APPENDIX C

INFRASTRUCTURE AND WATER QUALITY ANALYSIS

TECHNICAL MEMORANDUM
IMPACT OF 363-365 BOND STREET DEVELOPMENT
ON WET-WEATHER DISCHARGES AND WATER QUALITY
IN GOWANUS CANAL

This technical memorandum serves to summarize the results of analyses performed by HydroQual, Inc. to assess the impact of the proposed 363-365 Bond Street development project ("project") on annual discharges of combined-sewer overflows (CSOs) and stormwater, and the resulting impact on expected water quality and uses of Gowanus Canal. Using a typical hourly precipitation record (1988 at JFK Airport), hourly wet-weather discharges were developed using the latest available InfoWorks CS models of the Red Hook and Owls Head WPCP service areas. The Red Hook model was further modified to provide higher resolution in the project area. The latest available Gowanus Canal and Bay water-quality model was then used to assess the impact of the wet-weather discharges on the concentrations of dissolved oxygen, enteroccoccus, fecal coliform, and total coliform bacteria. Each of the following cases was simulated:

1. **2007 Existing Condition** – infrastructure and operation of the sewer system in its current state. The project site is specifically modeled in its existing condition, as shown on Figure 4 and in Table 7, and described on page 8.
2. **2011 No Build** – similar to the above, except that sanitary flow rates are adjusted upward to account for DEP-projected population increases as well as incremental increases in sanitary flow rates associated with the Atlantic Yards project in 2011.
3. **2011 Build, 56,200 gpd** – similar to item 2) above, except that site conditions are updated to reflect completion of the project, with a 56,200 gpd sanitary sewage flow contribution, and approximately 1.1 acre of rooftop area draining directly to the Canal as stormwater, rather than draining to the Bond-Lorraine Sewer as in the existing condition. The 56,200 gpd is the project-specific estimate of the sanitary flow contribution of the project developed by the applicant.
4. **2011 Build, 114,000 gpd** – similar to item 3) above, except that the project sanitary sewage flow reflects CEQR-specified, per-capita water-use rates amounting to 114,000 gpd for the project.
5. **2013 No Build** – similar to item 2) above, except the estimated sanitary sewage flow rate reflects population increases to 2013 and includes anticipated impacts of other projects expected to be completed by 2013 and affecting sewage flow rates. This and subsequent runs account for DEP's Gowanus Facilities Upgrade project as well as the Atlantic Yards and Downtown Brooklyn development projects.
6. **2013 Build, 56,200 gpd** –similar to item 5) above, except that site conditions are updated to reflect completion of the project with 56,200 gpd sanitary sewage flow and approximately 1.1 acre of rooftop area draining directly to the Canal as stormwater instead of to the combined sewer system.
7. **2013 Build, 114,000 gpd** – similar to item 6) above, except that the project sanitary sewage flow reflects CEQR-specified, per-capita water-use rates amounting to 114,000 gpd for the project.

Discussion of Results of Landside (Sewer System) Modeling

Gowanus Canal receives wet-weather discharges from 11 CSOs, of which seven drain from the Red Hook Water Pollution Control Plan (WPCP) service area and four drain from the Owls Head WPCP service area. Given the existing (2007) infrastructure and operations and an annual rainfall pattern causing average CSO discharges across New York City (the 1988 JFK rainfall record, which the City has adopted for CSO planning simulations in the CSO Long Term Control Planning project and other studies), these CSOs are projected to discharge during 68 wet-weather CSO "events" a total of 353 million gallons (MG) to the Canal—247 MG/yr from the Red Hook CSOs and 106 MG/yr from the Owls Head CSOs. Stormwater discharges via direct drainage and from separately sewered areas contribute an additional 76 MG/yr.

While the project would increase sanitary inflows to the sewer, it would also eliminate roof connections to the sewer, which would alleviate the burden on the sewer's capacity during wet weather. Though the increased sanitary flows would be relatively constant, the reduced stormwater inflows would occur only during wet weather and would vary depending upon the amount of runoff. Since more runoff is generated during larger storms, the greatest benefit would occur during the largest storms, with lesser benefits occurring during smaller storms. Whether the project represents a net burden or a net benefit to sewer capacity and CSOs depends both on the amount of additional sanitary flow and the size of the storms that are experienced.

Table 1 provides the model-calculated discharge volumes and frequencies for each CSO in the Red Hook WPCP service area, for each modeled scenario. CSO outfalls are grouped by receiving waterbody, for which total discharge information is summarized. The relevant incremental differences between scenarios are provided in Table 2. Note that contributions from Owls Head CSOs (which are not impacted by the project) are summarized in Table 3, while stormwater discharges to Gowanus Canal are summarized both with and without the project in Table 4.

The 2011 No Build condition provides an appropriate basis of comparison to assess the impact of the project on wet-weather discharges. As shown in Tables 1 and 2, the 2011 Build (56Kgpd) scenario shows a slight (less than 0.1 MG/yr) reduction in CSOs to Gowanus Canal compared to the 2011 No Build condition. Virtually all of this difference is realized at two CSO outfalls: RH-035 (a relief point from the Bond St. sewer located just downstream of the project area) and RH-031 (the next-downstream relief point along the Bond St. sewer). The number of overflows at RH-031 is projected to decrease from 25 per year to 24 per year with the project. This slight reduction in the CSO volume and frequency demonstrates that, on balance, removing runoff inflows to the sewer system more than offsets the increase in sanitary inflows, given the 1988 JFK rainfall record (which, as described above, results in average annual CSO discharges City-Wide) and the 56,200 gpd estimate of the sanitary flow contribution developed by the applicant.

