  - The unequal probability of household selection due to households with more than one voice telephone number; and
  - The unequal probability of selection of the individual selected for the interview due to different numbers of individuals being available to be interviewed in different households.

Method (cont'd)

Gowanus Canal Assessment Area

- In addition, post-stratification weighting was applied separately for each of the 26 primary waterways to balance the sample data to 2000 U.S. Census Data for:
  - The composition of the household – Single adult (18+) households vs. 2+ adult with children households vs. 2+ adult without children households;
  - Age within gender; and
  - Race/ethnicity.
- Data for each waterbody area were projected to actual population counts from the 2000 Census, so that the areas could be easily combined to yield an appropriately weighted sample of all adults 18+ in the five boroughs of New York City.

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Organization of the Report

Gowanus Canal Assessment Area

A separate report is provided for each of the 26 primary waterways included in the study. In each report, the results for the subject primary waterway is compared to the average for all 26 waterways. (A separate report of the findings on a city-wide basis has also been prepared.)

The findings for each individual waterway are organized as follows:

- Awareness of primary waterways
- Visiting primary waterways
- Participation in recreational activities and attitudes toward primary waterways
- Improvements to primary waterways -- past and desired in the future
- Demographic and other profile information.

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Glossary and Other Reading Notes

Gowanus Canal Assessment Area

- **Area residents** -- live in one of the zip codes that define the subject primary waterway
- **Total NYC residents** -- all respondents
- **Primary waterway** – one of the 26 New York City waterways for which respondents were asked their use of and attitudes toward
- **Other NYC waterways** – other New York City waterways respondents volunteered in response to various questions
- **Unaided awareness** -- a mention of a NYC waterway without prompting or aiding the respondent
- **Total awareness** -- a combination of unaided awareness and aided awareness. i.e., the respondent is given the name and asked if they have ever heard of that waterway
- **Visiting a waterway** -- spending recreational or leisure time in or on the waterway or the land alongside those waters
- **On water activities** – boating/speed boating, canoeing, cruising/tour boat, ferryboat ride (for leisure), kayaking, sailing.
- **In water activities** – jet skiing, surfing, swimming, wading.

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Glossary and Other Reading Notes (cont'd)

Gowanus Canal Assessment Area

All base sizes shown are the actual number of people who were asked the question, prior to projecting them to the population of New York City.

As mentioned earlier, two base sizes are shown for the total for New York City residents depending on the question:

- A base of 8,031 for all questions that are specific to a primary waterway; and
- A base of 7,424 for all questions that are not specific to a primary waterway.

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Glossary and Other Reading Notes (cont'd)

Gowanus Canal Assessment Area

Comparisons of the findings for the subject waterway are made to all New York City residents in two ways:

- An average of the values for all 26 primary waterways; and
- A median value for the 26 waterways -- the value at the mid-point of the values for the 26 waterways, that is, there are an equal number of values above and below the median value.

The median value is shown whenever extremely high values for a few waterways tend to distort the average. In these cases, the median value is more helpful than the average in placing where the subject waterway stands relative to all the other waterways.

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Awareness of Primary Waterway

Gowanus Canal

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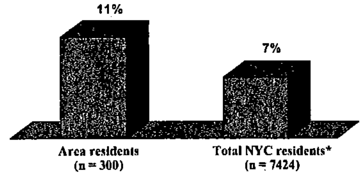
Total Unaided Awareness of Primary Waterway

Gowanus Canal Assessment Area

- **11% of area residents mention the Gowanus Canal on an unaided basis.**
  - **The average for unaided awareness for all the primary waterways is 13%.**
  - **The median value for unaided awareness for all the primary waterways is 7%. (See page 11.)**

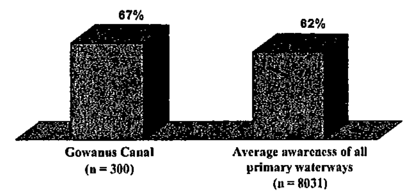


* Median

Total Awareness of Primary Waterway

Gowanus Canal Assessment Area

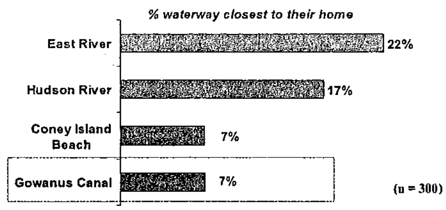
- **In total, 67% of Gowanus Canal area residents are aware of Gowanus Canal on a combined unaided and aided basis.**
  - **Average total awareness of all primary waterways among NYC residents is 62%.**



Waterway Closest to Home (Unaided)

Gowanus Canal Assessment Area

- **On an unaided basis, area residents most often mention the East River as the waterway closest to their home.**
  - **7% of area residents mention the Gowanus Canal unaided as the waterway closest to their home.**
  - **On average, 10% of NYC residents mention unaided the primary waterway in their assessment area as the waterway closest to their home. The median value for all primary waterways being regarded as the waterway closest to home is 3%. (See page 11.)**



Awareness Summary

Gowanus Canal Assessment Area

	Area Residents %	NYC Residents %
Total unaided awareness of primary waterway	11	13*
Total awareness of primary waterway	67	62
Primary waterway is waterway closest to home	7	10**

* Median is 7% ** Median is 3%

Visiting Primary Waterway

Gowanus Canal

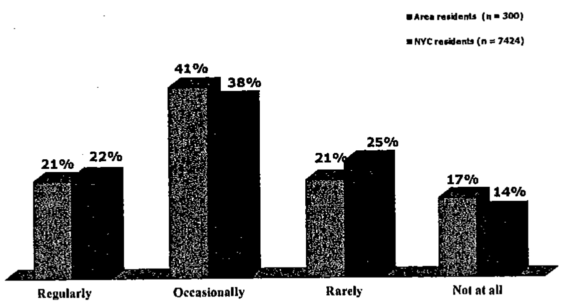
How Often Visit NYC Waterways Generally

Gowanus Canal Assessment Area

- **21% of area residents say they visit the waterways in their community or elsewhere in the city on a regular basis. 41% say they visit them occasionally.**
  - **22% of all NYC residents say they visit the city's waterways regularly while 38% say they visit them occasionally.**

How Often Visit NYC Waterways Generally

Gowanus Canal Assessment Area



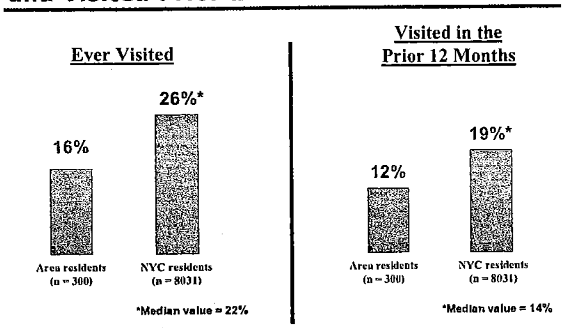
Ever Visited Primary Waterway and Visited Prior 12 Months

Gowanus Canal Assessment Area

- 16% of area residents have visited the Gowanus Canal at some point.
  - On average, 26% of NYC residents have visited the primary waterway in their assessment area. The median value is 22%.
- 12% of area residents report visiting the Gowanus Canal in the prior 12 months.
  - On average, 19% of NYC residents visited the primary waterway in their assessment area in the prior 12 months. The median value is 14%.

Ever Visited Primary Waterway and Visited Prior 12 Months

Gowanus Canal Assessment Area



Number of Visits in Prior 12 Months to Primary Waterway

Gowanus Canal Assessment Area

- Among prior 12 month visitors to the Gowanus Canal, the median number of visits made is 4.*
  - For all NYC primary waterway visitors, the median number of visits made in the prior 12 months is 4.

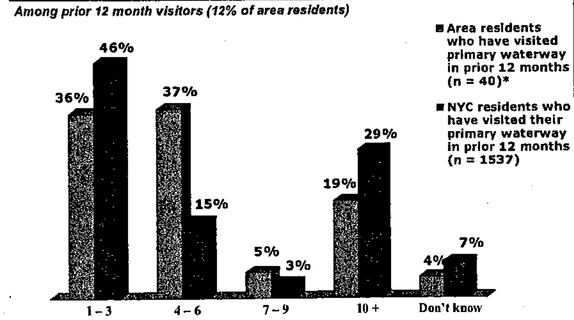
Median number of visits to Gowanus Canal: 4*
Average number of visits to Gowanus Canal: 13*
Median number of visits to each NYC primary waterways: 4
Average number of visits to each NYC primary waterways: 25

* Small base; use data with caution

Number of Visits in Prior 12 Months to Primary Waterway

Gowanus Canal Assessment Area

Among prior 12 month visitors (12% of area residents)



* Small base; use data with caution

Reasons for Never Visiting Primary Waterway

Gowanus Canal Assessment Area

Among those aware of primary waterway but never visited (51% of area residents)

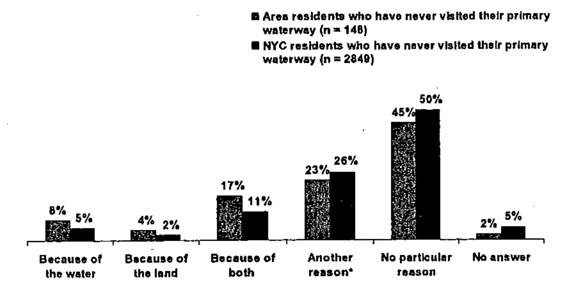
- 45% of area residents who have never visited the Gowanus Canal, but who are aware of it, say there is no particular reason for not visiting. 25% say they have never visited because of the water, and 21% say they've never visited because of the land.*
  - 50% of all NYC residents who have never visited their primary waterway, though aware, say there is no particular reason for not visiting. 16% say they have never visited because of the water and 13% say they have never visited because of the land.*

* These percentages include those who said only water or only land as well as those who said both water and land reasons.

Reasons for Never Visiting Primary Waterway

Gowanus Canal Assessment Area

Among those aware of primary waterway but never visited (51% of area residents)



* Further details not available

Water Reasons for Never Visiting Primary Waterway

Gowanus Canal Assessment Area

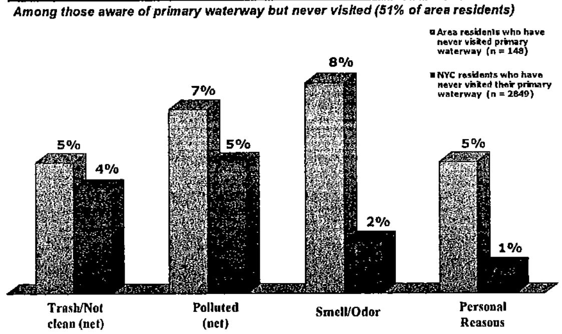
Among those aware of primary waterway but never visited (51% of area residents)

- When area residents cite negatives about the water as the reason for never having visited Gowanus Canal, the specific issues are:
  - Smell and/or odor (8%),
  - Pollution (7%)
  - Trash in the water/the water not being clean (5%).
- When NYC residents cite water negatives as the reason for never having visited the primary waterway in their assessment area, the specific issue most often mentioned is pollution (5%).

Water Reasons for Never Visiting Primary Waterway

Gowanus Canal Assessment Area

Among those aware of primary waterway but never visited (51% of area residents)



Land Reasons for Never Visiting Primary Waterway

Gowanus Canal Assessment Area

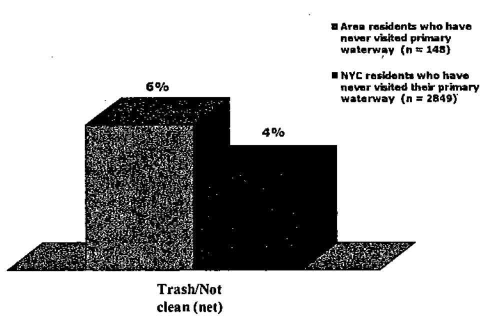
Among those aware of primary waterway but never visited (51% of area residents)

- When area residents cite negatives about the land as a reason for never having visited Gowanus Canal, the specific issue most often mentioned is:
  - Garbage/trash/land being dirty (6%).
- When NYC residents cite land negatives as a reason for never having visited the primary waterway in their assessment area, the specific issue most often mentioned is:
  - Garbage/trash/ land being dirty (4%).

Land Reasons for Never Visiting Primary Waterway

Gowanus Canal Assessment Area

Among those aware of primary waterway but never visited (51% of area residents)



Visiting Summary

Gowanus Canal Assessment Area

	Area Residents	NYC Residents
	%	%
Visit NYC waterways regularly/occasionally	62	60
Ever visited primary waterway	18	26*
Visited prior 12 months	12	19**
Median number of visits to primary waterway in prior 12 months	4	4
Haven't visited because of water (among aware never visitors)(Net)	25	18
Smell/odor	8	2
Pollution	7	5
Haven't visited because of land (among aware never visitors)(Net)	21	13
Garbage/trash	6	4

* Median is 22%
** Median is 14%

Participation in Recreational Activities at and Attitudes Toward Primary Waterway

Gowanus Canal

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Participation in Water Activities at Primary Waterway

Gowanus Canal Assessment Area

- **20% of area residents who have visited the Gowanus Canal have participated in water activities there. (16% of area residents have visited the Gowanus Canal so that, in total, 3% of area residents have participated in water actvities there.)**
  - **18% of NYC residents who have visited the primary waterway in their assessment area have participated in water activities there.**

Note: Due to the small base sizes, no data are shown for this waterway area regarding how enjoyable water activities were or what made water activities enjoyable/not enjoyable.

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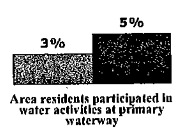
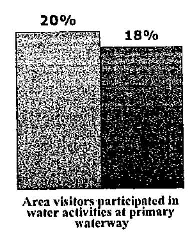
Participation in Water Activities at Primary Waterway

Gowanus Canal Assessment Area

Among area residents



Among ever visitors (16% of area residents)



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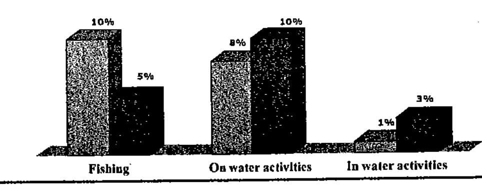
Most Frequent Water Activities Participated in at Primary Waterway

Gowanus Canal Assessment Area

- **Fishing is the most frequent water activity among those who have ever visited the Gowanus Canal -- 10%. (16% of area residents have visited.)**
  - On water activities are the most frequent type of water activity for all NYC residents who have ever visited the primary waterway in their assessment area (10%).



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Why Never Participated in Water Activities at Primary Waterway

Gowanus Canal Assessment Area

Among primary waterway visitors who never participated in water activities there (12% of area residents)

- **20% of area visitors who have never participated in any water activities at the Gowanus Canal say that there is no particular reason for their not participating. 18% say that pollution was the reason while 12% mention garbage in/on the water or the water being dirty.***
  - **22% of NYC primary waterway visitors who have never participated in water activities say that there is no particular reason for their not participating. 16% say they did not participate for various personal reasons.**

* Small base; use data with caution

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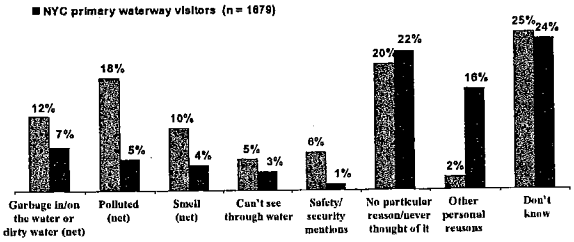
Why Never Participated in Water Activities at Primary Waterway

Gowanus Canal Assessment Area

Among primary waterway visitors who never participated in water activities there (12% of area residents)



* Small base; use data with caution

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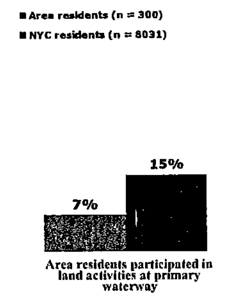
Participation in Land Activities at Primary Waterway
Gowanus Canal Assessment Area

- **42% of area residents who have visited the Gowanus Canal have participated in land activities there. (16% of area residents have visited the Gowanus Canal so that, in total, 7% of area residents have participated in land activities there.)**
  - **53% of NYC residents who have visited the primary waterway in their assessment area have participated in land activities there.**

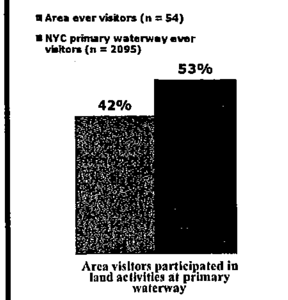
Note: Due to the small base sizes, no data are shown for this waterway area regarding how enjoyable land activities were or what made land activities enjoyable/not enjoyable.

Participation in Land Activities at Primary Waterway
Gowanus Canal Assessment Area

Among area residents



Among ever visitors (16% of area residents)



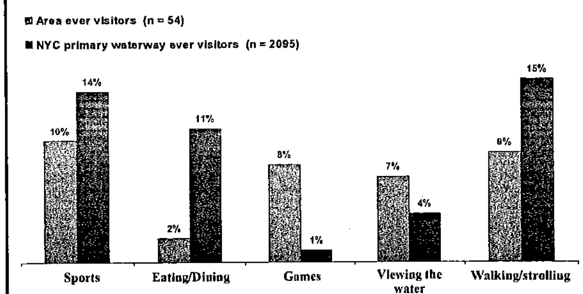
Most Frequent Land Activities Participated in at Primary Waterway
Gowanus Canal Assessment Area

Among primary waterway visitors (16% of area residents)

- The most popular land activity at the Gowanus Canal among area visitors is sports (10%); the second most popular is walking or strolling (9%).
  - Walking or strolling (15%) and sports (14%) are the most popular land activities among all NYC residents who have ever visited the primary waterway in their assessment area.

Most Frequent Land Activities Participated in at Primary Waterway
Gowanus Canal Assessment Area

Among primary waterway visitors (16% of area residents)



Why Never Participated in Land Activities at Primary Waterway
Gowanus Canal Assessment Area

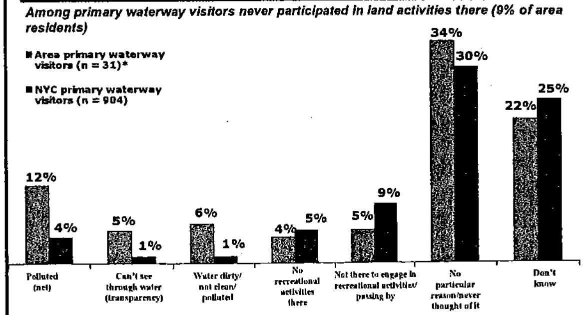
Among primary waterway visitors never participated in land activities there (9% of area residents)

- **34% of area visitors who have never participated in land activities at the Gowanus Canal say that there is no particular reason for their not participating.***
  - **30% of NYC primary waterway visitors who have never participated in land activities say that there is no particular reason for their not participating.**

* Small base; use data with caution

Why Never Participated in Land Activities at Primary Waterway
Gowanus Canal Assessment Area

Among primary waterway visitors never participated in land activities there (9% of area residents)



* Small base; use data with caution

Water Activities Participation Summary
Gowanus Canal Assessment Area

	Area Residents %	NYC Residents %
Participated in water activities at primary waterway (among area visitors)	20	18
Participated in water activities at primary waterway (among area residents)	3	6
Fishing is most frequent water activity at primary waterway (among area visitors)	10	5

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Land Activities Participation Summary
Gowanus Canal Assessment Area

	Area Residents %	NYC Residents %
Participated in land activities at primary waterway (among area visitors)	42	53
Participated in land activities at primary waterway (among area residents)	7	15
Sports is most frequent land activity at primary waterway (among area visitors)	10	14

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Improvements to Primary Waterways

Gowanus Canal

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Improvements Noticed in Past Five Years in NYC Waterways
Gowanus Canal Assessment Area

- **47% of area residents say they have noticed improvements in NYC waterways in general in the past five years. 7% have noticed improvements specifically at the Gowanus Canal.**
  - 48% of NYC residents say that they have noticed improvements in NYC waterways in general in the past five years. On average, 6% of NYC residents have noticed improvements at the primary waterway in their assessment area. The median value for those who have noticed improvements at the primary waterway in their assessment area is 3%. (See page 11.)
- **Improvements in the water (quality, appearance, color) are the most frequently mentioned improvement in NYC waterways in general noticed by area residents in the past five years (20%).**
  - Improvements in the water are the most frequently mentioned improvement noticed in NYC waterways in general among all NYC residents (21%).

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Improvements Noticed in Past Five Years in NYC Waterways
Gowanus Canal Assessment Area

	Area Residents (n = 300) %	NYC Residents (n = 7424) %
Have noticed improvements at NYC waterways (net)	47	48
Water mentions (quality, appearance, odor)	20	21
Cleaner/better (net)*	9	13
Benches (park benches)	5	2
Haven't seen improvements	32	31
Don't know	21	22

* Cleanliness/sanitation/better maintenance

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Improvement Would Most Like in Primary Waterway if Funds Available
Gowanus Canal Assessment Area

Among those aware of their primary waterway (67% of area residents)

- **If funds were available, improvements in the water (quality, appearance, odor) are the aspect that area residents would most like to see improved at the Gowanus Canal (41% of those aware of the Gowanus Canal).**
  - If funds were available, improvements in the water at their primary waterway are the most frequently cited desired improvement among all NYC residents (38% of those aware of the primary waterway in their assessment area).

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Improvement Would Most Like in Primary Waterway if Funds Available

Gowanus Canal Assessment Area

Among those aware of their primary waterway (67% of area residents)

	Area Residents (n = 202) %	NYC Residents (n = 4944) %
Water mentions (quality, appearance, odor)	41	38
Cleaner/better (net)*	13	11
More park areas/greenery/ nature preserves	5	3
Don't know	18	24

* Cleanliness/sanitation/better maintenance

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Importance of Most Desired Improvement at Primary Waterway

Gowanus Canal Assessment Area

Among those who identified the improvement would most like at their primary waterway (53% of area residents)

- **34% of area residents who identified the improvement they would most like to see in Gowanus Canal, if funds were available, say that that improvement is "extremely important" and another 30% say it is "somewhat important."**
  - 35% of NYC residents who identified the improvement they would most like to see in the primary waterway in their assessment area say that, if funds were available, that improvement is "extremely important" and an additional 29% say it is "somewhat important."

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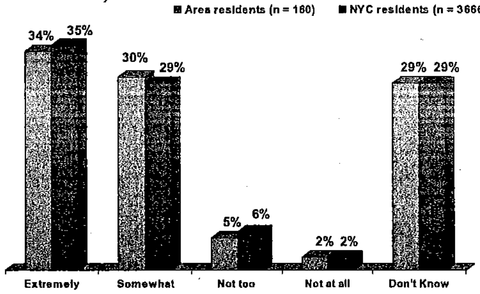
Importance of Most Desired Improvement at Primary Waterway

Gowanus Canal Assessment Area

Among those who identified the improvement would most like at their primary waterway (53% of area residents)



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Importance of Water Improvements at Primary Waterway

Gowanus Canal Assessment Area

Among those for whom it is the most important improvement at their primary waterway (27% of area residents)

- **Specifically among those area residents who identified improving the water quality, appearance and/or odor as the improvement they would most like to be made to the Gowanus Canal, 53% consider it "extremely important."**
  - 52% of NYC residents who identified improvements in water quality, appearance and/or odor in the primary waterway in their assessment area as the improvement they would most like to see in the primary waterway in their assessment area say this improvement is "extremely important."

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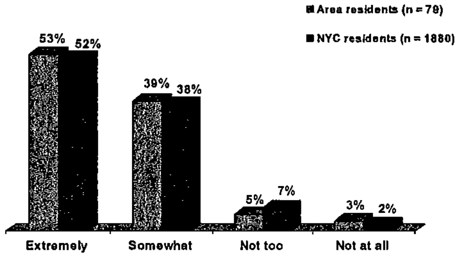
Importance of Water Quality Improvements at Primary Waterway

Gowanus Canal Assessment Area

Among those for whom it is the most important improvement at their primary waterway (27% of area residents)



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Amount Say Willing to Pay Per Year for Most Desired Improvement at Primary Waterway

Gowanus Canal Assessment Area

Among those who identified the improvement would most like at their primary waterway (53% of area residents)

- **47% of area residents who identified the improvement they would most like to see in the Gowanus Canal say they would be willing to pay between $10 and $25 a year for that improvement.**
- **15% say they would not be willing to pay anything.**
  - 39% of NYC residents who identified the improvement they would most like to see in the primary waterway in their assessment area say they would be willing to pay between $10 and $25 a year for that improvement.
  - 22% say they would not be willing to pay anything.

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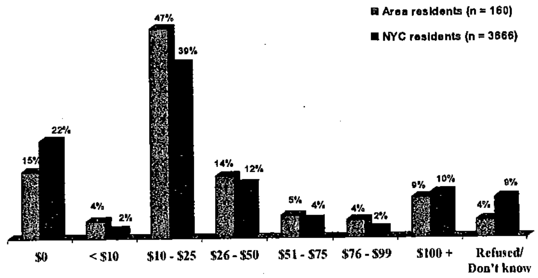
Amount Say Willing to Pay Per Year for Most Desired Improvement at Primary Waterway

Gowanus Canal Assessment Area

Among those who identified an improvement would most like at their primary waterway (53% of area residents)



Amount Say Willing to Pay Per Year for Water Quality Improvements at Primary Waterway

Gowanus Canal Assessment Area

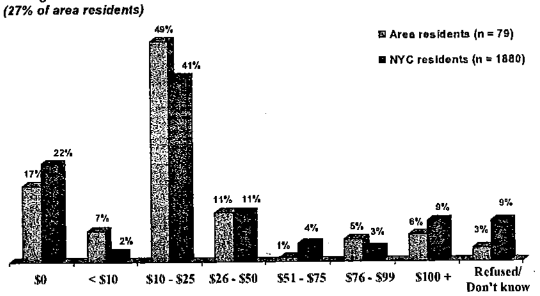
Among those for whom it is the most desired improvement at their primary waterway (27% of area residents)

- **Specifically among those area residents who identified water quality improvements as the improvement they most like made to the Gowanus Canal, 49% say they would be willing to pay between $10 and $25 per year for that improvement.**
- **17% are not willing to pay anything for water quality improvements to the Gowanus Canal.**
  - 41% of NYC residents who identified water quality improvements as the improvement they most like made to the primary waterway in their assessment area say they would be willing to pay between $10 and $25 each year for that improvement.
  - 22% are not willing to pay anything for water quality improvements to the primary waterway in their assessment area.

Amount Say Willing to Pay Per Year for Water Quality Improvements at Primary Waterway

Gowanus Canal Assessment Area

Among those for whom it is the most desired improvement at their primary waterway (27% of area residents)



Waterway Most Want Improved if Funds Available for Only One

Gowanus Canal Assessment Area

- **If funds were available to improve only one NYC waterway, 19% of area residents would like it to be the Gowanus Canal.**
  - On average, 18% of NYC residents would like the primary waterway in their assessment area to be the one to be improved.

Waterway Most Want Improved if Funds Available for Only One

Gowanus Canal Assessment Area

	Area Residents (n = 300) %	NYC Residents (n = 7424) %
The Gowanus Canal	19	2
The Hudson River	15	22
The East River	13	18
Coney Island Beach*	10	4
Don't know	20	17

* Not one of the 26 primary waterways studied.
** Less than 0.5%

Improvements Summary

Gowanus Canal Assessment Area

	Area Residents %	NYC Residents %
Noticed improvements in NYC waterways in past 5 years	47	48
Noticed improvements in primary waterway in past 5 years	7	6*
Improvements in water improvement most frequently noticed (at NYC waterways)	20	21
Improvements in water most desired improvement at primary waterway (among those aware of primary waterway)	41	38

*Median is 3%.

Improvements Summary (cont'd)

Gowanus Canal Assessment Area

	Area Residents	NYC Residents
	%	%
Percent rating most desired improvement "extremely/ somewhat important" (among those who identified improvement would most like at primary waterway)	64	64
Percent rating water improvements "extremely/ somewhat important" (among those for whom it is the most desired improvement at primary waterway)	92	90
Would pay $10-$25 annually for most desired improvement (among those who identified improvement would most like at primary waterway)	47	39
Would pay $10-$25 annually for water improvements (among those for whom it is the most desired improvement at primary waterway)	49	41
Primary waterway is one most want improved	19	18

Demographics

Gowanus Canal

Demographics

Gowanus Canal Assessment Area

	Gowanus Canal	Total NYC Residents
Gender	%	%
Male	44	46
Female	56	54
Age		
18-34	40	36
18-24	13	14
25-34	27	21
35-54	37	37
35-44	24	22
45-54	13	15
55+	21	26
55-64	13	13
65+	8	13

Demographics

Gowanus Canal Assessment Area

	Gowanus Canal	Total NYC Residents
Children Under 18 in HH	%	%
Yes	40	37
1	16	17
2	12	11
3	6	5
4	4	2
5	2	1
6+	1	1
No	59	62
Ethnicity/Race		
African-American	50	21
Asian	3	10
Hispanic	12	22
White	18	35
Other	18	12

Demographics

Gowanus Canal Assessment Area

	Gowanus Canal	Total NYC Residents
Education	%	%
H.S. or less	31	33
Grammar school or less	3	3
Some high school	9	6
High school graduate	19	24
Some College or More	68	65
Some college/ technical school	26	24
College graduate	26	28
Some/completed postgraduate	16	14

Demographics

Gowanus Canal Assessment Area

	Gowanus Canal	Total NYC Residents
Income	%	%
<$35,000	31	27
$35,000 to <$50,000	16	16
$50,000 to <$75,000	18	17
$75,000 to <$100,000	15	12
$100,000+	9	13
Refused	13	15
Own or Rent		
Rent	79	62
Own	19	36

Other Characteristics

Gowanus Canal Assessment Area

Ever volunteer to clean NYC parks/waters	Gowanus Canal %	Total NYC Residents %
Yes	22	13
No	78	86
Member of NYC boating/canoeing/kayaking club		
Yes	1	2
No	99	97

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Other Characteristics

Gowanus Canal Assessment Area

Water activities enjoy *	Gowanus Canal %	Total NYC Residents %
Boating/speed boating	16	22
Canoeing	6	5
Fishing	16	17
Kayaking	8	4
Sailing	5	5
Swimming	63	58
Water/jet skiing	9	7
None	18	18

* Not added until after field had begun so not everyone was asked this question.

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Appendix

Gowanus Canal

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NYC Primary Waterways Included in Study

Gowanus Canal Assessment Area

Alley Creek	Jamaica Bay
Arthur Kill	Kill Van Kull
Bergen Basin	Lower New York Bay
Bronx River	Mill Basin
Coney Island Creek	Newtown Creek
East River	Paedergat Basin
Flushing Bay	Raritan Bay
Fresh Creek	Sheepshead Bay
Gowanus Canal	Shellbank Basin
Harlem River	Spring Creek
Hendrix Creek	Thurston Basin
Hudson River	Upper New York Bay
Hutchinson River	Westchester Creek

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Questionnaire

NOTE: Final copies of each report will contain a copy of the questionnaire.

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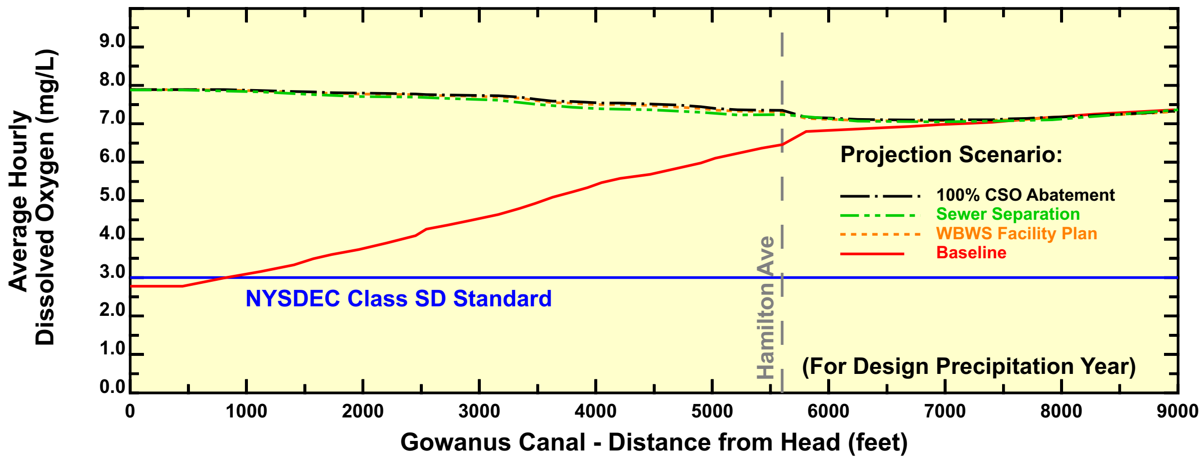
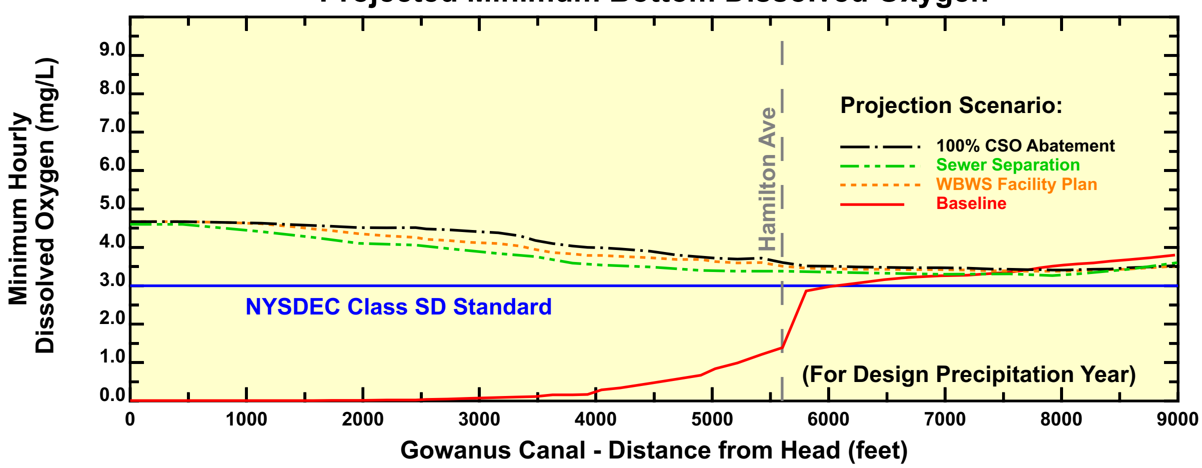
APPENDIX D

FIGURES FOR ALTERNATIVE ANALYSES

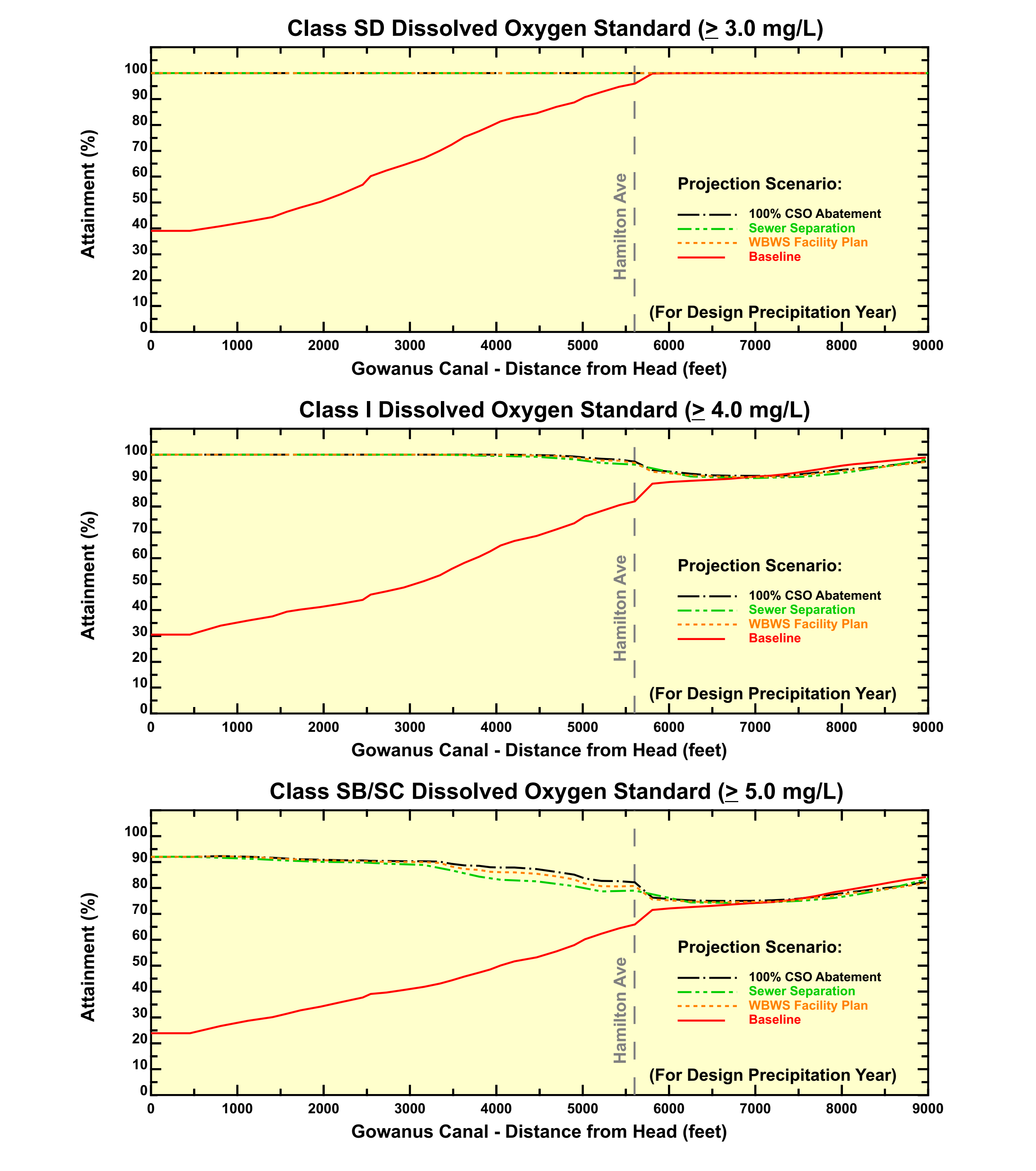
Projected Average Bottom Dissolved Oxygen