The 2011 Build (114Kgpd) scenario, which uses the CEQR-specified per-capita sanitary sewage rates, shows an overall increase in the CSO volume discharged to the Canal. In this scenario, the additional “dry weather” sanitary sewage contribution offsets the CSO reduction associated with redirecting the roof runoff away from the combined sewer.

Though the number of CSO events does not increase relative to the 2011 No Build condition (73 events), the CSO volume discharged to the Canal does increase by 0.8 MG/yr (0.2 percent of the total CSO discharge to the Canal). Virtually all of the increase occurs at outfall RH-035, with the remainder at outfall RH-031. Overall, CSO discharges to other waterbodies are the same as in the 2011 No Build condition.

Additional scenarios were developed to determine the impact of the project once the New York City Department of Environmental Protection’s Gowanus Facilities Upgrade (GFU) project is completed. The GFU project incorporates several improvements that will include expanding the capacity of the Gowanus Pump Station and constructing a new force main to send pumped flow directly to the Columbia Street Interceptor instead of through the Bond-Lorraine Sewer. According to the Gowanus Canal Waterbody-Watershed Facility Plan Report (September 2008), construction of the GFU is scheduled to be complete by the end of 2013. The GFU project has the net effect of reducing Red Hook service area CSOs by 53 MG/yr overall. Table 1 presents the CSO discharges from all outfalls for each modeled scenario, and Table 2 presents the incremental changes between selected scenarios.

Water-Quality Modeling Results

Water-quality impacts of wet-weather discharges to Gowanus Canal are related to low dissolved oxygen and high pathogen concentrations. Therefore, water-quality modeling herein focuses on dissolved oxygen as well as three indicator pathogens: fecal coliform, total coliform, and enterococcus bacteria. As a Class SD waterbody, Gowanus Canal is currently subject to a dissolved-oxygen criterion of never-less-than 3.0 mg/L, and no pathogen criteria. Water-quality improvements to be implemented by DEP are expected to attain the applicable NYSDEC Class SD standard 100 percent of the time over the entire length of the Canal.

Dissolved Oxygen

In the 2007 Existing condition, minimum dissolved oxygen concentrations are calculated to be about 3.2 mg/L in the Canal (near Hamilton Avenue). Under the same conditions, the increased pollutant loadings determined under the 2011 No Build condition did not impact the calculated dissolved oxygen concentrations. Calculated minimum dissolved oxygen concentrations also remained unchanged with the 2011 Build (56Kgpd) and 2011 Build (114Kgpd) scenarios (see Table 5). As demonstrated in Figure 1, the 0.8 MG/yr incremental increase in CSO discharged volume associated with the 2011 Build (114Kgpd) condition, which represented an increase of about 0.2 percent from the 2011 No Build condition, is not expected to impact dissolved oxygen concentrations in Gowanus Canal.

Pathogens

Model-calculated pathogen concentrations were assessed for each scenario. Between the 2011 No Build and 2011 Build (114Kgpd) conditions, pathogen concentrations differed most in the vicinity of outfall RH-035, the location where CSO volumes differed most. However, even at this location, the difference in pathogen concentrations is minor. Figure 2 presents probability distributions of the pathogen concentrations for both the 2011 No Build and the 2011 Build (114Kgpd) scenarios. As shown, the distributions show virtually no difference between the scenarios. Similarly, there is no difference in the projected attainment of pathogen criteria that are potentially applicable in the future (Figure 3). Secondary-contact criteria for fecal coliform and total coliform are expected to be attained for all months. With respect to enterococcus, the project does not impact the expected attainment of the water quality criterion (a seasonal geometric mean of less than 35 cells/100 mL.

Summary

It is anticipated that the effects of the proposed 363-365 Bond Street development project on CSO discharges and water quality would be difficult to detect since the calculated impacts are small, particularly compared to the ranges of discharged flows and concentrations that are currently experienced in the Canal (see Tables 1, 5 and 6 and Figures 1, 2 and 3). The project is expected to marginally reduce CSO discharges and pollutant loads to the Canal during larger storm events, but to marginally increase discharges and loads during smaller events. The overall impact would depend on the size and intensity of the individual storm events that occur. Given an annual rainfall pattern associated with average CSO hydraulics, the analyses conducted herein indicate that CSO volumes would increase by only about 0.2 percent from the existing level during the interim period prior to the completion of the Gowanus Facilities Upgrade project. However, accounting for water-conservation measures that would be implemented as part of the project, the project would be expected to slightly reduce CSO discharges to the Canal. Regardless of the method used to estimate the project dry-weather sanitary sewage contributions, the modeling analysis indicates that the 363-365 Bond Street development project will slightly reduce CSO volumes to the Canal upon completion of the Gowanus Facilities Upgrade project relative to the No Build condition.

ADDITIONAL MODELING BACKUP

The remainder of this document provides additional discussion of the modeling frameworks used, the methods employed, and the model inputs that were used in the analyses summarized above. Separate discussions are provided below for sewer-system modeling and water-quality modeling.

Sewer-System Modeling Methodology and Modeling Inputs

This section presents the methodology and inputs used for the sewer-system modeling conducted herein. The modeling framework, model versions used, and modifications made to enable assessment of project impacts are discussed. Inputs presented include future dry-weather (sanitary) sewage flow rates in the Red Hook sewer system, estimates of the project dry-weather (sanitary) sewage flow contributions, without-project and with-project wet-weather inputs to the combined sewer system, and project-area characteristics (such as roof area, paved area, and non-paved areas) are shown for the without-project and with-project conditions.

Modeling Framework

InfoWorks CS ("InfoWorks") is a commercially available modeling package developed by Wallingford Software. DEP has adopted InfoWorks for all of its current facility-planning projects, notably the ongoing CSO Long-Term Control Plan project.