Projected Minimum Bottom Dissolved Oxygen



Projected Dissolved Oxygen Concentrations for Evaluated Alternatives

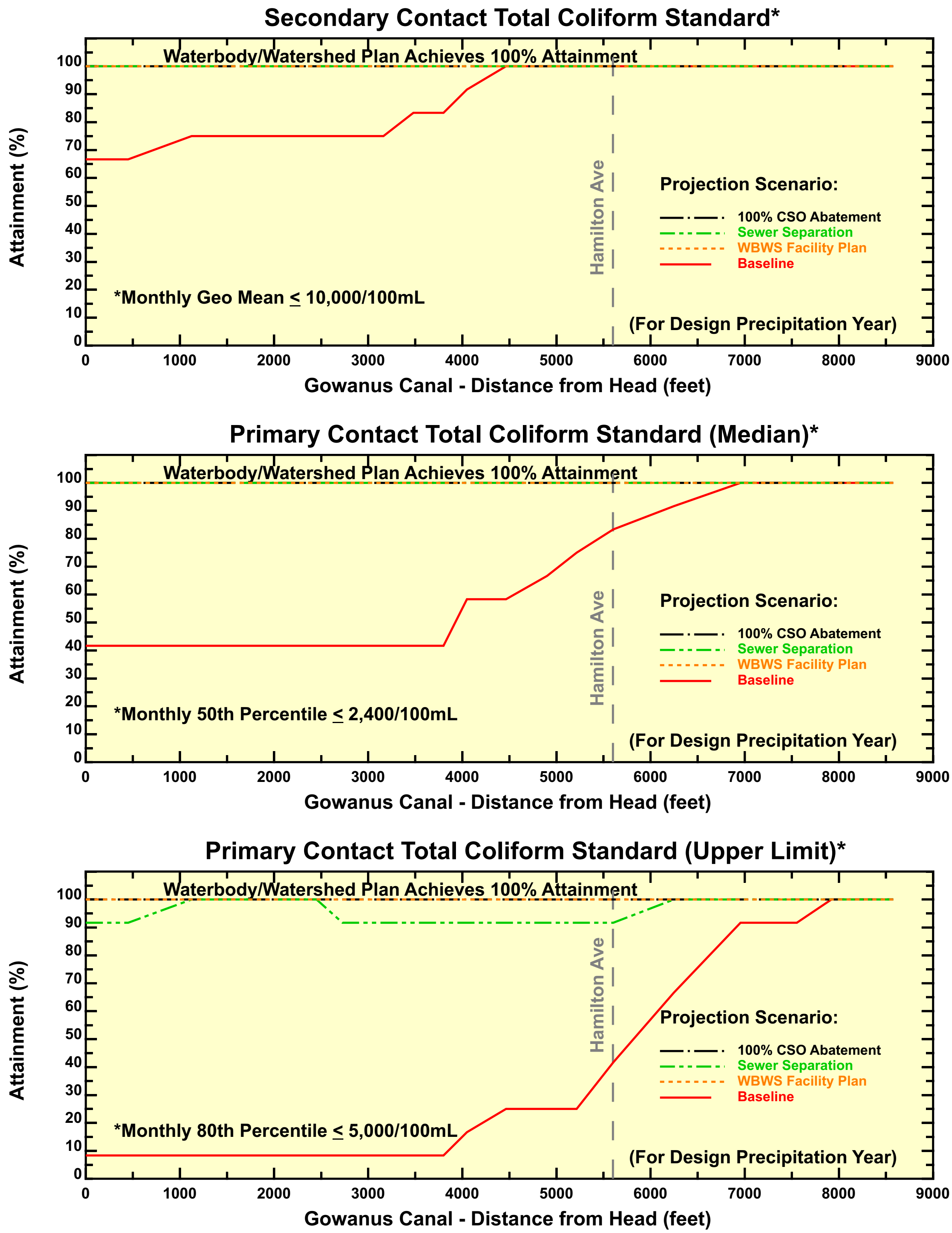


New York City
Department of Environmental Protection

Gowanus Canal Waterbody/Watershed Facility Plan

Projected Attainment of Dissolved Oxygen Standards for Evaluated Alternatives

FIGURE D-2



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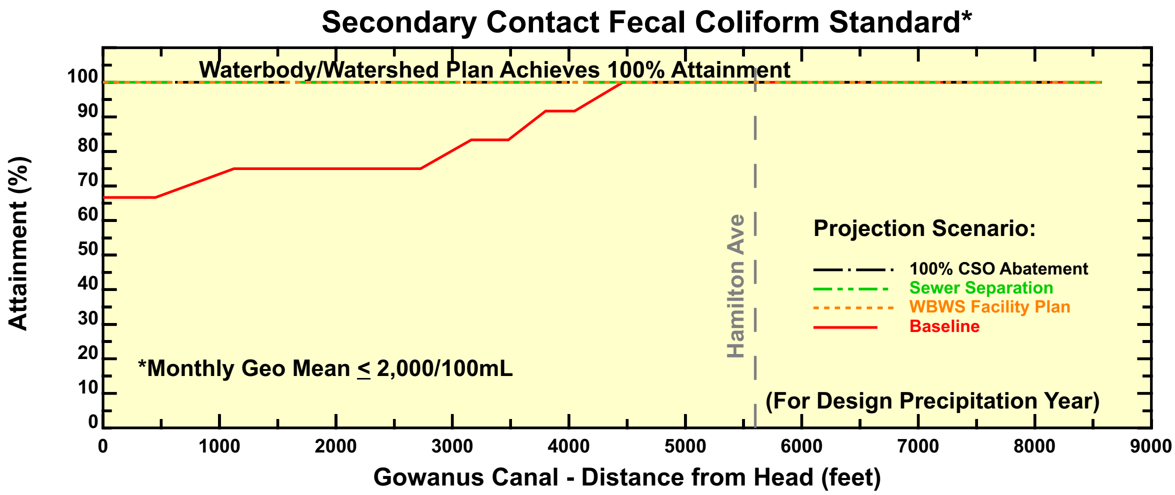
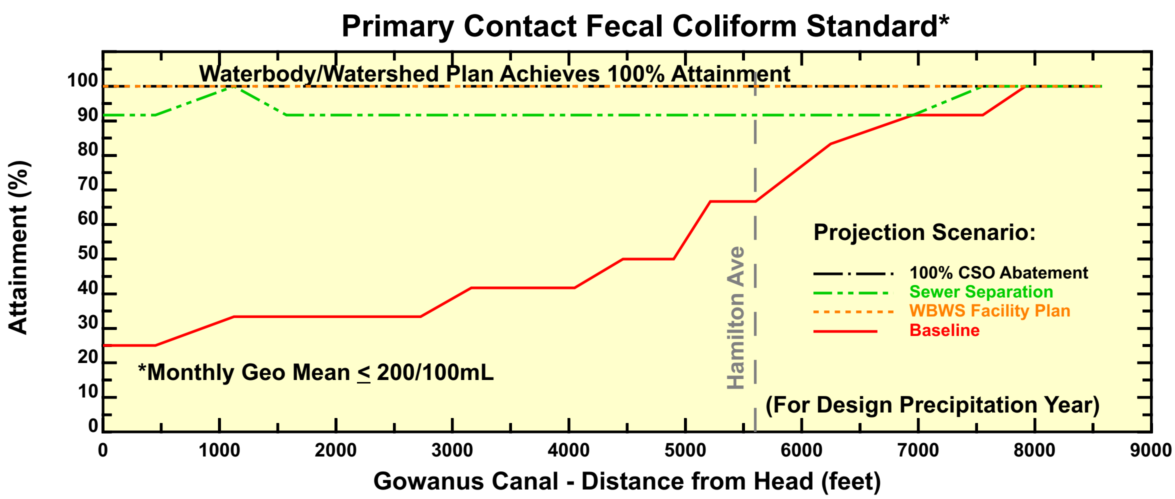
Gowanus Canal Waterbody/Watershed Facility Plan

Projected Attainment of Total Coliform Standards for Evaluated Alternatives

FIGURE D-3





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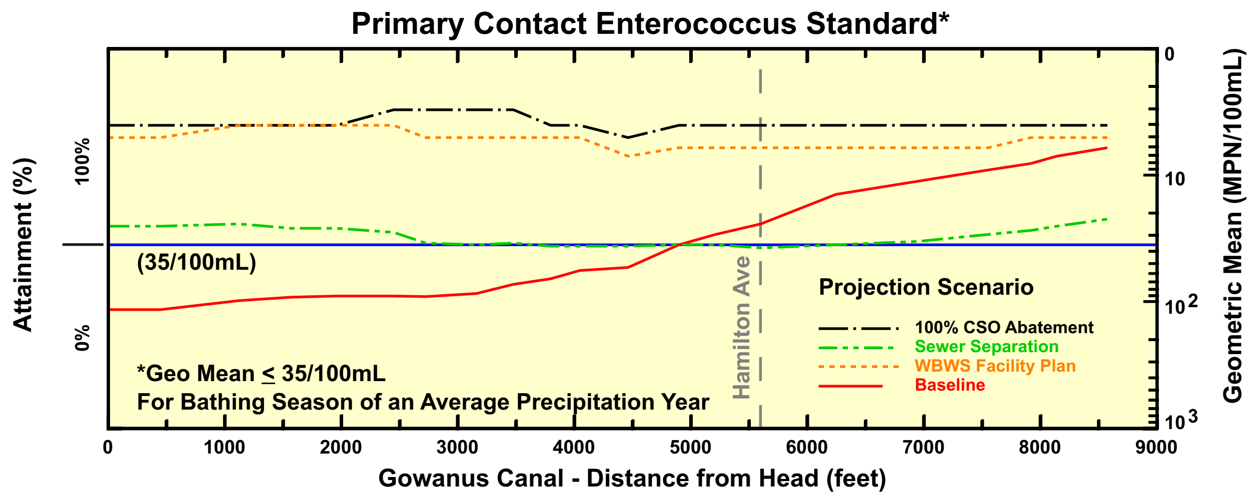
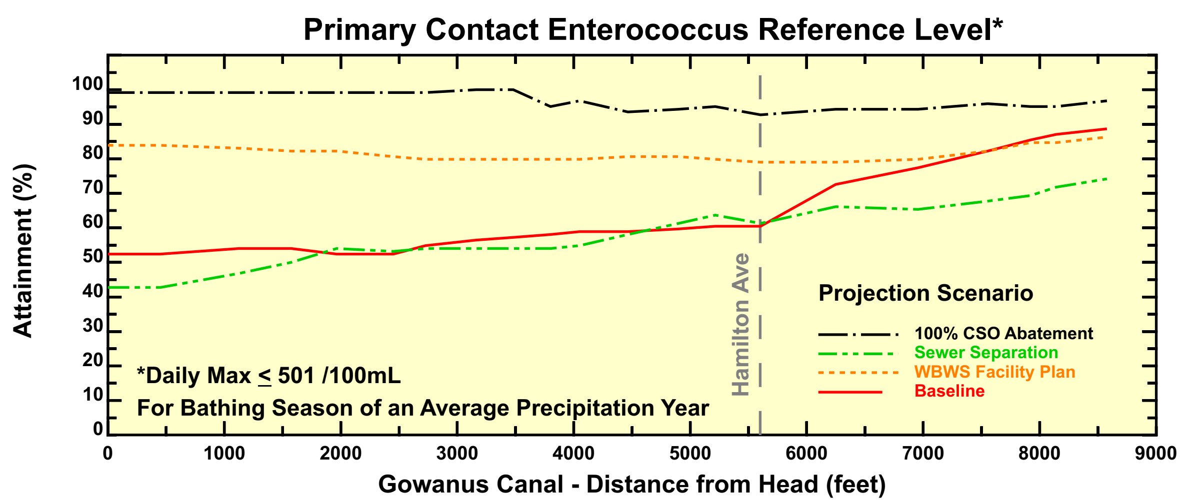
Projected Attainment of Fecal Coliform Standards for Evaluated Alternatives

FIGURE D-4





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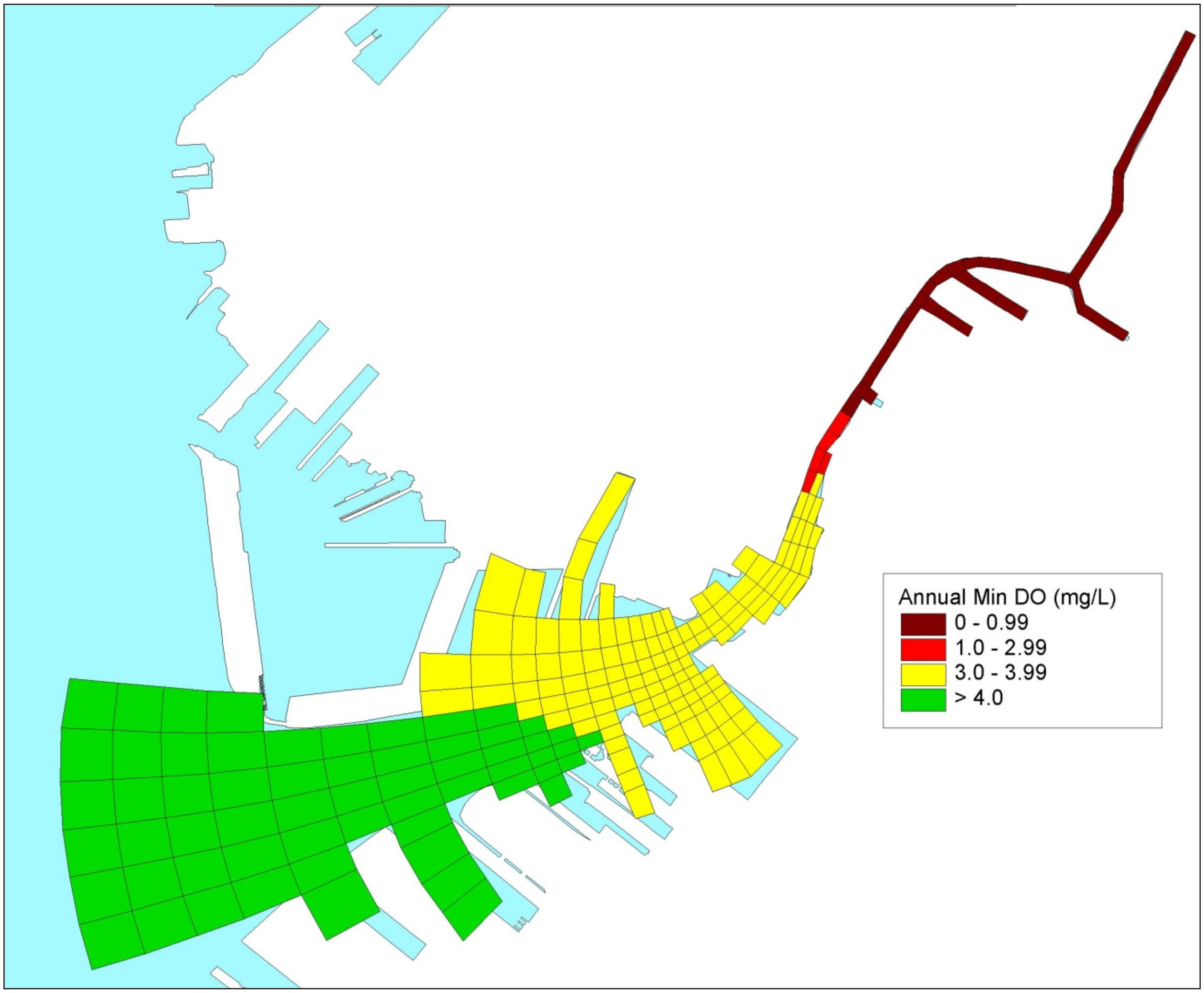
Projected Attainment of Enterococci Criteria during Bathing Season (May 15- September 15) for Evaluated Alternatives

APPENDIX E

MAPS OF PROJECTED DISSOLVED OXYGEN RESULTS



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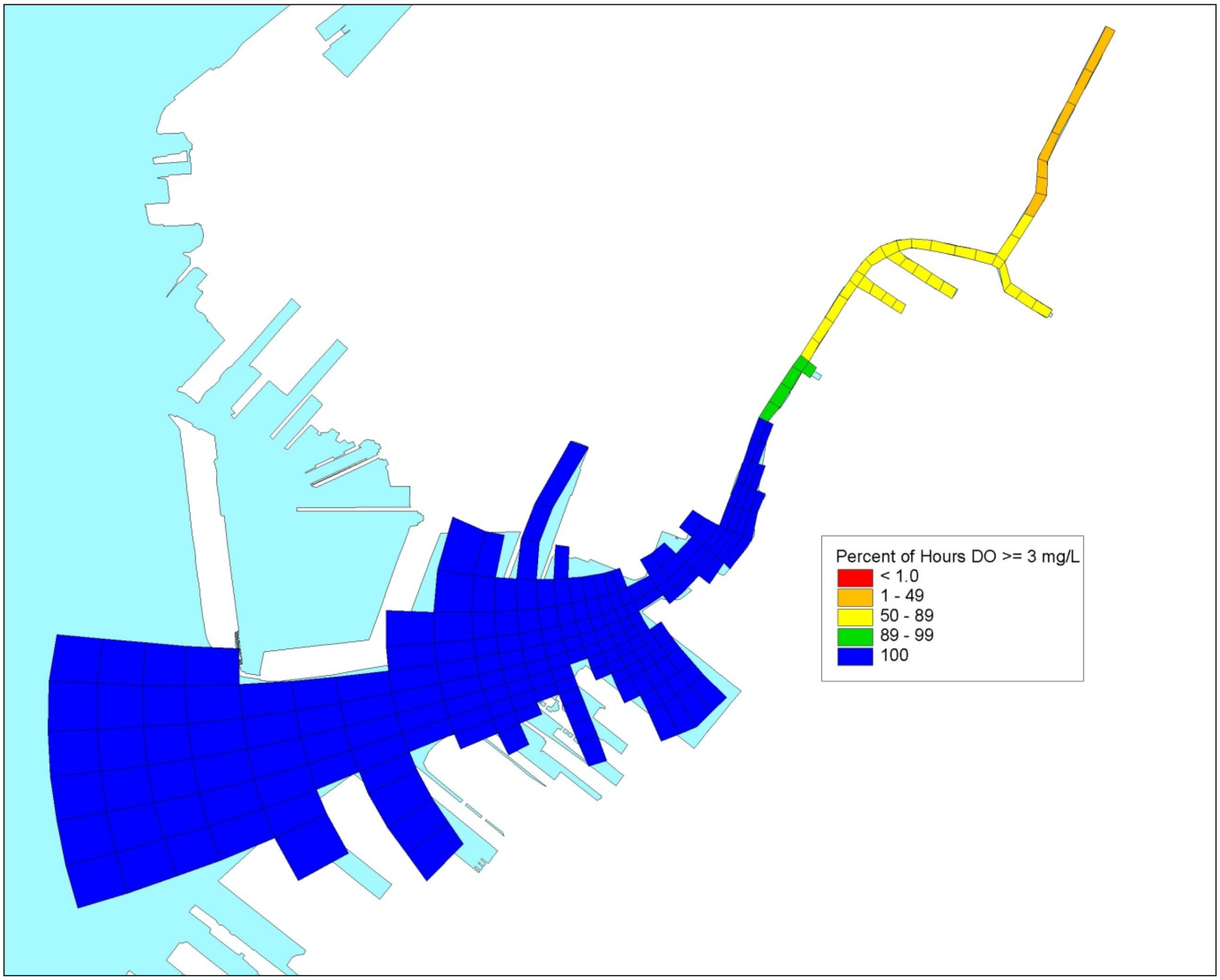
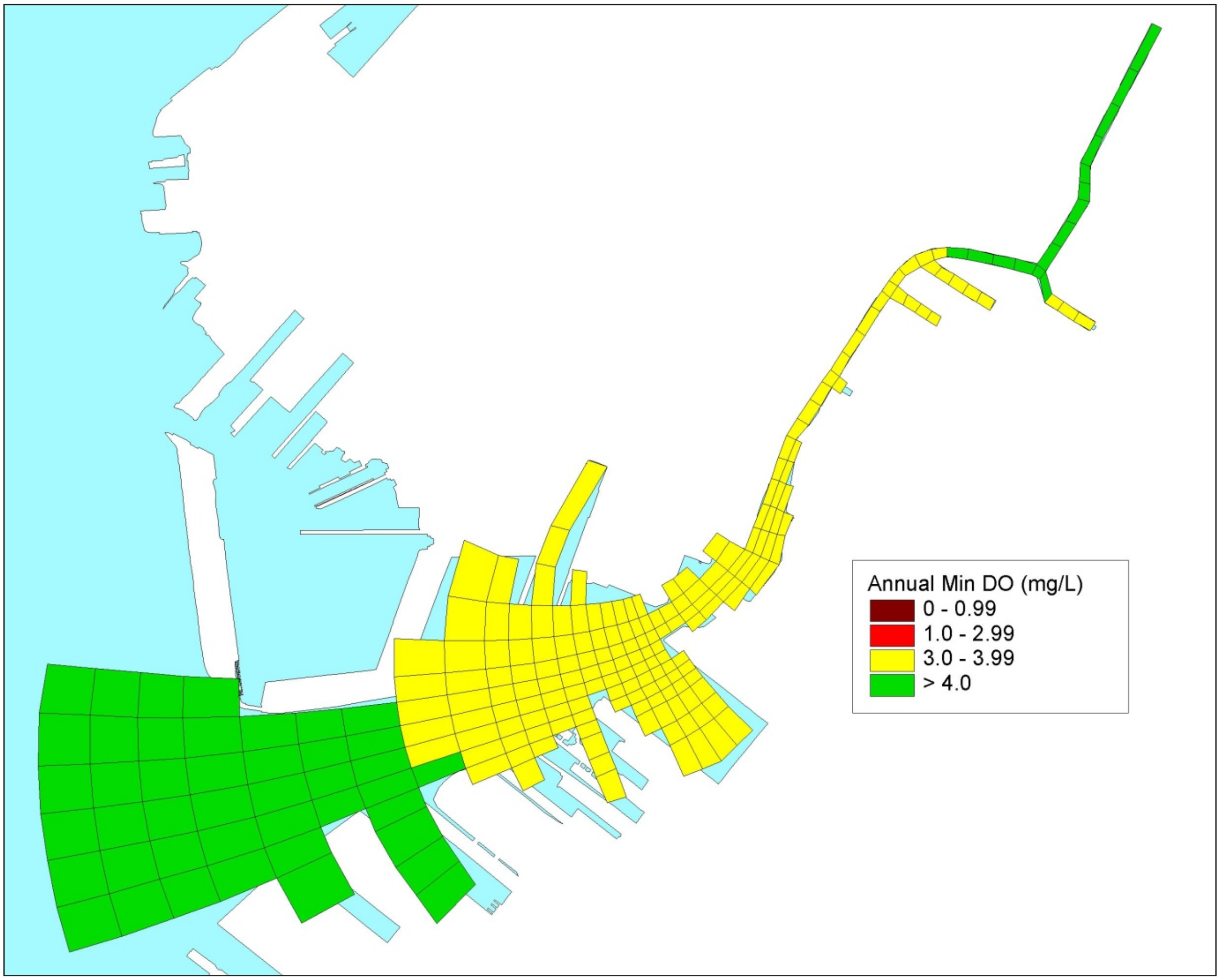
Mapping of Projected Annual Minimum Hourly Dissolved Oxygen Baseline Condition