The InfoWorks modeling framework includes components for both hydrology (rainfall-runoff) and hydraulics (pipe flow). For hydrology, InfoWorks uses specified rainfall information together with land-surface characteristics such as imperviousness and slope, as well as evaporation and infiltration to generate runoff from land surfaces on the project site and in the entire sewer system drainage area. The model uses appropriate equations for representing the hydrologic processes to generate the runoff volumes that reach the sewer system.

For hydraulics, InfoWorks uses Saint Venant's equations of continuity and momentum to route the flows within a sewer system and to account for virtually all sewer elements, including weirs, orfices, pumping stations, force mains, regulators, tide gates, outfalls, branch interceptors and interceptors. In dry weather, the diurnally varying sanitary flows are simulated throughout the sewer system. In wet weather, InfoWorks combines these sanitary flows with the runoff calculated in the hydrology component of the model, and routes the total flow through the combined sewer system. When the capacity of individual regulators to divert flow into the interceptor system is exceeded, the combined sanitary and runoff in excess of this capacity is discharged through a CSO outfall. The frequency and volume of CSOs in the Red Hook WPCP service area are dependent on both regulator /branch interceptor capacities and on the hydraulic gradient line (HGL) in the interceptors.

InfoWorks allows for long-term simulations with a high-resolution time step. In this investigation, full-year (12-month) simulations were performed with 5-minute raw output condensed into hourly flows and discharges. Post processing of the InfoWorks output was performed to provide annual total discharge volumes and frequencies by outfall. In addition, since InfoWorks output can keep track of the sanitary sewage versus rainfall runoff fractions in discharges, the output is well suited for developing pollutant loadings.
Application of InfoWorks to the Red Hook WPCP Drainage Area and Project Area

As noted above, DEP has selected InfoWorks for all facility-planning analyses being performed as part of the CSO Long Term Control Plan (LTCP) project. As part of that process, InfoWorks models were constructed and calibrated for each of the City's WPCP sewer systems. As ongoing changes to the City's sewer systems are made and new monitoring data becomes available, these models are continuously being updated and upgraded. Complete descriptions of the latest available calibrations are described in the Landside Modeling Reports created for each WPCP drainage area model as part of the LTCP project. Because both the Red Hook and Owls Head sewer systems impact Gowanus Canal, analyses of Gowanus Canal require InfoWorks model simulations using the InfoWorks models for both of these sewer system drainage areas. This analysis employed the latest available version of both models (March 2008, as calibrated to calendar year 2007 flows at the Red Hook and Owls Head WPCPs.) The 2007 Existing condition simulations were based upon these models.

To project to future dry-weather sanitary flow rates for the 2011 build year, expected increases in flow rates from current (calendar year 2007) rates were determined based on planning-level population and water-use projections made by the New York City Department of City Planning.[1] Based on these values, the 2011 average dry-weather (sanitary) sewage flow rate used in this analysis is 30.1 MGD, 0.2 MGD greater than the observed calendar year 2007 flow rate of 29.9 MGD.

Incorporation of Project Site into the InfoWorks Model

The 363-365 Bond Street development project proposed herein lies within and impacts only the Red Hook WPCP sewer system service area. To analyze the impacts of the proposed project on the sewer system and on Gowanus Canal, the resolution of the Red Hook sewer system model was modified to include the project site explicitly. Previously, the site area was modeled as part of an 87.7-acre subcatchment. This subcatchment was discretized into a higher-resolution representation of two subcatchments, with the project area modeled as its own subcatchment. The project site area is 4.70 acres, including 3.36 acres of property and another 1.34 acres of streets and sidewalks in the immediate area.

[1] "Population Projections for NYC Neighborhoods: 2010 and 2030," prepared by the NYC Department of City Planning for the Mayor's Strategic Planning Initiative, presented 11/16/2005 and distributed by Angela Sung, Office of the Deputy Mayor for Economic Development and Rebuilding, on November 18, 2005.

As shown in Table 7, the existing project site features 1.64 acres of roof area, of which 1.09 acres currently drains to the Bond Street combined sewer (see Figure 4), and 0.55 acres drains to the land surface and on to Gowanus Canal. In addition, the project site has another 1.53 acres of impervious surfaces, of which 0.79 acres are streets and 0.55 acres are sidewalks, and the remaining 0.19 acres are other paved areas such as driveways and parking lots. The remaining 1.53 acres are non-paved areas such as gravel, dirt parking surfaces, and grassy areas. With the exception of the roof area that drains to the combined sewer, all runoff generated on the site is discharged to Gowanus Canal.

Table 7 also presents the breakdown of the project site area under the build condition (see Figure 5). The total project site remains 4.70 acres, but all roof drainage to the combined sewer will be eliminated. With the project, there will be a total of 1.93 acres of roof, 0.78 acres of streets, 0.47 acres of sidewalks, and 0.40 acres of other paved areas such as driveways, parking areas, and walking paths. The remaining 1.12 acres are non-paved, landscaped areas. According to the developer, landscaping techniques that will be employed on the site will reduce the quantity of runoff generated from land surfaces, and much of the runoff generated on the site will be treated prior to discharge to Gowanus Canal. However, modeling conducted herein conservatively ignores any benefits from such landscaping and stormwater treatment.

<u>Project Site Dry-Weather (Sanitary) Sewage Contribution</u>

The existing dry-weather sanitary sewage flow contribution from the project site is negligible, as there are no residential sewer hookups, and existing business activity is very small. A value of 0 MGD was conservatively assigned as the existing sanitary flow contribution of the site.