Mapping of Projected Attainment of 3 mg/L Dissolved Oxygen Baseline Condition



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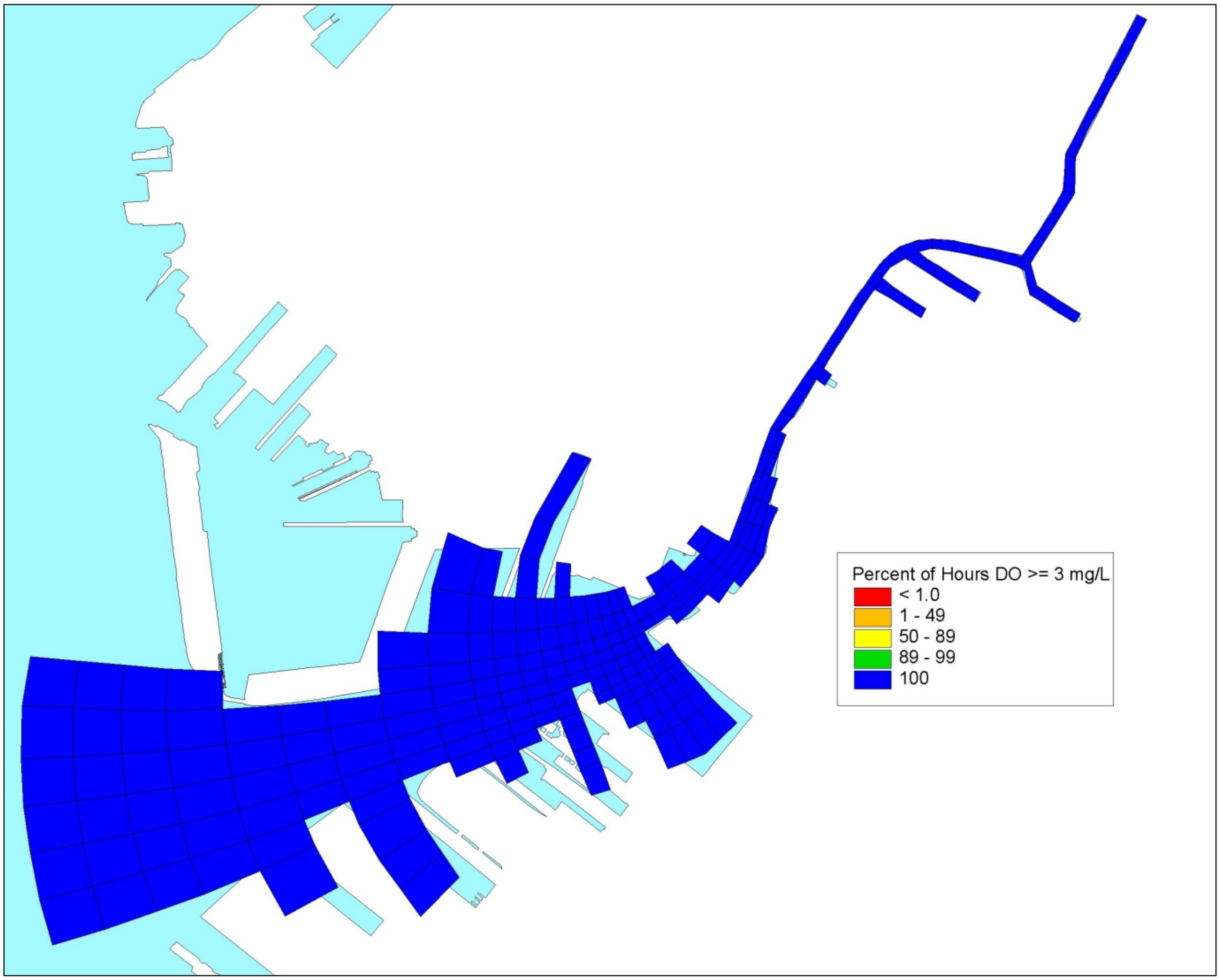
Mapping of Projected Annual Minimum Hourly Dissolved Oxygen Waterbody/Watershed Plan



Mapping of Projected Attainment of 3 mg/L Dissolved Oxygen Waterbody/Watershed Plan

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APPENDIX F

PRELIMINARY OPERATIONAL PLANS

Draft

Suggested Operations and Maintenance Activities for the Gowanus Canal Flushing Tunnel Pumping System and the Gowanus Wastewater Pumping Station

Background

The Gowanus Canal Flushing Tunnel and the Gowanus Wastewater Pumping Station are two facilities that operate within the Red Hook Wastewater Pollution Control Plant (WPCP) drainage area. The upgrade and operation of these facilities are important elements of the Gowanus Canal Waterbody/Watershed Facility Plan and the ongoing efforts to improve water quality in Gowanus Canal. The modernization of the Flushing Tunnel was intended to reliably enhance circulation through Gowanus Canal. The reconstruction of the Gowanus Wastewater Pumping Station was intended to increase the capacity of the station, restore routing of pumped flow to the force main (thereby removing pumped flow from the Bond Lorraine Sewer), and to provide floatables screening to CSO discharge from the pump station.

Operations and Maintenance Requirements

The Gowanus Flushing Tunnel system will be operated to reliably enhance circulation through Gowanus Canal. This will be accomplished through maximizing, to the extent possible, the flows pumped to Gowanus Canal from Buttermilk Channel with the Flushing Tunnel pumping system. The system is designed to pump an average of about 215 MGD, with about 252 MGD possible at high tide and about 175 MGD at low tide. The Flushing Tunnel Pumping System will operate continuously, controlled by variable frequency drives that will adjust the flow rate according to the available submergence at the pumps. The pumps will be coated for corrosion resistance and furnished with replaceable cathodic protection systems for corrosion protection

The Gowanus Wastewater Pumping Station will be operated to maximize the flows pumped to the force main, thereby minimizing, to the extent possible, the discharge of CSO to Gowanus Canal during wet weather. The upgraded capacity of the wastewater pumping system is 30 MGD; excess flow up to approximately 200 MGD will pass through the horizontal CSO screening system prior to discharge to the Canal. Should this overflow rate exceed 200 MGD, a portion of the flow will bypass the screens to discharge (unscreened) to the Canal; however, floatables retained on the CSO screens will be retained during such bypass. Under future conditions projected for year 2045 population estimates, and considering the pending improvements to the pump station and force main, a total of about 47 CSO discharges per year are expected from the pump station, given the rainfall record from JFK airport in 1988 (typical annual rainfall).

The Flushing Tunnel pumping facilities and the Gowanus Wastewater Pumping Station are located on the same site, and provide a base for the Operations & Maintenance Staff of 20 individuals. This staff is to be composed of Supervisors, Sewage Treatment Workers, Stationary Engineers-Electrical, Electricians, Machinists, and Instrumentation Workers.

In addition to the site specific maintenance tasks for the pumping facilities detailed in the accompanying table, the staff is also utilized to provide operations and maintenance support for multiple pumping stations and collections system facilities in the surrounding area.

The staff will be primarily responsible for the operation and maintenance of the two pumping facilities. Examples of the normal routine duties involved at the site include:

- Horizontal Bar Rack Screen Maintenance: This screening system is designed to keep floatable materials in the flow stream directed toward the pumping station. It is not designed to remove floatables into bins, etc. that need to be emptied during or after the wet weather event. During operation, operator oversight and immediate attention to relieve any obstruction that could cause an overload of the raking mechanism is *not* required because such an incident would not interfere with the wastewater flow to the pumping station. However, periodic inspection of the screen will ensure optimal floatables removal. Maintenance requirements of the system involve washing down the horizontal screen after every CSO event (during dry weather conditions). All maintenance may be carried out from the top of the screen with the guide rods, combs, and drive unit being easily removed for replacement/inspection. Other maintenance requirements include checking/replacing the hydraulic fluid within the hydraulic pump, which may be performed carried out at the pump's location within the control kiosk. These oil changes/checks should be carried out on an annual basis.

- Flow Diversion Chamber with Tipping Bucket: After each CSO event has ended, operating personnel will inspect and clean the screens from the grade level through the access hatch in the concrete roof slab. Following this inspection and cleaning process, operating personnel will activate the tipping bucket system in the Flow Diversion Chamber to flush accumulated solids from the bottom of the chamber into the sump containing the duplex solids handling pumps. The bucket will be filled manually with city water from an adjacent non-freeze hydrant and will automatically tip as its center of gravity shifts. The resulting discharge of clean water down the contoured wall of the chamber will create a flushing wave terminating in the sump at the opposite end of the chamber. All flushing water accumulated in the sump will subsequently be discharged back into the pumping station influent channel by the duplex solids handling pumps, which will be operated via an ultrasonic level control system. Depending on frequency of wet weather events during the spring and fall storm periods, the chamber may need to be inspected, pumped down and cleaned on a more frequent basis.

- Pumps and Grinders: These mechanical devices will experience wear and fouling due to the materials within the sanitary flow. Removal, cleaning, repair and replacement activities will need to be performed on a timely basis to prevent back-ups in the sewer and potential overflow into the Canal.

- Building and Grounds maintenance.

Maintenance/Replacement Parts

Due to the importance of the facilities at the Gowanus site, specific equipment parts, replacements, and spare parts should be held on site, to keep the system outages at a minimum. These items include but are not limited to the following:

- One complete motor and pump combination for the Flushing Tunnel.
- One complete motor and pump combination for the Wastewater Pumping Station.
- One new motor each for the pumps at both locations.
- 4 sets of packing or seal replacements for each set of pumps.
- Several replacement probes or sensors for the instrumentation.
- Several replacement SCADA components to maintain redundancy.
- Standby SCADA Computer system.
- 2 spare sets of motor control starter components.

Confined space entries will also be required, for the inspection and servicing of system components located within the combined sewer system. These activities will require a team of at least 3 individuals, retrieval equipment, atmospheric monitors, forced draft blowers, and two-way communication equipment.

Ref. Dvirka & Bartilucci, "Facility Plan – Gowanus Facilities Upgrade." April 2004.

Annual Manpower Estimate

Item	Task	Frequency	Annual Manpower Estimate (hrs/year) STW	SEE	Electrician	Machinist	Instrument Tech
CSO Screening System							
Screens	Inspect & Operate	Weekly	104				
Screens	CM-Hose down	Monthly	480				
Screens	Corrective maintenance	Weekly				26	
Hoses, combs, etc.	Inspection and repair	Semiannual	16				
Screens/Tipping Bucket	Corrective maintenance	Weekly	104				
Screen Controls	Preventive maintenance	Semiannual		16	32		
Hydraulic System	Preventive maintenance	Semiannual	4				
Tipping Bucket	Lubrication	Semiannual	8				
Submersible Trash Pumps	Inspection and repair	Semiannual	8				
Submersible Trash Pumps	Corrective maintenance	Monthly	24				
Emergency Bypass Chamber	Clean after storm event	Season		48			
Flushing Tunnel Pumping Station							
Intake Baffles	Inspect & clean	Annual	24				
Rubber Check Valves	Inspect & clean	Annual	12				
Rubber Check Valves	Corrective maintenance	Annual	16				
Mech. Climber Screens	Preventive maintenance	Weekly	104				
Mech. Climber Screens	Inspection and repair	Annual	32				
Mech. Climber Screens	Cleaning	Weekly	104				
Mech. Climber Screens	Corrective maintenance	Weekly				104	
Wiper Blades	Replace Blades	Annual	24				
Belt Conveyor	Inspect & clean.	Weekly	108				
Belt Conveyor	Lubrication	Quarterly	4				
Chamber	Cleaning	Weekly	52				
Flushing Pumps	Inspect	Annual	32				
Flushing Pumps	Replace Pumps	Annual	24				
Pump & Level Controls	Corrective maintenance	Weekly		108			
Wastewater Pumping Station							
Main Sewage Pumps	Remove and inspect	Annual	160				
Wet Well	Inspect and clean	Annual	72				
Sluice Gate	Inspect and lubricate	Annual	2				
Hydraulic Actuators	Inspect	Quarterly	96				
Grinders	Preventive maintenance	Weekly	108				
Grinders	Inspection and repair	Annual	64				
Grinders	Cleaning	Weekly	108				
Grinders	Corrective maintenance	Bi-weekly	416				
Belt Conveyor	Inspect & Clean	Weekly	108				
Belt Conveyor	Lubrication	Annual	2				
Motorized Hoist	Inspection	Semiannual		4			
Tide Gate	Inspection	Monthly	48				
Air Release Valve	Preventive maintenance	Quarterly	24				
Flow Meter	Calibration	Quarterly					32
Flow Meter	Corrective maintenance						52
Generator	Test/Run	Monthly		48			
Boiler	Inspection and service	Semiannual	32	16			
Support Service - Electrical							
CSO Screen Controls	Electrical preventive maintenance	Semiannual			96		
CSO Screen Controls	Corrective maintenance	Weekly			70		
Flushing Tunnel Pump Controls	Electrical preventive maintenance	Semiannual			96		
Flushing Tunnel Pump Controls	Corrective maintenance	Weekly			70		
Hydraulic Discharge Valves	Electrical preventive maintenance	Semiannual			64		
Hydraulic Discharge Valves	Corrective maintenance	Weekly			69		
Mechanical Climber Screens-Drive Motors	Electrical preventive maintenance	Semiannual			48		
Mechanical Climber Screens-Drive Motors	Corrective maintenance	Weekly			69		
Sub. Trash Pumps Controls	Electrical preventive maintenance	Semiannual			16		
Sub. Trash Pumps Controls	Corrective maintenance	Weekly			69		
Conveyor Belt Controls	Electrical preventive maintenance	Semiannual			16		
Conveyor Belt Controls	Corrective maintenance	Weekly			69		
		Totals:	**2,524**	**240**	**784**	**130**	**84**

STW = Sewage Treatment Worker
SEE = Stationary Engineer - Electrical

Table taken from Table 9-1, Dvirka and Bartilucci Consulting Engineers document entitled Facility Plan Gowanus Facilities Upgrade - Final Draft, April 2004

Draft

Suggested Operations and Maintenance Activities for the Floatables/Solids Trap Chamber of Combined Sewer Overflow OH-007

Background

The combined sewage overflow (CSO) outfall OH-007, located in Brooklyn at the northern terminus of 2nd Avenue, discharges from the Owls Head Wastewater Pollution Control Plant (WPCP) drainage area to Gowanus Canal. Between the tide gate and the outfall is a floatables/solids trap chamber measuring roughly 35 feet wide by 70 feet long. This chamber, which features a baffle/weir combination, was designed to help prevent floatables and settleable solids from discharging from this location to Gowanus Canal. A programmatic approach to inspecting and cleaning the trap chamber has been developed as part of the Gowanus Canal Waterbody/Watershed Facility Plan to minimize discharges of floatables and solids to the Canal.

Unit Description

This facility is an underground rectangular concrete chamber measuring approximately 70 feet long, 35 feet wide, and 8 feet high. The chamber is equipped with a static baffle/weir device that acts as a control mechanism to retain floatables and settleable solids. The chamber is located downstream of the 2nd Avenue Pumping Station diversion chamber and a tide gate. Discharge from the chamber is to Gowanus Canal via CSO outfall OH-007.

Access into the chamber is through six (6) manholes spaced evenly about the chamber. There is no mechanical or electrically operated equipment associated with this chamber.

Unit Operation

During wet weather, combined sewage exceeding the capacity of the 2nd Avenue Pump Station overtops a one-foot weir in an upstream diversion chamber, passes through tide gates, and enters the trap chamber. Inside the chamber, heavier solids settle to the bottom while floatables rise to the surface. These materials are retained in the chamber and are prevented from discharging due to the weir/baffle device. Over time, the materials accumulate in the chamber.

In the past, the chamber was not regularly cleaned and has lost effectiveness due to the buildup of floatables and settleable solid materials. As part of the Gowanus Canal Waterbody/Watershed Facility Plan, the NYCDEP has identified a regular inspection program with cleaning as necessary to maintain the functionality of the trap chamber to control discharges of floatables and settleable solids from OH-007.

Recommended Operations and Maintenance Activities

Because the rate of accumulation of materials within the trap chamber is not known, and due to the number of storm related discharges, it is recommended that a program of frequent inspections be followed initially until the accumulation rate is defined and an appropriate inspection/cleaning program can be established. The initial recommended program is as follows:

- Inspection: Non-entry, visual inspections of the trap chamber interior will be performed on a monthly basis. These inspections will involve examining the interior water surface for floatables, and probing the chamber bottom with a long pole to determine the amount of accumulated settleable materials present. The chamber should also be inspected immediately following a severe storm event such as a 10-year storm or hurricane.

- Cleaning: Cleanings of the trap chamber will be performed based on the results of the monthly inspections. For example, if the inspections show that material accumulation rates begin to decrease, this could indicate that the optimum retention has been reached and materials are beginning to wash through the chamber, and hence cleaning should be performed to maintain optimal removal performance. Records of the quantity of materials removed during cleaning will be retained and analyzed. This information will be provided to the NYSDEC as part of the post-construction monitoring program. Cleanings may involve dewatering and the utilization of Confined Space Entry Procedures.

- Periodic inspections for structural defects of the trap chamber baffle and weir will be performed by a qualified Engineer. Visual inspections of the baffle and weir will be recorded during entry to the chamber, such as during cleaning.

Once the accumulation rates have been sufficiently characterized, and again in the future as deemed appropriate or necessary to respond to seasonal or other long-term changes, the inspection and/or cleaning frequency can be modified with the preparation of revisions to the procedures and schedules for inspections and cleaning. These written procedures and schedules will then form the Operational Plan for the facility.

- Records detailing the routine cleanings and amount of debris recovered should be prepared, completed and held to develop historical trends.

- The frequency of the inspections and/or cleanings may be increased or decreased depending on experience, seasonal variations in storm flow/snow melt, and quantity of debris recovered during those seasonal variations.

APPENDIX G

STAKEHOLDER MEETING MINUTES FOR JULY 25, 2006

*Note: this version of the minutes was posted for stakeholder review on August 4, 2006

Long Term Control Plan
Gowanus Canal Stakeholder Team
July 25, 2006

The Gowanus Canal Meeting for the Long Term Control Plan was held at the community room of Mary Star of the Sea at 41 Hoyt Street. Mark Klein of DEP opened the meeting. Chris Villari of DEP defined Combined Sewer Outfalls (CSOs) and located New York's CSOs. Stephen Whitehouse, DEP's consultant for public participation from Starr Whitehouse, described the relationship between past and current work, stating that the Gowanus Waterbody/Watershed Facility Plan emerged from the Use and Standards Attainment project (USA). The USA project was carried out with input from a stakeholder group, many of whom were present. DEC issued a consent order in 2004, at which time the work carried out in the USA project was integrated into the Long Term Control Plan (LTCP). The LTCP project is on schedule to submit Waterbody/Watershed plans to NYS Department of Environmental Conservation (DEC) in June 2007. The review by DEC will result in the formulation of a Long Term Control Plan, for which DEC may schedule and conduct a public hearing.

Tom Newman, consultant engineer from HydroQual, described the waterbody, classified as SD, which supports fish survival and has no associated criteria for contact recreation. Tom noted that the drainage area is characterized by impervious surfaces. He located the CSO outfalls, pointing out the largest, at the head of the canal at the Gowanus Pump Station, and at OH-007 near the 4th Street turning basin. These two outfalls deliver roughly 85% of the annual CSO volume into the canal.

Tom noted that engineers have been working to improve the water quality of the canal for over a century. One such project was the flushing tunnel. Designed in the 19th century to bring water from the Buttermilk Channel, the flushing tunnel was completed in 1911 and operated until the mid 1960s. With the 1999 rehabilitation of the tunnel, approximately 96 percent of measured dissolved oxygen (DO) concentrations attain the applicable water quality standard—up from 35 percent prior to the rehabilitation of the tunnel. A stakeholder asked whether the introduced water is contaminated. Tom answered that the water is drawn from Buttermilk Channel and hence water quality is on par with that in the Harbor.

Tom explained that several CSO-related problems persist, including sediment exposed at low tide creating odor problems, visible floatables, pathogens, and low DO when the flushing tunnel is not operational. He presented several basic engineering alternatives to address these issues, including modernizing the flushing tunnel, increasing pump station capacities, constructing CSO-storage facilities, instream alternatives (such as dredging), and sewer-system adjustments.

Tom stated that the Gowanus Facilities Upgrade project, which is now in the pre-construction phases, will include some of the possible alternatives. This project involves two major elements: the modernization of the flushing tunnel and the reconstruction of the Gowanus Wastewater Pump Station. The modernization of the flushing tunnel will increase capacity and improve operations to reduce down time. Increasing capacity will involve removing a tunnel constriction at Columbia Street. A stakeholder asked about construction. Tom said that street disruption would be localized.

The second element of the Gowanus Facilities Upgrade project involves reconstruction of the Gowanus Pump Station to increase capacity and rehabilitate the force main leading to the Columbia Street Interceptor. The 50% increase in pumping capacity will reduce volume and frequency of CSO events from the head of the canal; it will also provide relief to the Bond Lorraine Sewer, thereby reducing CSO discharges along the west side of the canal. In Gowanus Pump Station overflow will be equipped with mechanized bar screens to catch floatables. Several stakeholders asked where the captured material would be treated and with what frequency. Tom explained that material would be kept in the flow to be treated at the Red Hook WPCP.

Tom then discussed other additional control alternatives that were considered. Expansion of other pump stations was considered but was found to be ineffective. Deployment of a skimmer vessel to remove waterbody floatables was considered and found to be a potentially effective way to address floatables issues. A program to inspect and clean an existing floatables and solids trap at CSO OH-007 was also found to be a potentially effective alternative. Tom also identified the CSO sediment mound at the head of the canal as an aesthetics issue that creates odor problems, and confirmed that this is the only exposed CSO sediment mound in the greater Gowanus Canal attributable to CSOs. Tom presented a plan to dredge the head of the canal to eliminate the exposed CSO sediments. He noted that dredging is a new feature of the facility plan, not previously in the USA stakeholder process. A stakeholder asked how the team would prevent the mound from reforming. Tom answered that other measures to be adopted (such as reduction in CSO discharges) may decrease the rate of sedimentation, and that monitoring would track whether the mounds form again in the future. A stakeholder expressed concern over the impact of dredging. Stephen responded that dredging work requires a detailed permitting process, involving public participation, to address these issues.

Tom presented alternatives that would eliminate up to 100 percent of the annual CSO volume, a required analysis for a Long Term Control Plan. Tom stated that the team considered CSO-storage tanks and underground CSO-storage tunnels, and found the latter to be favorable due to siting issues. An underground storage tunnel running under the canal would be created by boring machines that do not disrupt the surface. Underground storage tunnels have been used for CSO control in other American cities.