Under the build condition, the sanitary sewage flow contribution from the site is projected to be approximately 56,200 gpd (equivalent to 0.056 MGD or 0.087 cfs). However, using the general per-capita water usage specified for CEQR applications, the calculated sanitary sewage contribution is 114,032 gpd (equivalent to 0.114 MGD or 0.18 cfs). Because the sanitary flow contribution affects the incremental impact of the site on CSO discharges from the Bond Street sewer, calculations using both estimates of sanitary sewage flow are presented herein.

<u>Water-Quality Modeling Methodology and Modeling Inputs</u>

This section presents the methodology and inputs used for the water-quality modeling conducted herein. The modeling framework, model versions used, and modifications made to enable assessment of project impacts are explained. The same methodology and inputs used for analyses performed under the Gowanus Canal Waterbody/Watershed Facility Plan work were employed herein, unless other noted.

Water-Quality Modeling Framework

Changes in pollutant loadings can impact the water quality in the receiving waters in proximity to the discharge point and/or at locations that are removed from the discharge points. The interaction of the many physical, chemical, and biological factors can be complex, and water-quality impacts can be assessed most accurately using water-quality modeling methods. As part of DEP projects such as the CSO Long-Term Control Plan, HydroQual has developed a number of water-quality models that focus on various geographical regions. The ECOM/RCA hydronamic/water-quality modeling framework has been applied to Gowanus Canal and other waterbodies impacted by the Red Hook WPCP sewer system. These models have been reviewed and approved by the New York City DEP as well as the New York State DEC, and have most recently been applied as part of the ongoing CSO LTCP project. Specifically, both the Gowanus Canal and Bay model and the System-Wide Eutrophication Model (SWEM) have been applied as described in the September 2007 Gowanus Canal Waterbody/Watershed Facility Plan report and the associated Water Quality Modeling Reports, which provide a detailed account of the development and calibration of these water-quality models. Except as noted herein, the inputs used in these models are identical to those used in the September 2007 reports.

The Gowanus Canal hydrodynamic/water-quality model features a high-resolution grid system encompassing the Canal, Gowanus Bay, and the associated turning basins, as well as the Flushing Tunnel. The Canal itself is represented with some 200 discrete model segments, each with 10 vertical layers (see Figure 6). The model's hydrodynamic capabilities enable it to determine the circulation of water throughout the waterbody by incorporating the effects of tidal interactions as well as the action of the Flushing Tunnel (currently averaging about 154 MGD into the head of the Canal) and wet-weather inputs of fresh water from CSOs and stormwater, and its water-quality capabilities allow it to determine the additional effects chemical and biological processes on concentrations of dissolved oxygen, phytoplankton, nutrients, pathogens, and a host of other pollutants. Conditions at the model's boundaries (at the entrance to Gowanus Bay from Upper New York Bay, as well as from the Flushing Tunnel connection from Buttermilk Channel) can be assigned based on measurements (of tidal elevations, water temperatures, salinity, and constituent concentrations) or based on calculations of same made using SWEM, which is similar to the Gowanus model in many respects, but covers a larger geographic area and has a lower-resolution internal segmentation.

Assigned Flushing Tunnel Flow Rate

The Flushing Tunnel currently moves an average of approximately 154 MGD from Buttermilk Channel to the head of Gowanus Canal. The 2007 Existing and 2011 projection conditions include this flushing rate in the model simulations.

Meteorological and Boundary Conditions

The City has reviewed over 50 years of precipitation data and has identified a 12-month record that produces average hydraulic response with regard to CSOs. This precipitation record, the 1988 rainfall at JFK Airport, was used for all model simulations. The corresponding set of tide information and riverine flows (that is, for calendar year 1988) were used in the System Wide Eutrophication Model (SWEM) of New York Harbor. SWEM was calibrated and used to develop boundary conditions in Buttermilk Channel and at the entrance to Gowanus Bay from Upper New York Bay. The SWEM-calculated hourly tide elevations, salinity, temperature, and constituent concentrations were in turn used as boundary conditions for the Gowanus Canal and Bay water quality model. As described in the Gowanus Canal WB/WSFP, these boundary conditions are sufficiently removed from the Canal that they are not significantly impacted by conditions in the Canal. Additional details are available in the Gowanus Canal Water Quality Modeling Report.[2]

Assigned Pollutant Concentrations

To determine the impact of CSO and stormwater loadings on water quality in Gowanus Canal and Gowanus Bay, pollutant concentrations were assigned to the volumetric flows being calculated by the InfoWorks sewer system model as described above. Because the InfoWorks model calculates the fraction of sanitary and stormwater in combined sewage discharges, pollutant loadings can be estimated by applying characteristic concentrations to the sanitary and stormwater portions of the discharges. Stormwater discharges are assigned the stormwater concentration. Table 8 presents a summary of the pollutant concentrations used for this study, which are identical to those used in the Gowanus Canal Waterbody/Watershed Facility Plan.[3]

[2] "Water Quality Modeling Report, Volume 4: Gowanus Canal," City-Wide Long Term CSO Control Planning Project, City of New York Department of Environmental Protection, Bureau of Engineering Design and Construction, September 2007.

[3] "Gowanus Canal Waterbody/Watershed Facility Plan Report," City-Wide Long Term CSO Control Planning Project, City of New York Department of Environmental Protection, Bureau of Engineering Design and Construction, September 2007.

TABLES

Table 1 Results of Landside (Sewer-System) Modeling

Water Body	Outfall	Discharge Volume (MG/year)							CSO Events (Number/year)						
	Scenario:	1	2	3	4	5	6	7	1	2	3	4	5	6	7
						With Gowanus Facilities Upgrade							*With Gowanus Facilities Upgrade*		
		2007 Existing	2011 NoBuild	2011 Build *(56Kgpd)*	2011 Build *(114Kgpd)*	2013 NoBuild	2013 Build *(56Kgpd)*	2013 Build *(114Kgpd)*	2007 Existing	2011 NoBuild	2011 Build *(56Kgpd)*	2011 Build *(114Kgpd)*	2013 NoBuild	2013 Build *(56Kgpd)*	2013 Build *(114Kgpd)*
Gowanus Canal	RH-035	115.6	121.2	121.2	121.9	2.7	2.6	2.6	68	73	73	73	9	9	9
	RH-031	23.6	23.7	23.6	23.7	7.8	7.8	7.8	25	25	24	25	11	11	11
	RH-036	1.5	1.5	1.5	1.5	1.5	1.5	1.5	17	17	17	17	18	18	18
	RH-037	0.5	0.5	0.5	0.5	0.5	0.5	0.5	10	10	10	10	10	10	10
	RH-038	1.0	0.9	0.9	0.9	1.0	1.0	1.0	13	13	13	13	14	14	14
	RH-033	0.2	0.2	0.2	0.2	0.2	0.2	0.2	6	6	6	6	6	6	6
	RH-034	104.5	108.7	108.7	108.7	115.7	115.7	115.7	44	47	47	47	33	33	33
	Total CSO	***246.9***	***256.7***	***256.6***	***257.5***	***129.5***	***129.3***	***129.4***	***68***	***73***	***73***	***73***	***33***	***33***	***33***
Gowanus Bay	RH-030	14.9	14.9	14.9	14.9	7.4	7.3	7.4	22	22	22	22	13	13	13
	Total CSO	***14.9***	***14.9***	***14.9***	***14.9***	***7.4***	***7.3***	***7.4***	***22***	***22***	***22***	***22***	***13***	***13***	***13***
Upper NY Bay	RH-029	2.1	2.1	2.1	2.1	2.1	2.1	2.1	21	21	21	21	21	21	21
	Total CSO	***2.1***	***2.1***	***2.1***	***2.1***	***2.1***	***2.1***	***2.1***	***21***	***21***	***21***	***21***	***21***	***21***	***21***
Atlantic Basin	RH-025	3.6	3.6	3.6	3.6	6.2	6.2	6.3	20	21	21	21	24	24	24
	RH-024	1.2	1.2	1.2	1.2	3.2	3.2	3.2	17	17	17	17	21	21	21
	RH-023	1.1	1.2	1.2	1.2	3.4	3.4	3.4	17	18	18	18	23	23	23
	RH-022	1.6	1.6	1.6	1.6	4.6	4.6	4.6	20	20	20	21	28	28	28
	Total CSO	***7.5***	***7.6***	***7.6***	***7.7***	***17.4***	***17.4***	***17.4***	***20***	***21***	***21***	***21***	***28***	***28***	***28***
Buttermilk Channel	RH-028	71.1	71.9	71.9	71.9	65.5	65.4	65.6	35	35	35	35	23	23	23
	RH-019	9.7	9.8	9.8	9.8	18.9	18.9	19.0	23	23	23	23	30	30	30
	RH-020	0.1	0.1	0.1	0.1	0.5	0.5	0.5	6	6	6	6	10	10	10
	RH-018	2.9	2.9	2.9	2.9	7.3	7.3	7.3	15	15	15	15	21	21	21
	RH-016	11.6	11.7	11.7	11.7	27.8	27.8	27.8	16	16	16	16	22	22	22
	RH-014	38.3	38.4	38.4	38.4	41.1	41.1	41.1	50	50	50	50	50	50	50
	RH-013	0.1	0.1	0.1	0.1	0.2	0.2	0.2	6	6	6	6	9	9	9
	Total CSO	***133.7***	***134.9***	***134.8***	***134.9***	***161.3***	***161.2***	***161.5***	***50***	***50***	***50***	***50***	***50***	***50***	***50***
East River	RH-008	1.9	1.9	1.9	1.9	2.5	2.5	2.5	13	13	13	13	17	17	17
	RH-006	7.5	7.5	7.5	7.5	7.7	7.7	7.7	31	31	31	31	31	31	31
	RH-011	2.3	2.3	2.3	2.3	3.5	3.5	3.5	11	11	11	11	16	16	16
	RH-010	0.2	0.2	0.2	0.2	0.3	0.3	0.3	7	7	7	7	7	7	7
	RH-012	6.0	6.1	6.1	6.1	8.8	8.8	8.8	14	14	14	14	18	18	18
	RH-009	1.3	1.3	1.3	1.3	2.2	2.2	2.2	15	15	15	15	20	20	20
	RH-007	1.0	1.0	1.0	1.0	1.5	1.5	1.5	16	16	16	16	21	21	21
	RH-005	117.4	118.1	118.1	118.1	153.3	153.3	153.5	21	21	21	21	29	29	29
	RH-002	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0
	RH-003	0.1	0.1	0.1	0.1	0.2	0.2	0.2	4	4	4	4	5	5	5
	RH-040	32.1	32.3	32.3	32.3	36.6	36.6	36.6	30	30	30	30	31	31	31
	Total CSO	***169.8***	***170.7***	***170.8***	***170.8***	***216.6***	***216.6***	***216.8***	***31***	***31***	***31***	***31***	***31***	***31***	***31***
Red Hook WPCP	*Treated Flow*	12,390.4	12,586.5	12,602.8	12,621.4	13,407.3	13,555.5	13,577.5							
	Total CSO	***574.9***	***587.0***	***586.8***	***587.8***	***534.3***	***534.0***	***534.5***							