Tom showed the cost-benefit analysis of various control alternatives. This analysis showed that beyond a certain level of control, little additional benefit would result relative to the additional cost. Based on this analysis, the Waterbody/Watershed Facility Plan was defined as the following combination of control elements: reconstruction of the Gowanus Pump Station; modernization of the flushing tunnel; floatables controls at major outfalls; periodic waterbody skimming for floatables; and dredging to remove exposed CSO sediments. Water quality modeling analyses showed that, with these improvements, the Gowanus Canal water quality would meet the applicable Class SD standard of 3mg/L of DO 100% of the time and the higher Class I standard of 4mg/L of DO 93% of the time. Tom also indicated that these improvements are also expected to significantly reduce floatables. In addition, while bacteria standards do not apply in the canal as a class SD waterbody, the plan should yield substantial reductions in pathogens and is expected to meet secondary contact standards. One stakeholder stated that a measure describing the water quality on most days, rather than the number of times a particular level is reached, is more relevant to residents. Tom replied that results were presented in the manner that water quality standards were expressed in the regulations, and indicated that in fact "typical" water quality would also improve. He showed a graphic of average dissolved oxygen to demonstrate this point.

Tom spoke about post-construction monitoring as a way to verify that the controls produce the desired improvements. One stakeholder noted that this provides an opportunity to interface with schools and science curriculum. Tom then presented the schedule of implementation of the Waterbody/Watershed Facility Plan elements. Most elements of the plan are scheduled to be completed in 2012. Dredging applications are scheduled to be submitted to the State in 2009; dredging will begin within 3 years of an approved permit.

Stakeholders were concerned with the impact of several development projects on population and water quality, and whether these projects were accounted for in the analyses. The team explained that the modeling analyses used the Department of City Planning's population projections to 2045, which do include development in a general way, though not specific projects. Stephen stated that the City has an interest in projecting high, avoiding costly capacity issues. A stakeholder requested the population projections for the study area. The team agreed to give the population projection numbers to the stakeholder team, by way of Community Board 6.

A stakeholder asked what the impact would be if the yearly rainfall was greater than the baseline data. Tom answered that prediction of CSO frequency is complex and that factors apart from rainfall volume, like the intensity of storms, are more important indicators. Another stakeholder asked for the ratio of sewage to rainwater in CSOs which Tom estimated very roughly to be 20% sanitary, 80% rainwater. Stephen clarified that, since the area was largely impermeable, the redevelopment of sites with new buildings will not take away permeable ground currently used for stormwater absorption. He noted that, since the main component in volume is storm water, increased population will not drastically increase overall volume. One stakeholder added that the combination of increased frequency of large storms, due to global warming, and more sewage from more people could be problematic.

The floor was opened to questions:

> One stakeholder asked whether the work on the flushing tunnel will disrupt the operation of the system. Tom answered that a temporary system will be in place during construction that will provide the current flushing capacity, but that there will be an initial period during which the tunnel will not be operational. This period will be scheduled during the colder months to limit odors and other impacts.

> Another stakeholder asked about the timetable for environmental dredging. Stephen explained that the period until 2009 was necessary to prepare the dredging permit application, which involves planning and verifying the methods of construction and environmental issues associated with dredging. Chris Villari noted the close cooperation of DEP with the Army Corps of Engineers habitat restoration planning for the canal, and suggested that this shared planning would be helpful in permit review and approval.

> Another stakeholder expressed concern that the floatables skimming vessel would require bridge openings, adding to traffic problems in the area.

> A CB 6 Board member asked DEP to hold a meeting for CB 6. The District Manager of Board 6 clarified that the request would come directly from the Board to DEP.

> Another stakeholder asked how Best Management Practices (BMP) were integrated into the plan. Tom indicated that various BMPs were considered in the analysis, and that various BMPs are included in the plan. He clarified that the stakeholder was specifically speaking of "green roofs," and shared rough calculations showing that if every flat-roofed building in the drainage area had a green roof to retain up to 2 inches of rainfall, CSO would be reduced by about 32 MG per year. This volume, which represents an extreme upper limit theoretically possible with green roofs, compares to the 60 MG per year reduction in CSO that will be achieved by increasing the capacity of the Gowanus Pump Station by 10 MG per day. Stephen added that DEP is hoping to learn more about the quantifiable effects of BMPs in the Jamaica Bay Watershed Protection Plan. The Plan will analyze and assess technologies and evaluate potential sites that may be applicable to Jamaica Bay and other areas of the City.

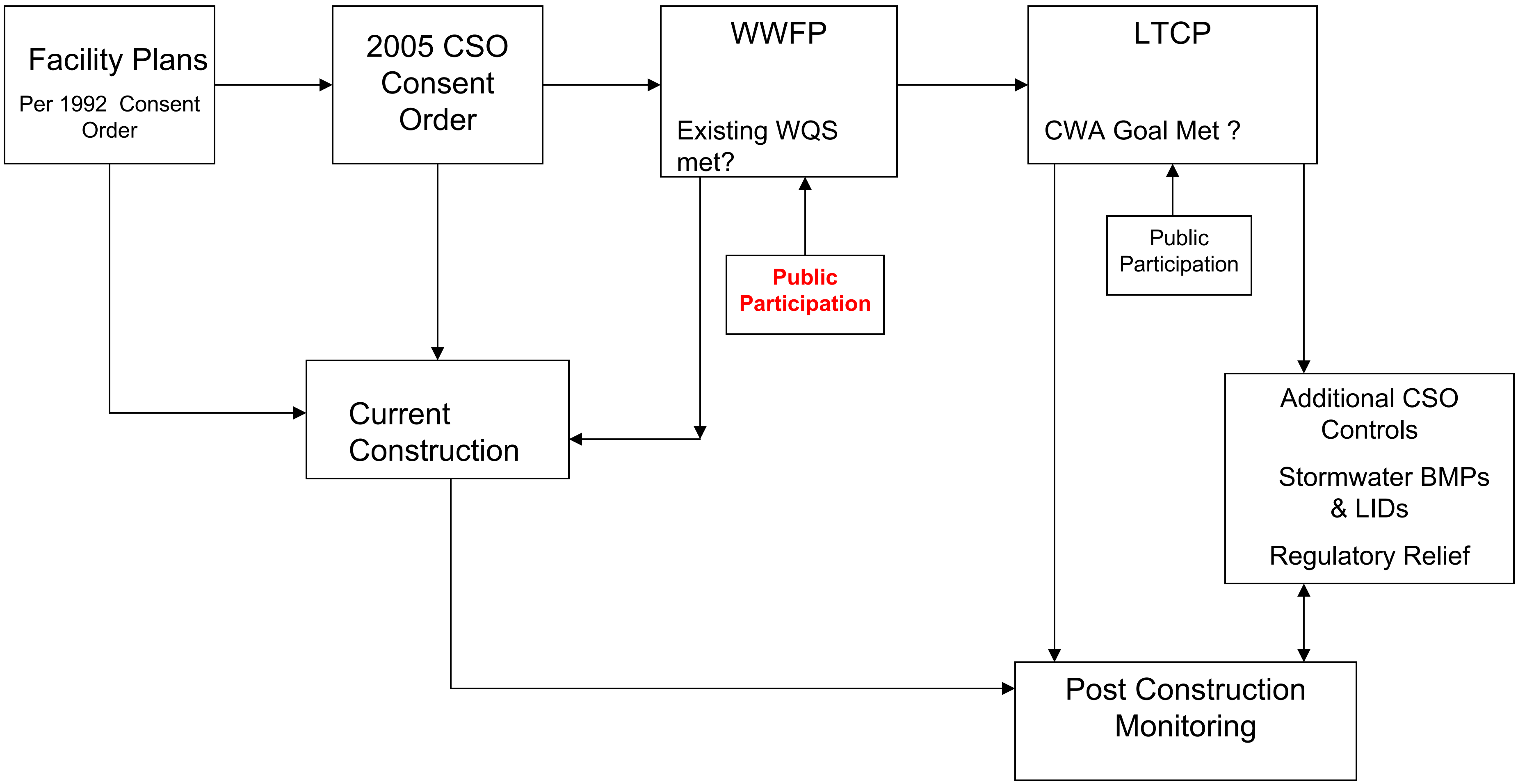
> A stakeholder asked whether the modeling looked at other environmental issues, such petrochemicals recently discovered on a nearby site. Tom explained that the model examines water quality based on standards of DO, pathogens, and aesthetics. Chris Villari, of the DEP, added that work at that particular site showed that matter sinks and blends with older petrochemicals, from past industrial activities, on the bottom.

Stephen closed the meeting. He said that the presentation would be posted on the project website. Draft meeting notes will be available for comment on the website in 3-4 weeks.

APPENDIX H

FEBRUARY 12, 2008 PUBLIC PRESENTATION
AND
NYCDEP PUBLIC RESPONSIVENESS SUMMARY

CSO Long Term Control Plan Process



Waterbody/Watershed Facility Plan (WWFP) Current Document Review

- Identify and Evaluate
  - Cost effective CSO controls to meet or exceed current WQS
  - 100% CSO abatement
  - The highest reasonably attainable uses of the water body
  - Acts as a foundation for future long term control planning

- Public Participation
  - Draft Gowanus WWFP provided to the public after DEC's initial review
  - Public information meeting held by DEC/DEP – 2/12/08
  - 30 day public comment period closes 3/13/08 with published responsiveness summary to follow

Long Term Control Plan

- Evaluation of anticipated WQ (post-WWFP implementation) vs. CWA Goals - The "Gap"
- Identification of cost-effective alternatives and feasibility analysis of additional CSO abatement to meet CWA Goals
- Inclusion of Stormwater BMPs and LIDs
- Looking for
  - Incremental WQ improvements over time (20-30 years)
  - Ways to bridge the "Gap"
    - 9 Minimum Controls
    - Source Control – Stormwater BMPs & LIDs
    - Additional cost-effective CSO reduction
    - Variance – allows operation to verify effectiveness through post construction monitoring
    - Use Attainability Analysis (UAA)

Long Term Control Plan

- Public Participation
  - Draft Gowanus LTCP provided to the public after DEC's initial review
  - Public information meeting will be held by DEC/DEP
  - 30 day public comment period with responsiveness summary
- 5-Year review cycle to correspond with SPDES Renewal
- Gowanus LTCP due 6 months after DEC approval of WWFP – anticipated by end of 2008
- City-Wide LTCP – compilation of all 12 LTCPs – due 12/31/2017

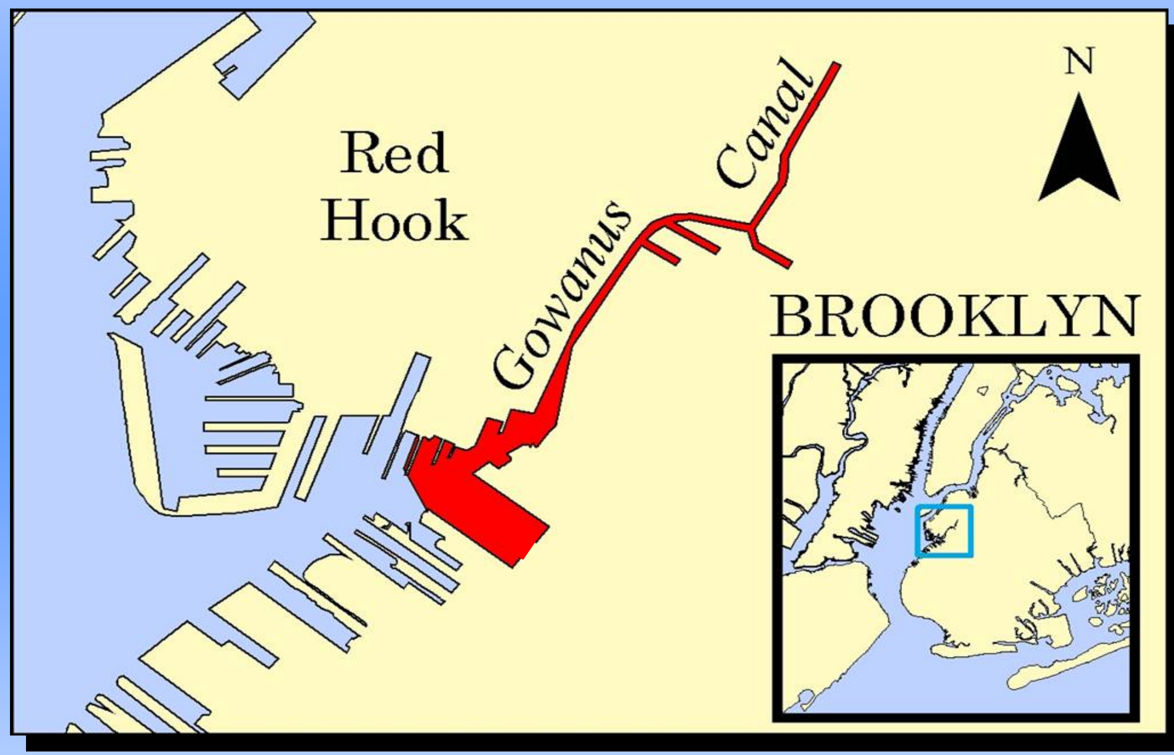
Post Construction Monitoring

- Data to be used in re-evaluation of the LTCP every 5 years upon SPDES permit renewal
  - May identify additional CSO controls
  - Evaluation and implementation of BMPs & LIDs as appropriate
  - LTCPs are "living documents"

Gowanus Canal WWFP

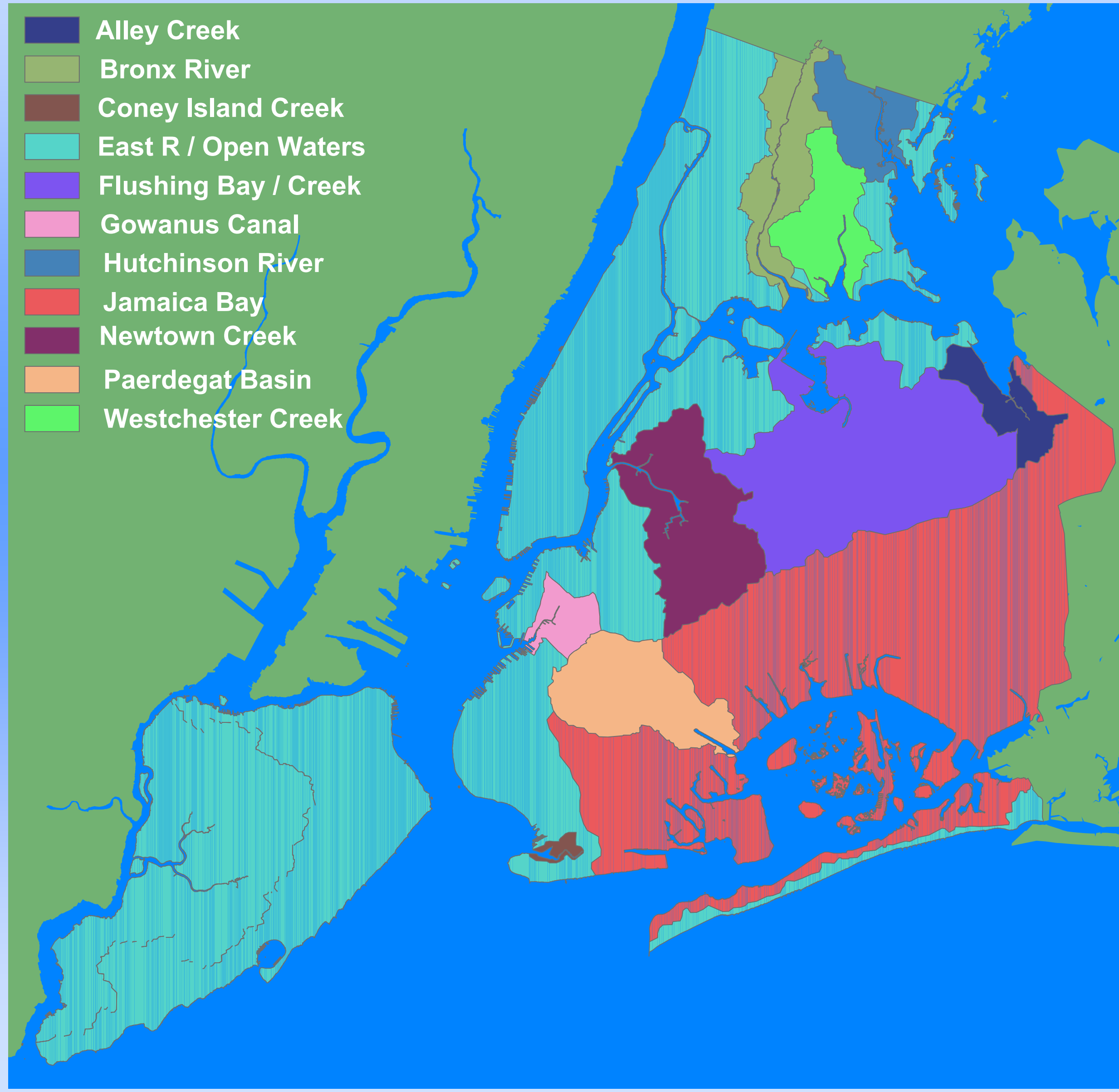
- DEC and EPA support core components
- Implementation will be a major step in incremental WQ improvement
- Will likely allow DEC to upgrade the waterbody classification: SD to I
- Upgrade will support the designated uses of secondary contact and fish propagation
- DEC expects additional incremental improvements through the LTCP process

Long-Term Control Plan Project



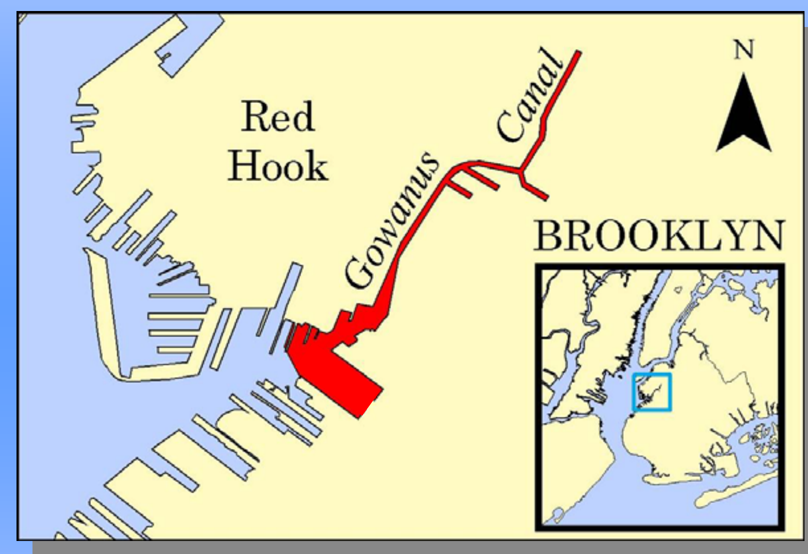
Gowanus Canal
Waterbody Watershed Plan

City-Wide CSO LTCP Program



Gowanus Canal
Long-Term Control Planning

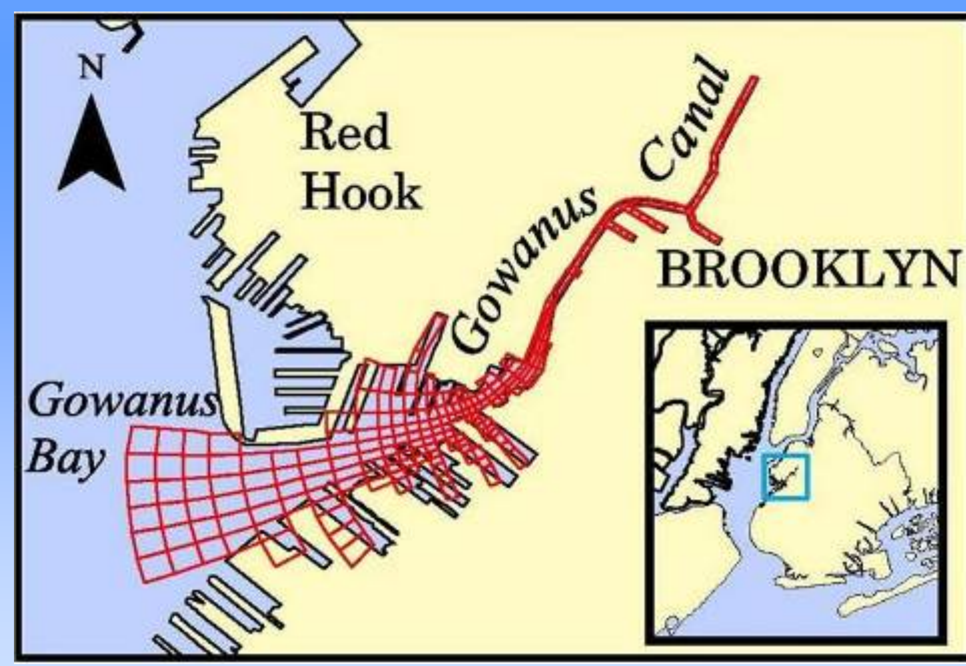
- Planning Area:
  - NYS delineates Canal as shown
- NYS Waterbody Classification: SD
  - Designated Use: Fish Survival
  - Contact Recreation is not supported
- NYS 303(d) List: Canal is Impaired
  - For Dissolved Oxygen/ DO Demand
  - Cause: “CSO/SW/Urban Runoff”
- Current Planning in Gowanus Canal
  - Product of several past/ongoing studies/projects
- CSO Consent Order:
  - Waterbody/Watershed Plan: submitted September 2007
  - Long Term Control Plan: pending DEC approval of WBWS plan