Notes: Totals may not appear to sum exactly due to rounding.
"CSO events" reflect a 12-hour minimum interevent time and a minimum hourly flow of 0.004167 MG

CSO_volumes_comparison20080627.xls

Table 2 Incremental Impacts of Project to CSO Discharges

Water Body	Outfall	DIFFERENCES IN DISCHARGED VOLUME (MG/yr)						DIFFERENCES IN CSO EVENTS (Number/yr)					
	Scenarios:	(2-1)	(3-2)	(4-2)	(5-2)	(6-5)	(7-5)	(2-1)	(3-2)	(4-2)	(5-2)	(6-5)	(7-5)
		2007 Existing to 2011 No Build	2011 No Build to 2011 Build *(56Kgpd)*	2011 No Build to 2011 Build *(114Kgpd)*	2011 No Build to 2013 No Build	2013 No Build to 2013 Build *(56Kgpd)*	2013 No Build to 2013 Build *(114Kgpd)*	2007 Existing to 2001 No Build	2011 No Build to 2011 Build *(56Kgpd)*	2011 No Build to 2011 Build *(114Kgpd)*	2011 No Build to 2013 No Build	2013 No Build to 2013 Build *(56Kgpd)*	2013 No Build to 2013 Build *(114Kgpd)*
Gowanus Canal	RH-035	5.6	0.0	0.8	-118.5	-0.1	0.0	5	0	0	-64	0	0
	RH-031	0.1	-0.1	0.0	-15.9	-0.1	0.0	0	-1	0	-14	0	0
	RH-036	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	1	0	0
	RH-037	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0
	RH-038	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	1	0	0
	RH-033	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0
	RH-034	4.2	0.0	0.0	7.1	0.0	0.0	3	0	0	-14	0	0
	Total CSO	***9.8***	***0.0***	***0.8***	***-127.2***	***-0.1***	***-0.1***	***5***	***0***	***0***	***-40***	***0***	***0***
Gowanus Bay	RH-030	0.1	0.0	0.0	-7.6	0.0	0.0	0	0	0	-9	0	0
	Total CSO	***0.1***	***0.0***	***0.0***	***-7.6***	***0.0***	***0.0***	***0***	***0***	***0***	***-9***	***0***	***0***
Upper NY Bay	RH-029	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0
	Total CSO	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0***	***0***	***0***	***0***	***0***	***0***
Atlantic Basin	RH-025	0.0	0.0	0.0	2.6	0.0	0.0	1	0	0	3	0	0
	RH-024	0.0	0.0	0.0	1.9	0.0	0.0	0	0	0	4	0	0
	RH-023	0.0	0.0	0.0	2.2	0.0	0.0	1	0	0	5	0	0
	RH-022	0.0	0.0	0.0	3.0	0.0	0.0	0	0	1	8	0	0
	Total CSO	***0.1***	***0.0***	***0.0***	***9.7***	***0.0***	***0.0***	***1***	***0***	***0***	***7***	***0***	***0***
Buttermilk Channel	RH-028	0.8	0.0	0.0	-6.4	-0.1	0.1	0	0	0	-12	0	0
	RH-019	0.1	0.0	0.0	9.2	0.0	0.0	0	0	0	7	0	0
	RH-020	0.0	0.0	0.0	0.4	0.0	0.0	0	0	0	4	0	0
	RH-018	0.0	0.0	0.0	4.4	0.0	0.0	0	0	0	6	0	0
	RH-016	0.1	0.0	0.0	16.1	0.0	0.0	0	0	0	6	0	0
	RH-014	0.1	0.0	0.0	2.7	0.0	0.0	0	0	0	0	0	0
	RH-013	0.0	0.0	0.0	0.1	0.0	0.0	0	0	0	3	0	0
	Total CSO	***1.1***	***0.0***	***0.0***	***26.5***	***-0.1***	***0.2***	***0***	***0***	***0***	***0***	***0***	***0***
East River	RH-008	0.0	0.0	0.0	0.6	0.0	0.0	0	0	0	4	0	0
	RH-006	0.0	0.0	0.0	0.3	0.0	0.0	0	0	0	0	0	0
	RH-011	0.0	0.0	0.0	1.1	0.0	0.0	0	0	0	5	0	0
	RH-010	0.0	0.0	0.0	0.1	0.0	0.0	0	0	0	0	0	0
	RH-012	0.0	0.0	0.0	2.7	0.0	0.0	0	0	0	4	0	0
	RH-009	0.0	0.0	0.0	0.9	0.0	0.0	0	0	0	5	0	0
	RH-007	0.0	0.0	0.0	0.5	0.0	0.0	0	0	0	5	0	0
	RH-005	0.7	0.0	0.0	35.2	0.0	0.1	0	0	0	8	0	0
	RH-002	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0
	RH-003	0.0	0.0	0.0	0.1	0.0	0.0	0	0	0	1	0	0
	RH-040	0.2	0.0	0.0	4.3	0.0	0.0	0	0	0	1	0	0
	Total CSO	***0.9***	***0.0***	***0.0***	***45.9***	***0.0***	***0.2***	***0***	***0***	***0***	***0***	***0***	***0***
Red Hook WPCP	*Treated Flow*	196.0	16.3	34.9	820.8	148.2	170.2						
	Total CSO	***12.1***	***-0.1***	***0.8***	***-52.7***	***-0.3***	***0.2***						

Notes: Totals may not appear to sum exactly due to rounding.
"CSO events" reflect a 12-hour minimum interevent time and a minimum hourly flow of 0.004167 MG

CSO_volumes_comparison20080627.xls

Table 3
Owls Head WPCP CSO Contributions
to Gowanus Canal

SPDES	Annual CSO Volume (MG)
OH-005	0.7
OH-006	12.6
OH-007	69.4
OH-024	23.4
Total CSO	**106.1**

Table 4
Stormwater Discharges
to Gowanus Canal

Annual Stormwater Discharges (MG)		
Storm Sewer	**Without Project**	**With Project**
Project site	2.7	4.2
RH-601	1.5	1.5
OH-601	10.0	10.0
OH-602	0.1	0.1
OH-607	0.1	0.1
Overland Runoff	62.0	62.0
Total Stormwater	**76.4**	**78.0**

Table 5 Dissolved Oxygen Calculations

	2007 Existing		2011 No Build		2011 Build(56Kgpd)		2011 Build(114Kgpd)		Incremental DO (mg/L)		
Feet From Head	Minimum DO (mg/L)	Average DO (mg/L)	Minimum DO (mg/L)	Average DO (mg/L)	Minimum DO (mg/L)	Average DO (mg/L)	Minimum DO (mg/L)	Average DO (mg/L)	2007 Existing to 2011 No Build	2011 No Build to Build56K	2011 No Build to Build114K
450	4.7	7.9	4.7	7.9	4.7	7.9	4.7	7.9	0.0	0.0	0.0
806	4.6	7.9	4.6	7.9	4.6	7.9	4.6	7.9	0.0	0.0	0.0
1,127	4.5	7.8	4.5	7.8	4.5	7.8	4.5	7.8	0.0	0.0	0.0
1,406	4.4	7.8	4.4	7.8	4.4	7.8	4.4	7.8	0.0	0.0	0.0
1,574	4.3	7.8	4.3	7.8	4.3	7.8	4.3	7.8	0.0	0.0	0.0
1,731	4.3	7.7	4.2	7.7	4.2	7.7	4.2	7.7	0.0	0.0	0.0
1,964	4.2	7.7	4.2	7.7	4.2	7.7	4.2	7.7	0.0	0.0	0.0
2,204	4.1	7.7	4.1	7.7	4.1	7.7	4.1	7.7	0.0	0.0	0.0
2,452	4.1	7.7	4.1	7.7	4.1	7.7	4.1	7.7	0.0	0.0	0.0
2,544	4.0	7.7	4.0	7.7	4.0	7.7	4.0	7.7	0.0	0.0	0.0
2,728	4.0	7.7	4.0	7.7	4.0	7.7	4.0	7.7	0.0	0.0	0.0
2,928	3.9	7.6	3.9	7.6	3.9	7.6	3.9	7.6	0.0	0.0	0.0
3,162	3.9	7.6	3.9	7.6	3.9	7.6	3.9	7.6	0.0	0.0	0.0
3,348	3.8	7.6	3.8	7.6	3.8	7.6	3.8	7.6	0.0	0.0	0.0
3,480	3.6	7.5	3.6	7.5	3.6	7.5	3.6	7.5	0.0	0.0	0.0
3,630	3.6	7.4	3.5	7.4	3.5	7.4	3.5	7.4	0.0	0.0	0.0
3,800	3.5	7.4	3.5	7.4	3.4	7.4	3.4	7.4	0.0	0.0	0.0
3,929	3.4	7.4	3.4	7.4	3.4	7.4	3.4	7.4	0.0	0.0	0.0
4,049	3.4	7.3	3.4	7.3	3.4	7.3	3.4	7.3	0.0	0.0	0.0
4,209	3.4	7.3	3.3	7.3	3.3	7.3	3.3	7.3	0.0	0.0	0.0
4,465	3.3	7.3	3.3	7.3	3.3	7.3	3.3	7.3	0.0	0.0	0.0
4,696	3.2	7.3	3.2	7.3	3.2	7.3	3.2	7.3	0.0	0.0	0.0
4,900	3.2	7.3	3.2	7.3	3.2	7.3	3.2	7.3	0.0	0.0	0.0
5,024	3.1	7.2	3.1	7.2	3.1	7.2	3.1	7.2	0.0	0.0	0.0
5,215	3.1	7.2	3.1	7.2	3.1	7.2	3.1	7.2	0.0	0.0	0.0
5,422	3.2	7.2	3.2	7.2	3.2	7.2	3.2	7.2	0.0	0.0	0.0
5,604	3.2	7.2	3.2	7.2	3.2	7.2	3.2	7.2	0.0	0.0	0.0
5,806	3.4	7.1	3.4	7.1	3.4	7.1	3.4	7.1	0.0	0.0	0.0
6,008	3.4	7.1	3.4	7.1	3.4	7.1	3.4	7.1	0.0	0.0	0.0
6,248	3.4	7.1	3.4	7.1	3.4	7.1	3.4	7.1	0.0	0.0	0.0
6,479	3.4	7.1	3.4	7.1	3.4	7.1	3.4	7.1	0.0	0.0	0.0
6,695	3.5	7.1	3.4	7.1	3.4	7.1	3.4	7.1	0.0	0.0	0.0
6,954	3.5	7.1	3.5	7.1	3.5	7.1	3.5	7.1	0.0	0.0	0.0
7,189	3.5	7.1	3.5	7.1	3.5	7.1	3.5	7.1	0.0	0.0	0.0
7,402	3.5	7.1	3.5	7.1	3.5	7.1	3.5	7.1	0.0	0.0	0.0
7,553	3.6	7.1	3.5	7.1	3.5	7.1	3.5	7.1	0.0	0.0	0.0
7,703	3.6	7.2	3.6	7.2	3.6	7.2	3.6	7.2	0.0	0.0	0.0
7,819	3.6	7.2	3.6	7.2	3.6	7.2	3.6	7.2	0.0	0.0	0.0
7,922	3.6	7.2	3.6	7.2	3.6	7.2	3.6	7.2	0.0	0.0	0.0
8,020	3.6	7.2	3.6	7.2	3.6	7.2	3.6	7.2	0.0	0.0	0.0
8,142	3.6	7.2	3.6	7.2	3.6	7.2	3.6	7.2	0.0	0.0	0.0
8,274	3.6	7.3	3.6	7.3	3.6	7.3	3.6	7.3	0.0	0.0	0.0
8,416	3.7	7.3	3.7	7.3	3.7	7.3	3.7	7.3	0.0	0.0	0.0
8,576	3.7	7.3	3.7	7.3	3.7	7.3	3.7	7.3	0.0	0.0	0.0
8,761	3.8	7.3	3.8	7.3	3.8	7.3	3.8	7.3	0.0	0.0	0.0
8,974	3.8	7.4	3.8	7.4	3.8	7.4	3.8	7.4	0.0	0.0	0.0
9,194	3.9	7.4	3.9	7.4	3.9	7.4	3.9	7.4	0.0	0.0	0.0
9,418	3.9	7.5	3.9	7.5	3.9	7.5	3.9	7.5	0.0	0.0	0.0
9,792	4.0	7.5	4.0	7.5	4.0	7.5	4.0	7.5	0.0	0.0	0.0
10,253	4.0	7.5	4.0	7.5	4.0	7.5	4.0	7.5	0.0	0.0	0.0