Gowanus Canal Waterbody Planning Area

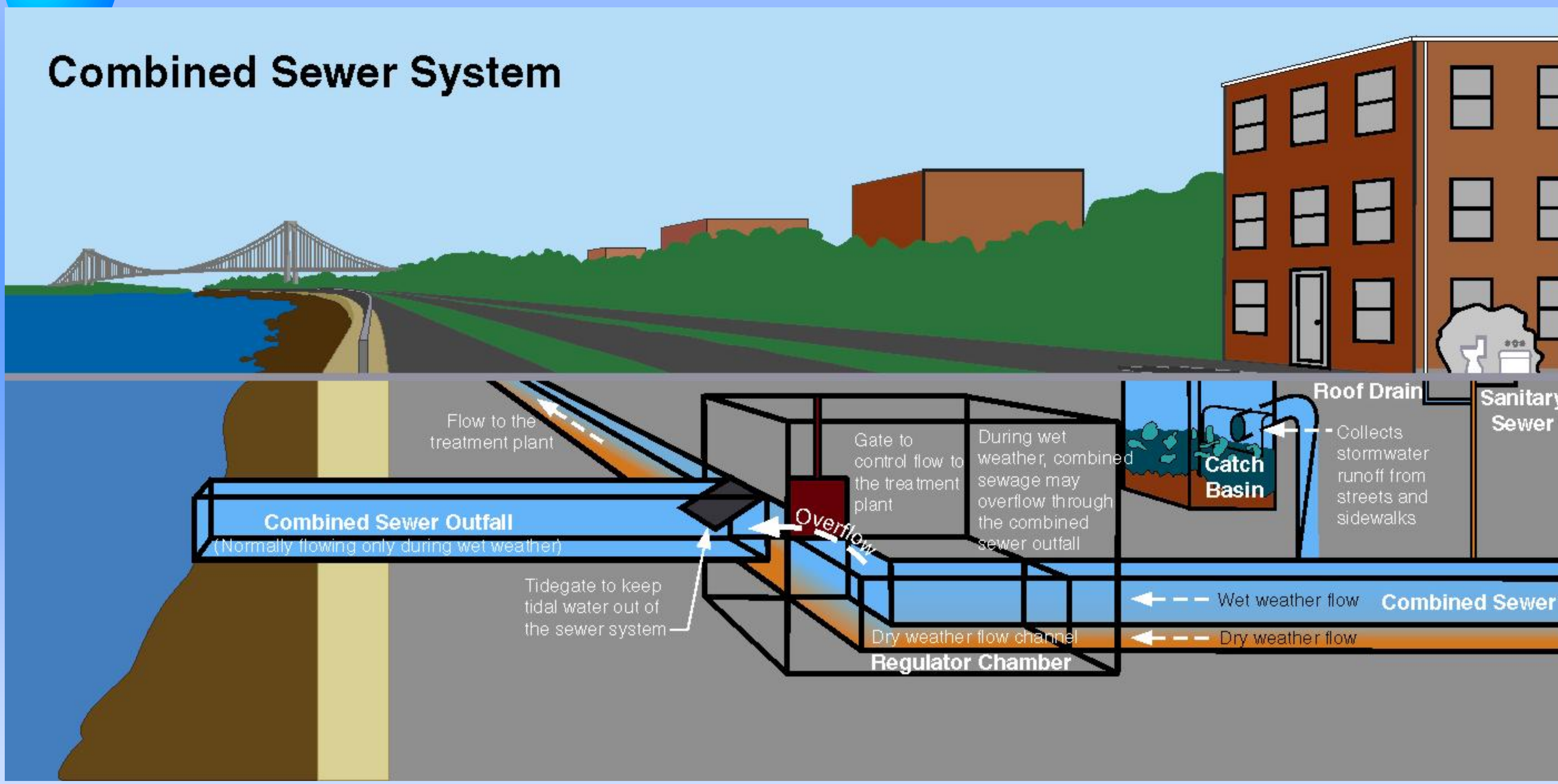
Elements of Gowanus Facility Planning

- Waterbody and Watershed Characterizations
  - Inspections and flow monitoring of sewer system
  - Sampling of physical, chemical & biological parameters
- Mathematical Modeling
  - Watershed
  - Receiving Waters
- Use-Attainability Evaluations
  - Aquatic Life
  - Recreation
  - Aesthetics
- Engineering Evaluations
  - To achieve water-quality standards
  - Integrate past/ongoing planning
  - Identify additional alternatives



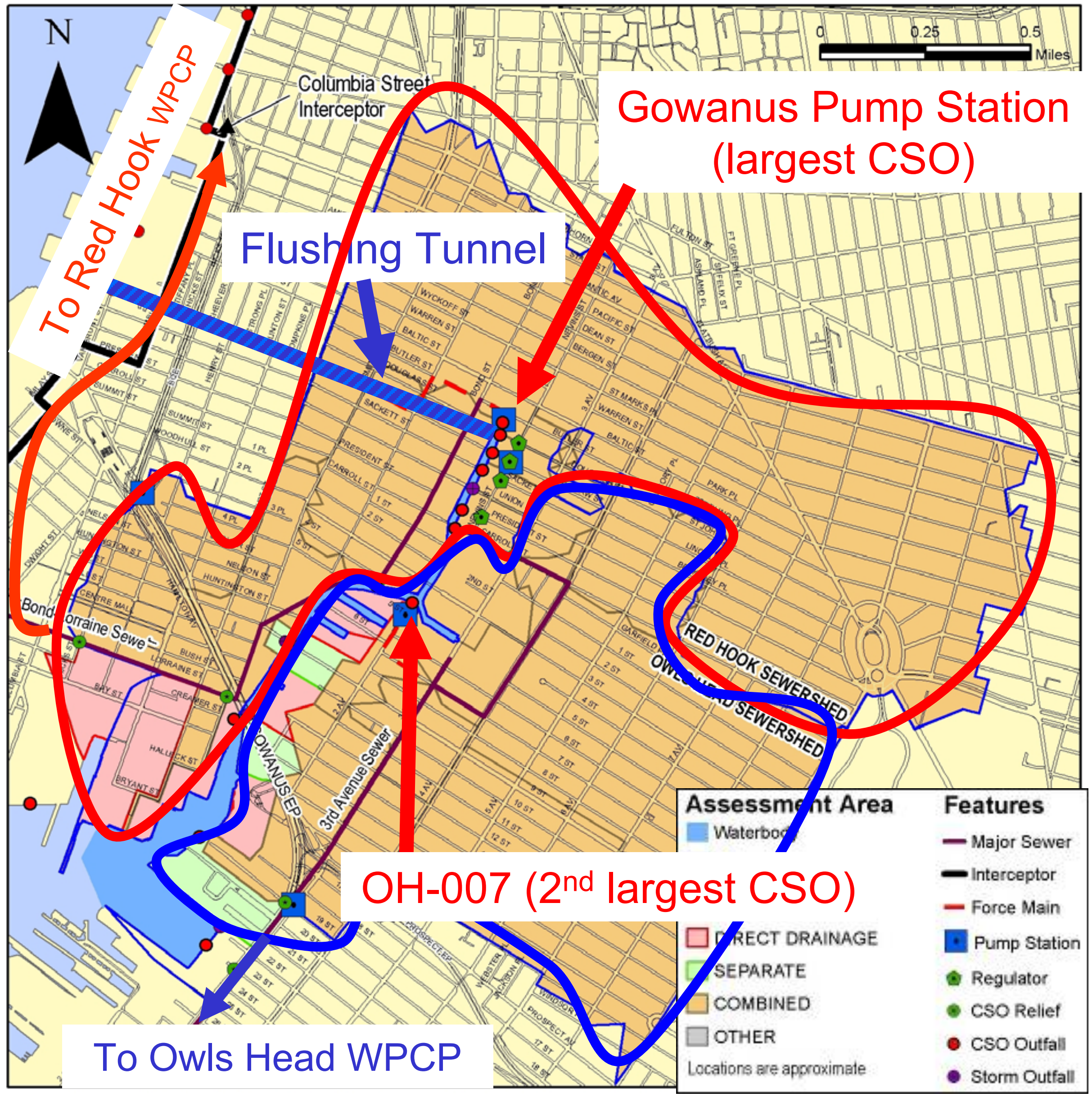
Gowanus Canal Receiving Water Model

What is a CSO?


Combined Sewer System
Flow to the treatment plant
Gate to control flow to the treatment plant
During wet weather, combined sewage may overflow through the combined sewer outfall
Roof Drain
Sanitary Sewer
Collects stormwater runoff from streets and sidewalks
Catch Basin
Overflow
Combined Sewer Outfall
(Normally flowing only during wet weather)
Tidegate to keep tidal water out of the sewer system
Wet weather flow
Combined Sewer
Dry weather flow channel
Dry weather flow
Regulator Chamber

Waterbody/Watershed Characteristics

- Watershed Drainage Area
  - –Entirely urbanized sewer-shed
  - –No continuous fresh inputs
  - –1,759 Acres
    - 92% Combined (1,613 acres)
    - 8% Stormwater (146 acres)
- Combined Sewer System
  - –2 WPCP Service Areas
    - Red Hook WPCP
    - Owls Head WPCP
  - –Pump Stations
  - –11 CSO Outfalls
  - – 4 Storm Sewer Outfalls
- Annual Wet-Weather Discharge Volume:
  - 300$^{+/-}$ MG (typical year)
    - CSO: ~70%
    - Stormwater: ~30%
- Currently SD Classification
  - –Fish Survival
  - –Water Quality Issues
    - Low DO w/o tunnel
    - Floatables and Grease
    - Exposed Nuisance Sediments



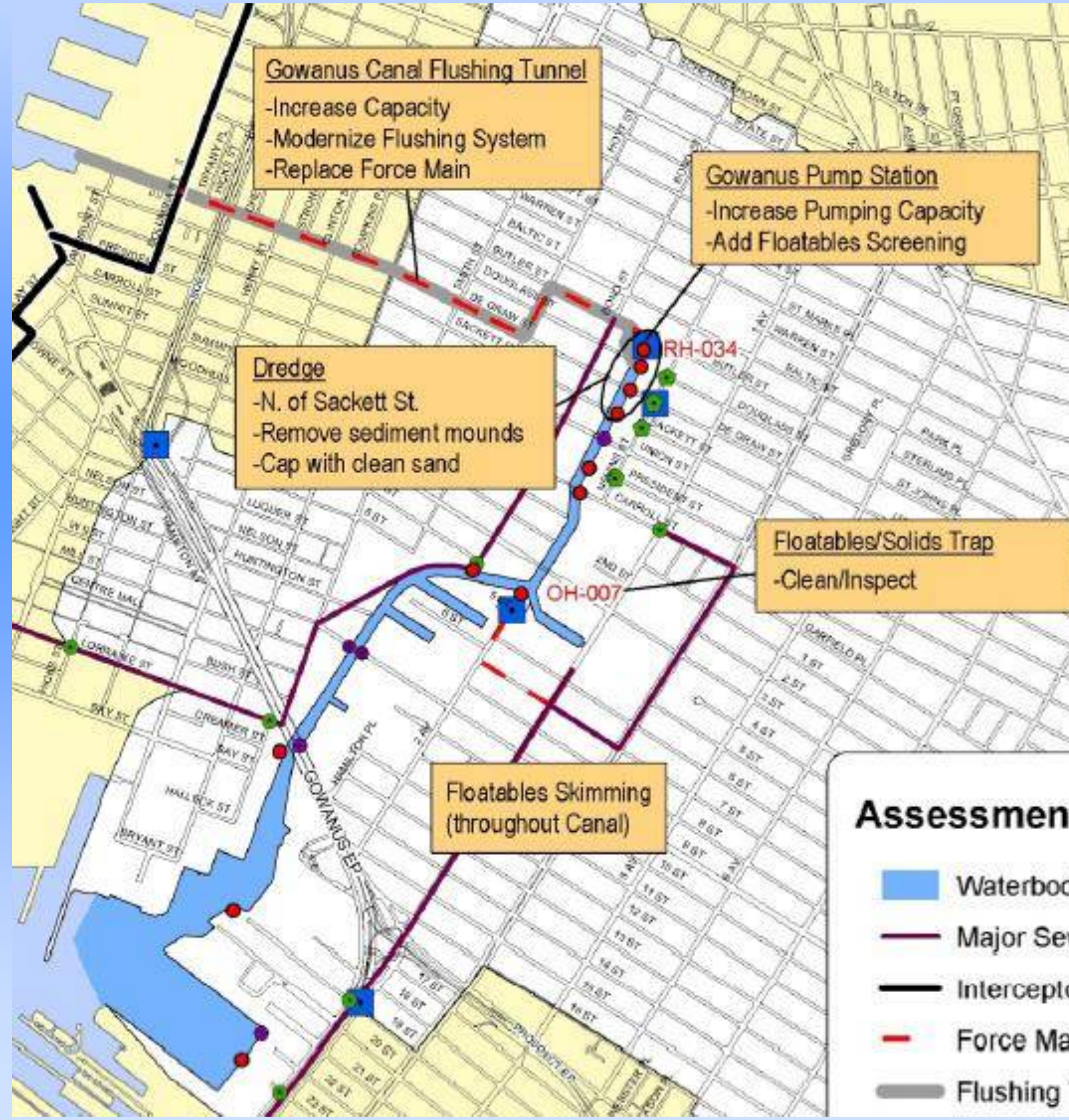
What is
Attainable and Appropriate?

- Aquatic-Life Uses
  - Meet fish survival standard (Class SD standard is $\geq$3 mg/L)
  - Fish propagation may not be attainable ($\geq$ 4 mg/L)
- Recreational Uses
  - Stakeholder team desires secondary contact recreation (Class SD does not support this)
  - Bacteria levels are improving
  - Criteria for primary contact recreation (swimming/bathing) are not met; this use is not consistent with commercial/industrial uses

- Aesthetics
  - No fish kills, obnoxious algal growth, odors
  - Floatables and other aesthetics conditions to be consistent with planned and proposed increases in shoreline access by local community

Gowanus Facility Plan

- Modernize Flushing Tunnel
- Reconstruct Gowanus Pump Station
- Rehabilitate 2nd Ave Outfall Trap
- Floatables Skimming Canal-Wide
- Dredge To Remove Exposed Sediments
- Programmatic Controls



Gowanus Facility Plan

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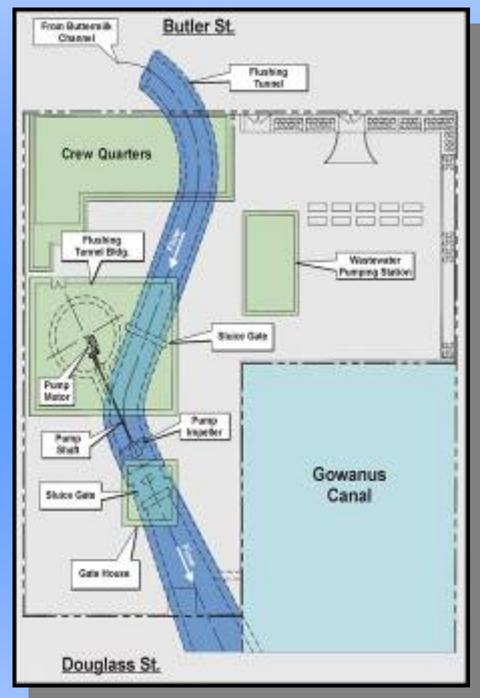
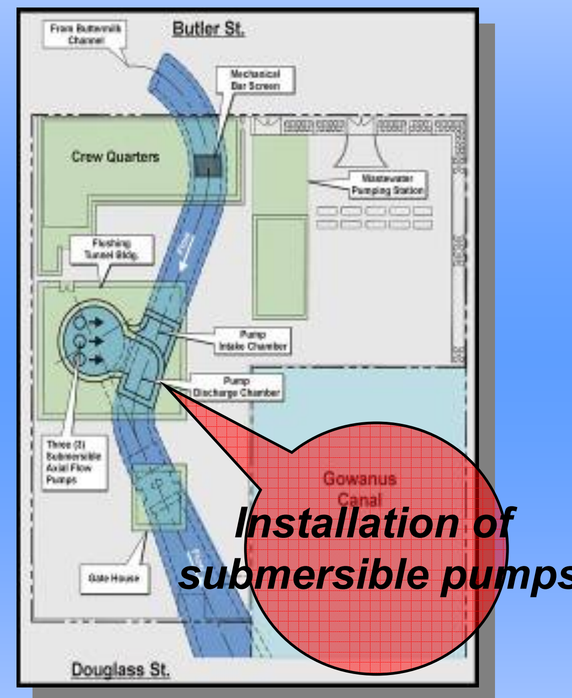


Existing Pumping System



Modernized Pumping System

- Increase tunnel flushing capacity (140 up to 210 MGD)
- Eliminate shutdowns at low tide
- Reduce shutdowns for maintenance

Gowanus Facility Plan

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- Programmatic Controls

- Increase pump station capacity by 50%
- Install new force-main to bypass Bond Lorraine sewer
- Install new screens to remove floatables

Gowanus Facility Plan

- Modernize Flushing Tunnel
- Reconstruct Gowanus Pump Station
- Rehabilitate 2nd Ave Outfall Trap
- Floatables Skimming Canal-Wide
- Dredge To Remove Exposed Sediments
- Programmatic Controls

- Install CSO screen at Gowanus PS
  - Screens up to 200 MGD

Gowanus Facility Plan

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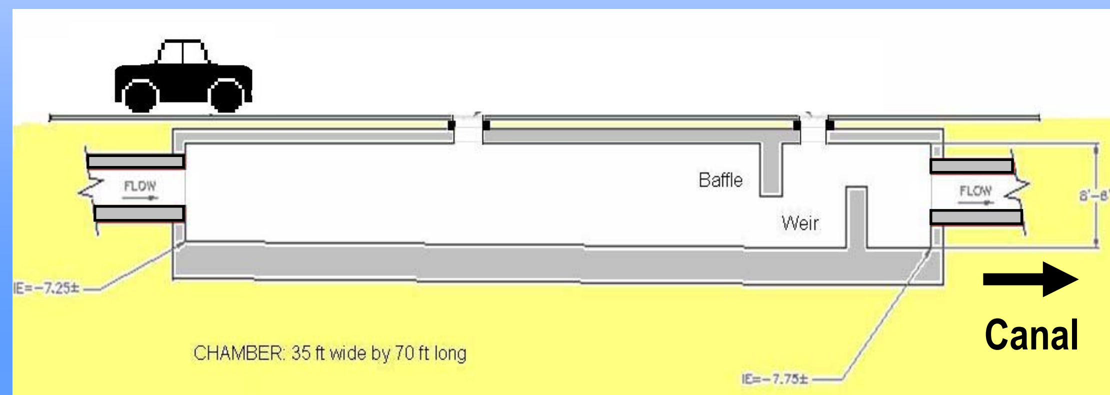
- Reconstruct Gowanus Pump Station
- Rehabilitate 2nd Ave Outfall Trap
- Floatables Skimming Canal-Wide
- Dredge To Remove Exposed Sediments
- Programmatic Controls

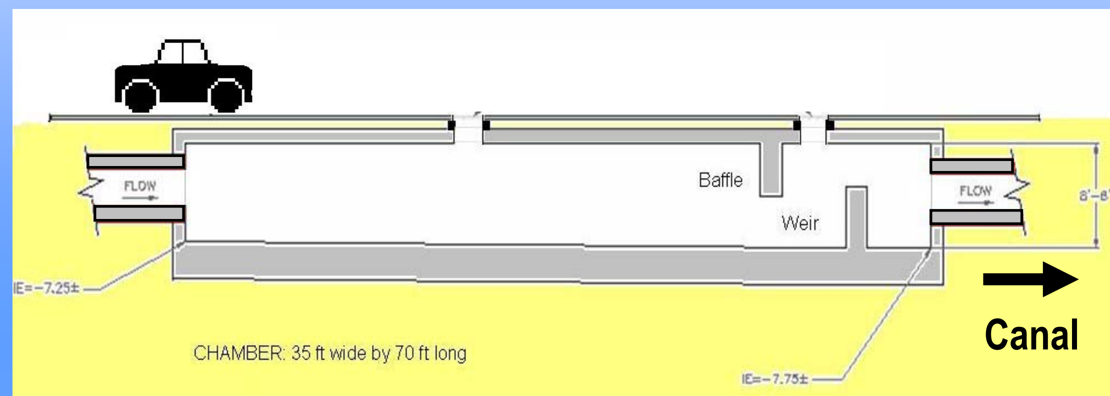


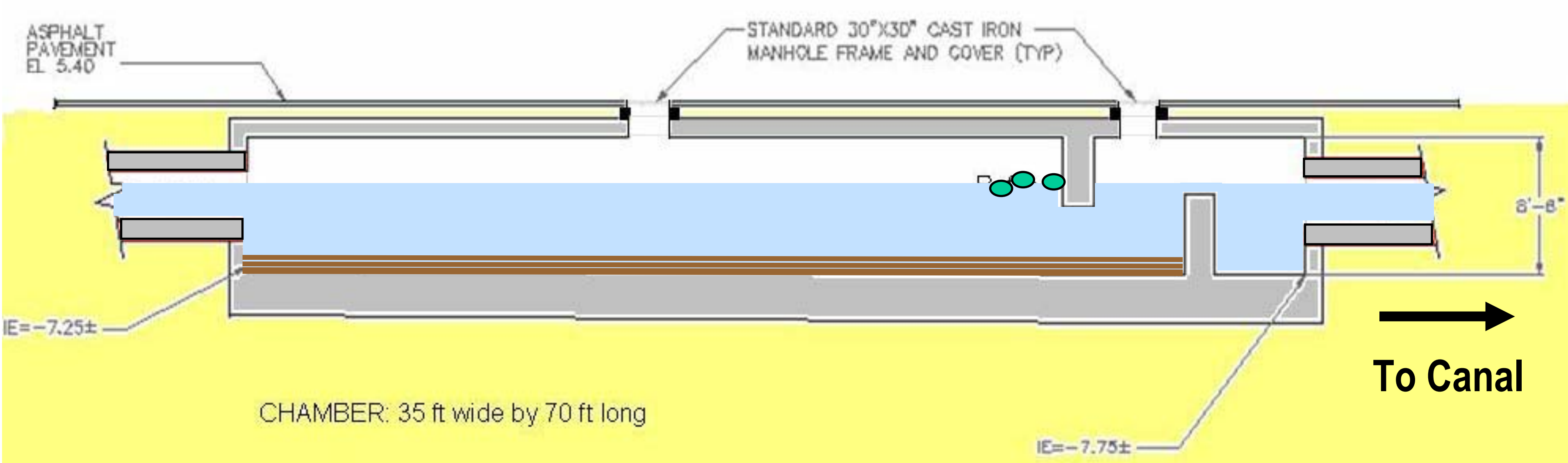
- Original outfall trap designed to capture grit, floatables prior to WPCP construction.
- Plan to rehabilitate and maintain original system to improve capture of grit, floatables, and grease.

Gowanus Facility Plan

Rehabilitate
2nd Ave Outfall Trap

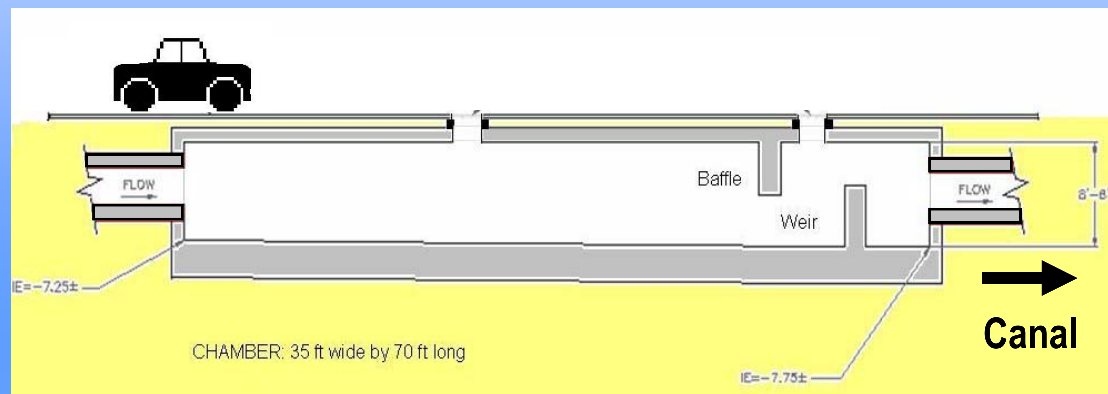
- Click to Animate
- Click to Continue

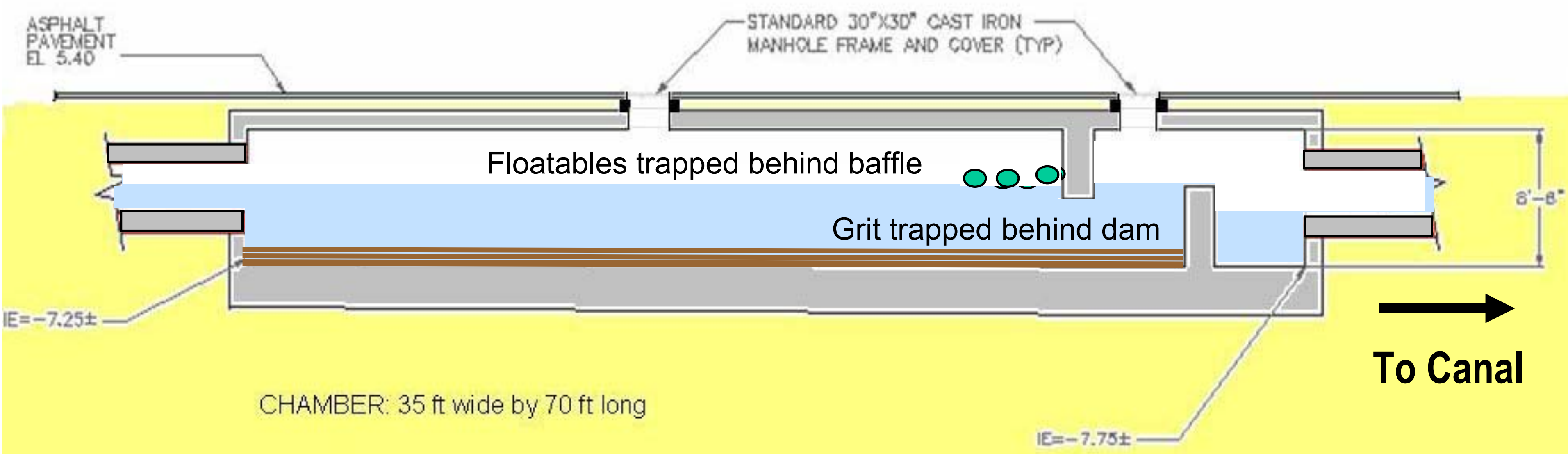




Gowanus Facility Plan

Rehabilitate
2nd Ave Outfall Trap





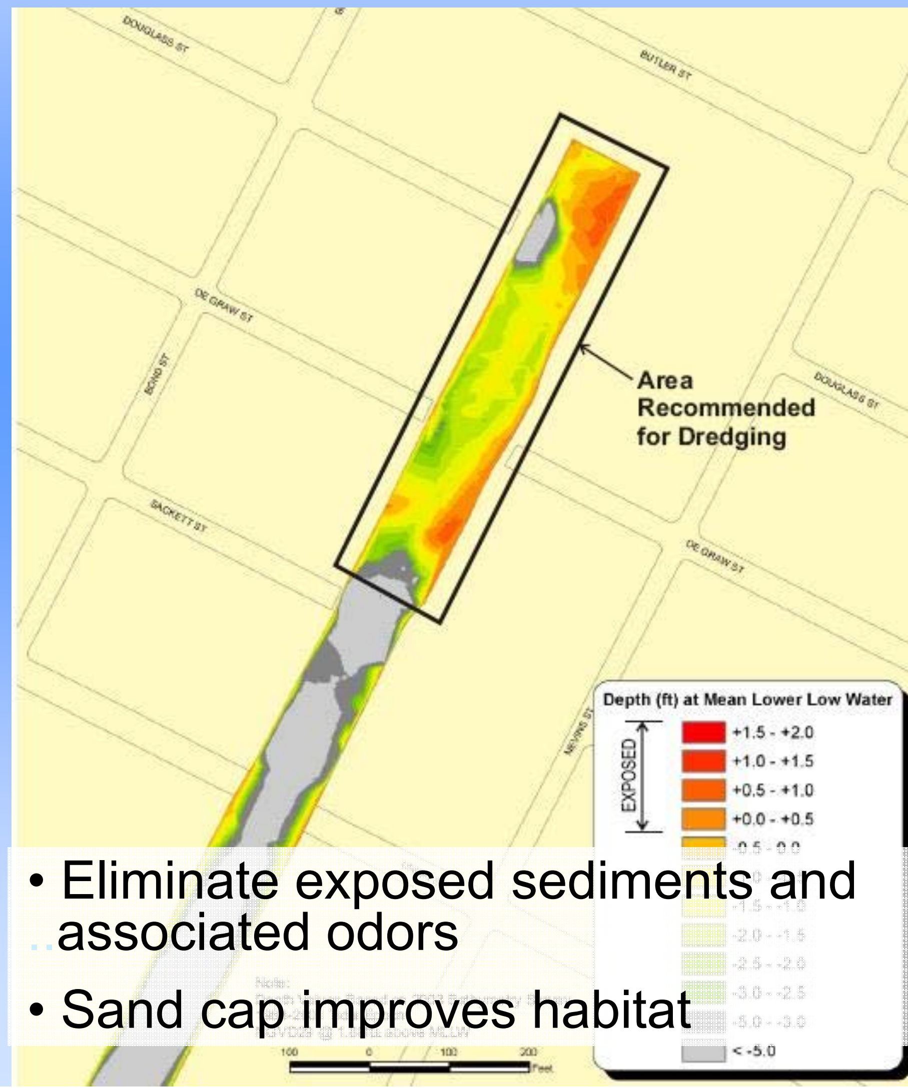
Gowanus Facility Plan

- Modernize Flushing Tunnel
- Reconstruct Gowanus Pump Station
- Rehabilitate 2nd Ave Outfall Trap
- **Floatables Skimming Canal-Wide**
- Dredge To Remove Exposed Sediments
- Programmatic Controls

- Implement in-line floatables controls
- Deploy an open waters skimming vessel, on as needed basis.

Gowanus Facility Plan

- Modernize Flushing Tunnel
- Reconstruct Gowanus Pump Station
- Rehabilitate 2nd Ave Outfall Trap
- Floatables Skimming Canal-Wide
- **Dredge To Remove Exposed Sediments**
- Programmatic Controls



- Eliminate exposed sediments and associated odors
- Sand cap improves habitat

Gowanus Facility Plan

- Modernize Flushing Tunnel
- Reconstruct Gowanus Pump Station
- Rehabilitate 2nd Ave Outfall Trap
- Floatables Skimming Canal-Wide
- Dredge To Remove Exposed Sediments
- Programmatic Controls

- Best Management Practices (BMPs) for collection system:
  - SPDES permit requirement
  - Maximize flow to WPCP
  - Reduce contaminants in sewer system
- Low-Impact Development / other BMPs
  - Reduce rainfall runoff
  - To be incorporated into LTCP
- Floatables Control Plan
  - Comprehensive, City-Wide Plan
  - Street sweeping, catch basins, etc.
- Monitoring
  - Floatables, water quality

Gowanus Facility Plan
Projected Construction Costs

Modernize Flushing Tunnel	**$ 67 Million**
Reconstruct Gowanus Pump Station	**$126 Million**
Rehabilitate 2nd Ave Outfall Trap	***(No construction costs)***
Floatables Skimming Canal-Wide	**$ 0.8 Million (skimmer vessel)**
Dredge To Remove Exposed Sediments	**$ 5 Million (dredge and place sand cap)** **$ 13.2 Million (bulkhead replacement)**
Programmatic Controls	***(No direct construction costs)***
	$212 Million

Gowanus Facility Plan Implementation Schedule

Modernize Flushing Tunnel	**2009 → 2013**
Reconstruct Gowanus Pump Station	**2009 → 2013**
Rehabilitate 2nd Ave Outfall Trap	**2006 (Ongoing O&M)**
Floatables Skimming Canal-Wide	**2013 →**
Dredge To Remove Exposed Sediments	**Permit Application in 2009 (Initiate 3 yrs from approval)**
Programmatic Controls	***Ongoing* →**

Gowanus Facility Plan
Projected Benefits

- **34% Reduction of CSO Volume**
  - reduce pollutant discharge to Canal
- **Attain Dissolved Oxygen Standards**
  - ensure fish survival
  - allow for fish propagation 93% of time
  - *Additional controls do not increase attainment*
- **Attain Secondary Contact Standards for Bacteria**
  - Bacteria standards do not apply in Canal
  - Substantial reduction: projected to meet secondary contact standards
- **78% Reduction of Floatables**
  - Through CSO reduction and screening at Gowanus Pump Station
  - Address remaining floatables with waterbody skimming
- **Eliminate Exposed Sediments & Associated Odors**
  - North of Sackett Street (Head)

Gowanus Facility Plan
Assuring Performance

- **Monitor waterbody to check plan performance**
  - Expectations from modeling are uncertain
  - Actual results will vary depending on weather, tides, time of day, specific location, other factors
  - Monitor waterbody to determine if controls are meeting expectations for “average conditions” -- requires monitoring for extended period
  - At least 2 monitoring locations in each waterbody

➢ **Based on monitoring results, adjust controls**

7/11/2008

Responsiveness Summary
To Questions and Comments Presented to the
New York State Department of Environmental Conservation and the
New York City Department of Environmental Protection
On the Gowanus Canal Waterbody/Watershed Facility Plan

A. QUESTIONS BY ATTENDEES AT PUBLIC MEETING HELD TUESDAY, FEBRUARY 12, 2008 AT P.S. 58 IN BROOKLYN, NY

A.1. QUESTIONS ON BMPs / LOW-IMPACT DEVELOPMENT / "GREEN" INFRASTRUCTURE

A.1.a) How will the Intro 630 (a.k.a. Local Law 5 of 2008 for development of a city-wide stormwater management plan) schedule be linked to Waterbody/Watershed Facility Plan (WB/WSFP) and Long Term Control Plan (LTCP)?

Developing and improving ways to infiltrate, control, recycle, and otherwise mitigate stormwater runoff improves stormwater and wastewater conveyance and treatment capacity by reducing the load to the system at its source. DEP is evaluating several stormwater best management practices (BMPs) that are being undertaken in connection with the settlement of an enforcement action taken by New York State and DEC for violations of New York State law and DEC regulations. Additionally, the Mayor's Office and DEP have created a BMP interagency task force as part of PlaNYC 2030. Information from the task force meetings and the pilot studies will be used by the Mayor's Office of Long Term Planning and Sustainability to create the stormwater management plan required by Intro 630 [Local Law 5 of 2008]. Several pilot projects are in the design phase, including green roofs, rain gardens, enhanced tree pits, permeable surface treatments, and blue roofs. Once these pilot projects are implemented and data are collected, meaningful information related to costs, environmental benefits and public acceptance will be used to update both the stormwater management plan as well as DEP's long term Combined Sewer Overflow (CSO) control planning efforts.

In addition, the following BMP strategies are being implemented at the Gowanus Facilities Site:

- *A 1,700 square foot green roof will be constructed atop the pump station building to handle approximately 5% of the site runoff.*
- *Bio-retention and other landscaped areas will be constructed on portions of the site and planted with engineered soils and vegetation for an additional 2,350 square feet of pervious surface to receive approximately 35% of the site runoff.*

A.1.b) Why did the alternatives analyses assume no BMPs for sewer separation? This biases against [BMPs] because it assumes unnecessarily high pollutant loadings from separate (storm) sewer discharges.

Sewer separation was considered in the WB/WSFP. Although DEP does support partial separation for new construction near a water body, both partial and complete separation were considered and both were not retained as viable alternatives. These alternatives were ruled out due to the widespread excavation and lengthy time frames that would be needed for construction, as well as the extreme disruptions that would occur in every neighborhood, the potential lack of space under City streets to place an additional sewer line, and the potential for increased floatables discharges after separation.

Additionally, the alternatives analyses did not include potential benefits from BMPs in either a combined or separate stormwater system because the degree to which these BMPs can be implemented, and their impacts on water quality, are not fully known. Stormwater BMPs are generally considered to have a positive impact on stormwater volume and water quality, so the water quality benefits that actually result from BMPs will further support an upgrade of the Canal's designated classification as improved water quality is realized during post-construction monitoring activities.

Because of the need to conservatively evaluate the performance of engineered technologies, DEP is pursuing BMPs in parallel with the CSO program. DEP's commitment is further demonstrated by the recent release of a Request for Proposals for a multiyear program that will design, construct, and assess multiple BMP pilot projects, and review potential regulatory mechanisms to facilitate BMP implementation. The Mayor's Office of Long Term Planning and Sustainability will also continue to pursue these green solutions as part of Local Law 5. The DEP/DEC will also undertake a number of Environmental Benefit Projects that will allocate $4 million to evaluate/implement various Stormwater BMPs.

A.1.c) Should it be mandated for new high-rise buildings to have a wet well that holds wastewater until after a storm? After a storm, the wastewater can be pumped out to Red Hook or Owls Head wastewater treatment plants.

New developments are already required to construct some form of stormwater detention on site (i.e., subsurface or rooftop) when it is determined that there is insufficient capacity in the sewer systems.

A.1.d) The City has assembled an interagency task force to look at specific ways to capture and use stormwater before it enters and overwhelms the sewer system. Are there any funding opportunities at DEC that members of the Gowanus Canal community could apply for in order to try and address combined sewer overflow in a more environmentally responsible way?

A representative of Congresswoman Nydia Velazquez noted that the congresswoman had obtained funds for green roof projects through the Congressional appropriations process and that there might be Environmental Justice grant money available as well. As a follow-up to these comments, DEC staff mentioned that the agency's Environmental Justice Community Impact

Grant program had recently opened its 2008 funding cycle and encouraged attendees to take part in environmental justice grant-writing workshops scheduled for March.

In addition, DEC staff responded that, although DEC does not have a grant program primarily or solely focused on stormwater management, particular activities funded by DEC's Urban and Community Forestry Grants, the Hudson River Estuary Grants Program, or the New York City Environmental Fund could address stormwater management issues. In addition, under the Consent Order between DEC and DEP, a $4 million penalty will be used for environmental benefits projects (EBPs) that mitigate the deleterious effects of urban stormwater and CSO on the environment. This EBP funding will be used to pilot and evaluate Low Impact Development and BMP alternatives such as porous pavement, swales, enhanced tree pits, and other treatments. The funding will be dispersed in the form of grants once the exact scope of the projects is approved by DEC.

A.1.e) With PlaNYC 2030 extolling the virtues of green roofs, and with the City about to pass Intro 630 [Local Law 5 of 2008], will the DEC and/or DEP and/or the Department of Buildings <u>mandate</u> installation of a green roof by Whole Foods, given the planned store's large footprint and adjacency to the banks of the Gowanus Canal?

At this time, neither DEC, DEP, or the Department of Buildings can require Whole Foods to install a green roof. However, the City is reviewing ways to incorporate green solutions into the review process for new developments. The Whole Foods developer will need a NYS DEC wetlands permit and a DEP sewer connection permit, and may also need to prepare an environmental review, all of which will need to be noticed for public comment. Also, please refer back to the answer for Question A.1.c) above.

A.1.f) Given the topography of Gowanus and the fact that the Canal was originally marshland, thereby predisposed to runoff, is there any way to work with other agencies (such as DOT) to curtail the need for so much wastewater management? In other words, could permeable surface treatments be applied to the surrounding area?

The drainage area tributary to Gowanus Canal is highly impervious due to urbanization of the area. Future redevelopment of existing impervious areas will likely result in decreases in imperviousness with the implementation of stormwater BMPs, change in city building codes, and environmental review procedures that were not in place when much of the area was developed to its present state. Please refer to the answer to Question A.1.a) above. Also note that the Interagency BMP task force under PlaNYC 2030 includes the DOT as a member of the task force. The Mayor's Office of Long-Term Planning and Sustainability will also continue to pursue these green solutions as part of Local Law 5.

2. QUESTIONS ON WATER-QUALITY STANDARDS

A.2.a) Meeting the "I" standard 100% of the time; does this reference to the East River at the entrance to the Flushing Tunnel imply the East River's water quality is worse than Gowanus?

No. The Gowanus Canal is currently designated as a Class SD waterbody, which means it is suitable only for fish passage, but not for recreational uses. Class SD waterbodies have no pathogen requirements and have a dissolved oxygen requirement of never less than 3.0 mg/L. Most of New York Harbor is designated Class I, a higher water-quality standard protective of both fish propagation and secondary-contact recreation (such as boating). The Class I dissolved oxygen requirement is never less than 4.0 mg/L and the Flushing Tunnel improves the water quality of Gowanus Canal by bringing in higher-oxygen water from Buttermilk Channel and improving circulation in the Canal. Without the Flushing Tunnel in service, Gowanus Canal would not consistently attain the Class SD dissolved oxygen requirements. Improvements to the Flushing Tunnel will help enable the Canal to attain Class I pathogen standards 100% of the time and to attain Class I dissolved oxygen standards well over 90% of the time—a significant improvement in overall water quality.

A.2.b) What controls would be necessary to meet the Class I dissolved oxygen standard 100% of the time?

Under the Waterbody/Watershed Facility Plan, model projections indicate that Class I standards will be met nearly 100% of the time in a typical year. These projections indicate that even 100% CSO control may not result in Class I standards being met all of the time. One reason for these excursions is that the current DO standard is never less than 4 mg/L and any intermittent excursion below this, regardless of duration, equals non-attainment. To assess attainment, a water quality model was used to calculate hourly dissolved oxygen concentrations over an entire year at numerous vertical and horizontal locations throughout the Canal—including at the bottom, where oxygen is lowest. Any calculation of less than 4 mg/L at any location represents non-attainment for the entire water column at that time, even if the excursion is localized and brief. This is one of a number of "conservative" assumptions designed to offset uncertainty in the projections. The Plan may be sufficient to meet the Class I requirements all of the time in a typical year. The post-construction monitoring program referenced in Section 8.5 of the WB/WSFP is necessary to validate the projections and determine the overall attainment with water quality standards once the proposed Plan is fully implemented.

A.2.c) Why aren't the City and state aiming for a classification that allows swimming and fishing? What would it take to get to that level?

The goal of the WB/WSFP is the attainment of existing water quality standards, which in the Gowanus Canal would be Class SD (Fish Passage). However, the proposed plan goes beyond this level of attainment and is projected to attain Class I (Secondary Contact) standards. The improvements necessary to achieve "swimmable" water quality (Class SB/SC) standards will be evaluated in the Gowanus Canal CSO Long Term Control Plan.

3. QUESTIONS ABOUT FUTURE DEVELOPMENT / POST-CONSTRUCTION MONITORING / CLIMATE CHANGE

A.3.a) Climate meteorologists expect future rainfall to be much like it has been over the past few years, where sixty-two inches of rain has fallen annually. Does the DEP expect Class I standards to be met under these expected rain conditions? Explain.

As noted in the document, the WB/WSFP focused on attainment of existing standards, i.e., Class SD, but included the expectation of over 90% attainment of Class I standards during a typical year with full implementation of the Plan. This expectation is based on a rainfall pattern that represents a long-term average condition with respect to CSO discharges, in accordance with EPA policy. DEP has studied over 50 years of rainfall records for the metropolitan area and has found that, while CSO response to precipitation is complicated, rainfall intensity has a greater influence on CSO than total annual rainfall volume. Simulations that used records from 2003, a recent "wet year" (in terms of total annual rainfall), produced less CSO volume than the rainfall pattern selected for evaluating alternatives and projecting water quality.

DEP has already begun a study to evaluate the impact of climate change on rainfall and sea levels and how these affect the City's sewer infrastructure and CSO discharges. The first part of the study, The NYC DEP Climate Change Program Assessment and Action Plan (May 2008) is complete and is available on DEP's website at http://home2.nyc.gov/html/dep/html/news/climate_change_report_05-08.shtml. As part of this ongoing study, DEP will assess whether a different rainfall pattern should be adopted for future analyses. Existing evidence suggests that the selected rainfall pattern is suitable for comparing the performance of infrastructure improvements to one another to develop the most cost-effective CSO abatement alternatives. The post construction monitoring plans will provide DEP with additional data to evaluate impacts of climate change and rainfall variability on attaining water quality standards and this will further be addressed via subsequent Long Term Control Plans.

A.3.b) New York State DOT is in the process of designing a new Gowanus Expressway from Hamilton Avenue to Bay Ridge. What are New York City and New York State doing to reduce the amount of runoff from this gigantic highway into our combined sewer system?

The expansion of the Gowanus Expressway was not evaluated in the WB/WSFP; however, the change from existing conditions is not expected to be significant, considering the 1,800-acre overall drainage area. Though replacing pervious (i.e., grass) areas with impervious (i.e., paved) areas would marginally increase the runoff from those areas, an expansion of the existing expressway would not represent an appreciable addition of imperviousness because the existing right of way is already highly impervious. In addition, as a general practice, highways near waterways are typically drained directly to the waterway via storm sewers, in which case the runoff would not enter the combined sewer system and would not contribute to CSOs.

A.3.c) Have you or will you consider the long-term effects of sea-level rise resulting from global warming? The Flushing Tunnel is perhaps over 100 years old. To what extent will past or future sea-level rise be a factor for design? To what extent if any is or can natural tidal action be taken into account to make the flushing more efficient and effective?

DEP continues to study the potential impacts of climate change and sea-level rise on predicted rainfall patterns, sewer capacity, and wastewater treatment capacity. Please refer to the answer *to Question A.3.a) above. Sea-level rise itself is expected to reduce CSOs, since higher water levels in the receiving waters tend to hold back the tide gates and maximize the storage of combined sewage within the sewer system.*

Natural tidal action results in water levels with a roughly five-foot difference between low and high tides. This variation in water level significantly impacts the operation of the Flushing Tunnel, as the existing pumping system is much less effective at lower tides. One element of the Plan is the installation of a new pumping system that is much more effective at lower tides and will increase overall flushing rates by nearly 40%. Because higher water levels improve the effectiveness of the pumping/flushing system, sea-level rise is not expected to adversely affect the Flushing Tunnel and might even result in a slightly higher pumping rate (i.e., more flushing).

A.4. MISCELLANEOUS QUESTIONS

A.4.a) It (*the WB/WSFP*) all sounds great – but not anything to look forward to. The Plan does not address the south end of the canal where the scrap metal and concrete companies contribute to the pollution. They are not monitored. Concrete and cement are being dumped into the canal.

The proposed Plan addresses water quality over the entire length of Gowanus Canal, and is expected to attain the applicable (Class SD) water-quality standards 100% of the time and the next-higher (Class I) water-quality standards nearly 100% of the time. The dumping cited in the comment is illegal and may be curtailed through legal action. Observed illegal dumping should be reported, either by calling 311, or by notifying DEC.

A.4.b) Can the clean up of Public Place help stop pollution into the Canal and into area groundwater?

Yes, any remediation of soil or groundwater contamination adjacent to the Canal will have an added benefit of preventing these contaminants from making their way into Gowanus Canal. DEP is also planning to dredge the head of the Canal to address any CSO-related sediment accumulation. This dredging project will take necessary measures such as installing a membrane/sand cap to help mitigate any future migration of subsurface contaminants into the Canal.

A.4.c) Repair of the Bulkheads from the Head of Canal to Sackett Street has been in progress for the last several weeks. Who is doing this work and why?

Private owners of bulkheads can make bulkhead repairs provided they have the proper permits issued by NYSDEC. These permits require public notification and provide for a comment period prior to being issued.

A.4.d) Can we have a Health Study (in the community) because of the pathogens in the water, land, and air in the Gowanus neighborhood?

The Gowanus Canal WB/WSFP is projected to result in full attainment of secondary-contact water quality standards for bacteria. These standards were developed by the EPA based on comprehensive epidemiological studies to protect human health. It is unlikely that any pathogens from the water are being transferred to the land or air. However, if there are specific concerns regarding this issue, please contact agencies such as the City Department of Health and Mental Hygiene (DOHMH) or the Centers for Disease Control (CDC) with as much detail as possible.

A.4.e) Is there a need to monitor check valves in buildings near the waterbodies to avoid their wet weather discharges?

No. Check valves are installed on sewer service connections where necessary to prevent sewage flow from entering buildings from the street. If they fail, sewage from the surrounding collection system could flow into basements, a condition that is recognized rapidly.

A.4.f) A follow-up comment noted that CSOs actually function to prevent sewage backups into buildings. Another commenter stated that sewage backups are an issue in the community, particularly on the east side of the Canal.

The questioner is correct that CSOs are relief points that allow excessive wet-weather flow to discharge to the receiving water rather than back up into buildings. The objective of this project is to improve water quality in Gowanus Canal through control of these CSO discharges. Progress in these efforts should not contribute to an increase in the occurrence of sewer backups into buildings. Issues involving sewage backups into basements are handled through DEP's Bureau of Water and Sewer Operations (BWSO), which provides maintenance of the sewer systems and responds to complaints of sewer backups.

A.4.g) Can the PowerPoint presentation be sent to elected officials and the public by e-mail?

Yes. The PowerPoint presentation is appended to the Responsiveness Summary.

B. QUESTIONS RECEIVED DURING THE PUBLIC COMMENT PERIOD

B.1. BMPs / LOW-IMPACT DEVELOPMENT / "GREEN" INFRASTRUCTURE

B.1.a) Several comments were associated with this topic. One commenter stated that the quantitative analysis of BMPs was inadequate. It was recommended that the Plan be revised to include a deadline for completing source control modeling efforts. Questions pertaining to Local Law 5 and incorporating it into the schedule were raised, and it was suggested that all costs and benefits of such practices be included in the evaluation.

DEP focused its alternatives analysis on technologies that showed promise in attaining the goals of the study in cost-effective, timely, measurable ways. Source controls offer an exciting *alternative for the long term, and the City is pursuing these technologies on a parallel track. CSO reduction from these technologies was not expected to be realized on the scale and time frame necessary to satisfy the requirements of the Consent Order.*

B.2. QUESTIONS ON WATER-QUALITY STANDARDS

B.2.a) The Plan should clearly state the PlaNYC 2030 goal to meet or raise existing water quality standards so that 98% of NYC waters are suitable for recreation and design the CSO plans to meet that goal.

The WB/WSFPs have the goal of attaining existing standards. Attainment of higher standards that are protective of recreation will be evaluated in the Long Term Control Plans.

B.2.b) The use of average conditions as a metric is incomplete, and binary decisions regarding compliance or non-compliance are inadequate in describing water quality response. The frequency, duration and magnitude of episodic "spikes" in pollution levels associated with CSO events should be evaluated.

The Gowanus Canal and Bay water-quality model represents the waterbody with nearly 200 segments, each of which includes 10 vertical layers, for a total of some 2,000 "cells." Each cell represents a different location for which there is a unique calculation of water-quality concentrations for every hour of the year. For each modeled water-quality parameter, this represents nearly 9,000 calculated concentrations in each of the 2,000 cells. To assess the water-quality conditions throughout the Canal over the course of the year, the WB/WSFP condenses these millions of calculations into an expression of the percentage of hours that applicable water-quality standards are attained along the Canal. These results are presented graphically in Sections 7 and 8, as well as in Appendix D of the WB/WSFP. The dissolved oxygen standard is expressed as a "never-less-than" single value so that any one location not meeting that value during any hour of the year represents a contravention of the water-quality standard. For pathogens, the standards are typically expressed in terms of geometric means, as established by EPA based on epidemiological studies that use these statistical measures to account for health impacts of variable pathogen concentrations in natural surface waters. Though extreme conditions are not explicitly relevant to these standards, frequency, duration and magnitude are accounted for indirectly in the statistical measures. Focusing on the spikes themselves would involve working with unwieldy and irreducible sets of data that do not indicate compliance with standards and are not conducive to the planning-level analyses contained in the WB/WSFP.

B.2.c) Please explain the analysis conducted that identified the sources of the "DO deficit" projected to remain in Gowanus Canal after the WB/WSFP is implemented. DEP has indicated that both the water from Buttermilk Channel and Gowanus Bay meet the dissolved oxygen (DO) standard (never less than 4.0 mg/L) 97% of the time.

In general, NY Harbor water quality meets current NYS DO standards. However, a DO deficit from saturation conditions occurs in NY Harbor water due to a number of natural and human-related conditions. Saturation is defined as the maximum amount of DO that a waterbody can *sustain at a given time and temperature. DO deficit is the difference between saturation and the measured DO level in the water body. Therefore, DO deficit can occur whether or not DO standards are met. This deficit in Harbor water quality, limits DO improvement in Gowanus Canal during critical conditions.*

For example, at the time of critically low DO in the Canal, the highest oxygen deficit (nearly 4½ mg/L) occurs near the Hamilton Avenue Bridge, where CSOs account for 12% (½ mg/L) of the oxygen depletion; water brought in via the Flushing Tunnel accounts for about 44% (2 mg/L) of oxygen depletion; and water coming in from Upper NY Bay via Gowanus Bay accounts for about 44% (2 mg/L) of oxygen depletion. Saturation in Gowanus Canal is less than 8 mg/L of oxygen during the warm critical summer months. Therefore, the total DO deficit results in Gowanus Canal DO less than 4 mg/L (the Class I standard). This is a conservative modeled projection that predicts non-compliance with Class I DO standards (4 mg/L) approximately 5% of the time. DEC will evaluate this projection through post-construction monitoring and if validated, will propose upgrading the Classification to Class I to support secondary contact. Any future improvement of Gowanus Canal water quality is dependent on continued improvement of NY Harbor waters.

B.3. QUESTIONS ON FUTURE DEVELOPMENT / POST-CONSTRUCTION MONITORING / CLIMATE CHANGE

B.3.a) Several comments suggested that the evaluation did not account for the likely range of dry weather sewage flows expected in the future, and that growth in the City would lead to increased CSO.

Future development in the watershed and its effect on stormwater and CSO discharges were included in the analyses. All projection scenarios utilized dry-weather sanitary sewage flow conditions that were extrapolated to the year 2045 based on Department of City Planning population projections for each of the 188 neighborhoods in New York City. Please refer to the answer for Question B.3.c.

B.3.b) Multiple comments were received questioning the use of the 1988 precipitation year in light of highly publicized anticipation of climate change. The evaluation should account for the likely range of water levels in open waters and during storm surge events.

In accordance with EPA CSO policy, DEP analyses are based upon long-term average conditions rather than extreme event conditions. DEP analyzed over 50 years of rainfall in the metropolitan area to identify a rainfall record that represents long-term average hydraulic conditions, thus satisfying the EPA requirement. Tide conditions were selected to be consistent with the selected rainfall condition. It should be noted that higher water levels, would occur as a result of storm surges or climate-related sea-level rise, would tend to keep outfall tide gates closed and so would reduce CSOs. Please refer to the answers for Questions A.3.a. and c.

B.3.c) Have you or will you consider the long-term effects of major increases in CSO discharge due to new development in the watershed? How can the water quality possibly

improve if the population grows and grows and the infrastructure and water management remain stagnant? (Specific concern was expressed regarding the proposed Brooklyn Atlantic Yards and Toll Brothers developments.)

Future development in the watershed and its effect on stormwater and CSO discharges were included in all model-projection scenarios, including the baseline conditions. Year 2045 populations were projected using estimates of 2030 population developed by the NYC Department of City Planning for each of the 188 neighborhood areas in New York City. In consultation with City Planning, DEP further projected neighborhood populations to year 2045 to provide a more suitable and conservative projection point for long-term infrastructure planning. The projected population was used to determine the portion of the collection system capacity taken by sanitary flow and therefore unavailable to handle stormwater. An additional conservative assumption was made that per capita water consumption in 2045 would be the same as it was in 2000, which ignores the substantial and ongoing reductions in water usage resulting from various DEP programs such as metering and low-flow toilets. City Planning developed their projections using practices consistent with U.S. Census Bureau methodology. Thus, the assessment of various engineering alternatives examined under the Gowanus Canal Waterbody/ Watershed Facility Plan includes the expected impact of future growth and development.

Regulations are in place requiring developers to take appropriate stormwater-management measures to prevent adverse impacts to receiving waters. New York City Environmental Quality Review (CEQR) requires the mitigation of stormwater-induced adverse impacts, including degraded water quality, increased flooding risk, and construction-related sediment and erosion. The Brooklyn Atlantic Yards proposal includes a number of innovative BMPs to control stormwater, such as rooftop collection systems for rainwater, smaller treatment swales along roadways and walkways, large above-ground detention systems landscaped as water features, and underground detention and storage basins. Under the existing plan, much of the collected stormwater will be treated on site and reused for landscaping, as flushing water for toilets, and as feed water for air cooling systems. Excess stormwater would be collected in detention basins and released to the sewer system at a regulated rate to minimize impacts on the available capacity of the collection system and treatment facilities. Although a developer cannot be forced to use a specific BMP technology for stormwater management, the innovative stormwater management techniques developed for the Atlantic Yards project are the direct result of the need to undergo CEQR.

B.4. MISCELLANEOUS QUESTIONS

B.4.a) Several comments addressed the methodology of alternative evaluations. One comment suggested that the evaluation should consider existing CSO discharge volumes in addition to the hypothetical "Baseline."

The hypothetical "Baseline" is established to compare alternatives to one another using conservative assumptions about future conditions. The Baseline condition represents a future typical year without implementing any further controls but with the added pressure of increased population. Each alternative in comparison results in a CSO reduction that can be attributed entirely to that alternative, and its implementation cost can be understood in terms of reduction value to CSO abatement. In contrast, existing CSO discharges can be misleading. In a year characterized by *particularly intense storms, CSO might appear to be unusually large, and in a wet year in terms of total volume, CSO might actually be reduced, thus underestimating the gap between existing infrastructure and what would be necessary to achieve water quality goals.*

B.4.b) Comments questioned why additional sizing alternatives were not considered for several remediation technologies, as follows: Why was only one pumping capacity considered for the Flushing Tunnel? Why was dredging selected for only a 750-ft section rather than a 1,700-ft section of the Canal when the extra cost of the broader alternative is relatively small considering the potential environmental benefits? Why was instream aeration eliminated prior to availability of data from other installations? Why doesn't the plan address the ability to expand CSO controls, which could be necessary in the future, as required by CSO Policy?

The WB/WSFP answers each of these points. Section 5.9.2 (pages 5-24 to 5-25) describes how multiple Flushing Tunnel pumping systems were considered, and that the selected configuration maximizes the flow rate, which is limited by physical constrictions within the Flushing Tunnel, and provides redundancy allowing two pumps to operate while a third is replaced. Dredging was selected for 750-ft at the head end because additional dredging was not expected to improve attainment of water quality standards despite much higher associated costs. As explained on page 7-48, a major additional cost of dredging is bulkhead replacement, which adds roughly $8,784 per linear foot of bulkhead. With 3,500 ft of bulkhead to be replaced, the 1,700-ft dredging alternative would cost a total of $40.2 million, an additional $20.3 million beyond the selected alternative. Instream aeration was not included in the Plan because it was not necessary to attain water-quality standards. Additionally, as described in Section 7.3.7, instream aeration is included as a potential future expansion of the Plan should the post-construction compliance monitoring program show that additional controls are necessary to meet water quality standards. Other examples of additional controls that were also identified as potential means to expand the Plan are end-of-pipe storage facilities at individual outfalls (discussed in Section 7.3.8), additional floatables controls at CSO OH-007 (page 7-43), and, as more information becomes available on their applicability and effectiveness, new techniques such as oxygenation and, of course, source controls.

B.4.c) Floatables screening at the Gowanus Pump Station is proposed to have the capacity to capture floatables when there is a flow rate up to twice the maximum hourly flow (i.e., 2x100 = 200MGD). This is said to account for the fact that, for portions of an hour during peak flows, the maximum flow rate will be greater than the maximum hourly rate. Why was twice the maximum flow rate selected as the standard for capacity? How frequently will the flow rate exceed the capacity, such that excess CSO flow will be discharged without floatable control?

A maximum hourly CSO discharge rate of 100 MGD was identified for the reconstructed Gowanus Pump Station based on modeling of the new system under typical annual conditions. Doubling the capacity provides a margin of safety for the screening equipment and accounts for instantaneous surges that very briefly exceed the maximum hourly average. The capture of floatables is expected to be very high even for events that exceed the design capacity of the screening equipment because floatables capture during the critical "first flush" will still occur. The actual frequency of such an occurrence will be determined during post-construction monitoring.

B.4.d) The performance of the proposed Plan using the 2045 Baseline as documented in the report was questioned, as was the magnitude of CSO reduction and whether the Plan satisfies EPA's demonstration approach requirement to achieve the "maximum pollution reduction benefits reasonably attainable." One comment recommended not including any costs for work that would or should have been done anyway. Another comment claimed that the conclusion that more CSO reduction would not improve water quality was unsubstantiated.

Section 7 of the proposed Plan does indicate the range of water-quality benefits (dissolved oxygen concentrations) attainable through CSO control, and assesses the cost-effectiveness of the required controls. The alternative evaluation process identifies a reasonable course of action that is expected to result in attainment of current water quality standards and shows that meeting higher thresholds of dissolved oxygen is not reasonably attainable due to the marginal cost benefits of additional controls. This evaluation is consistent with the CSO Control Policy, which allows cost/benefit analysis to be used in the selection of alternatives.

The City has been studying the CSO problems in Gowanus Canal for decades. Water quality improvement has been an evolving process and CSO control is described as such in the CSO Control Policy. Regular maintenance is not included in the costs associated with improvements, but projected benefits of ongoing activities such as the upgrades of the Gowanus Pump Station and the modernization of the Flushing Tunnel are correctly included because they are the direct result of plans to mitigate CSO impacts to the Gowanus Canal. In addition, these controls and the costs associated with them reflect improvements to existing facilities (improved pumping capacity, for example) and are not just replacements of aging equipment.

B.4.e) One comment noted that Gowanus Canal was designated as a sensitive area and stated that the report does not provide analysis of whether the proposed plan satisfies the requirements of the CSO Control Policy pertaining to this designation.

The sensitive area designation is intended to provide a prioritization for controlling overflows. For such an area, the LTCP should either (a) prohibit new or significantly increased overflows or (b) eliminate or relocate overflows that discharge to sensitive areas if physically possible and economically achievable, unless elimination or relocation creates more environmental impact than continued discharge, with additional treatment as necessary to meet water quality standards.

Gowanus Canal was listed in the written response from DEC's Marine Resources staff from whom the sensitive areas determination was solicited in the spring of 2005. Their response listed the following: Jamaica Bay; Bird Conservation Areas; Hudson River Park; 'important tributaries' such as the Bronx River in the Bronx, and Mill, Richmond, Old Place, and Main Creeks in Staten Island; the Raritan Bay shellfish harvest area; and waterbodies targeted for regional watershed management plans (Newtown Creek and Gowanus Canal). However, within the constraints of the Consent Order, DEP was required to evaluate Gowanus Canal as a waterbody on its own. As such, relocation and removal of outfalls was evaluated. The 100% removal of CSO was deemed infeasible given the cost constraints. However, the relocation of CSO from the Bond Lorraine Sewer is one of the central components of the Plan. By routing the Gowanus Pump Station force main directly to the Columbia Street Interceptor, CSO discharges from the Bond-Lorraine Sewer (outfalls RH-035 and RH-031) will be reduced.