Note: Values are rounded to nearest 0.1 mg/L

Table 6
Projected Attainment of Secondary-Contact Criteria
In Gowanus Canal

Pathogen Scenario	**Criteria** Compliance
Enterococcus	**Bathing Season Geometric Mean < 35 cells/100mL**
2007 Existing	100
2011 No Build	100
2011 Build (56Kgpd)	100
2011 Build (114Kgpd)	100
Fecal Coliform	**Monthly Geo.Mean < 2,000 cells/100mL**
2007 Existing	100
2011 No Build	100
2011 Build (56Kgpd)	100
2011 Build (114Kgpd)	100
Total Coliform	**Monthly Geo.Mean <10,000 cells/100mL**
2007 Existing	100
2011 No Build	100
2011 Build (56Kgpd)	100
2011 Build (114Kgpd)	100

Table 7
Project Site Area Characterization

Area Type[1]	Existing Site Area (acres)	Proposed Site Area (acres)
Roof area draining to combined sewer	1.09	0.00
Other roof areas	0.55	1.93
Sidewalks	0.55	0.47
Streets	0.79	0.78
Other paved areas[2]	0.19	0.40
Non-paved areas[3]	1.53	1.12
Total	**4.70**	**4.70**

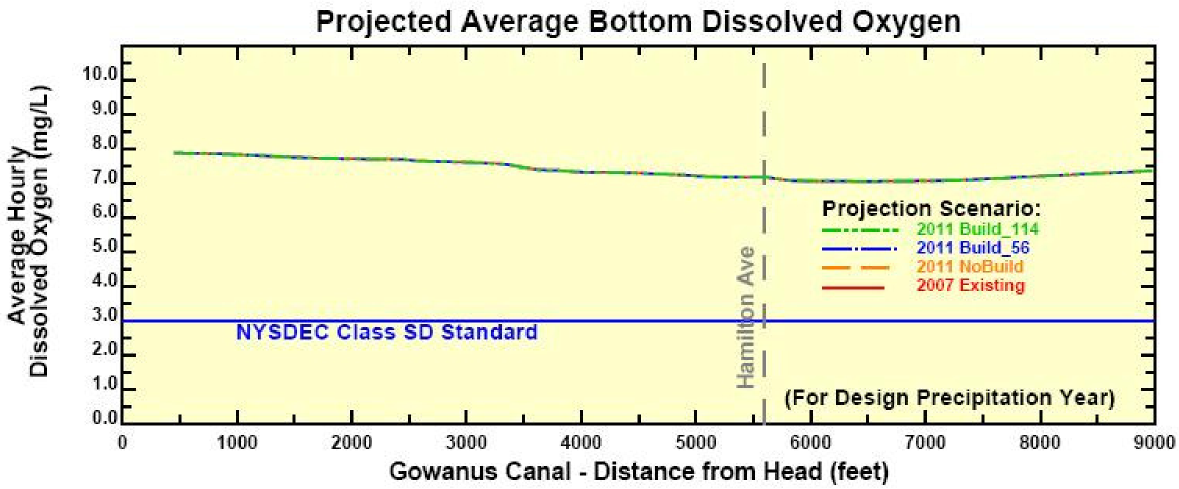
Notes:
[1]except as noted, all areas drain directly to Gowanus Canal via overland flow or storm sewers.
[2] includes driveways, parking areas, and paved walking paths
[3] for existing condition, includes gravel, dirt, and grassy areas; for proposed condition, includes landscaped areas and planters.

Table 8
Pollutant Concentrations
Used for Sanitary and Stormwater Discharges

Constituent	Sanitary Concentration	Stormwater Concentration
Dissolved Oxygen, (mg/L)	1.0	4.0
Biochemical Oxygen Demand, BOD (mg/L)	120	15
Total Coliform Bacteria, (cells/100mL)	150×10^5	2.0×10^5
Fecal Coliform Bacteria, (cells/100mL)	27×10^5	0.3×10^5
Enterococci Bacteria, (cells/100mL)	10×10^5	0.7×10^5

Concentrations taken from Gowanus Canal WB/WSFP, September 2007

FIGURES



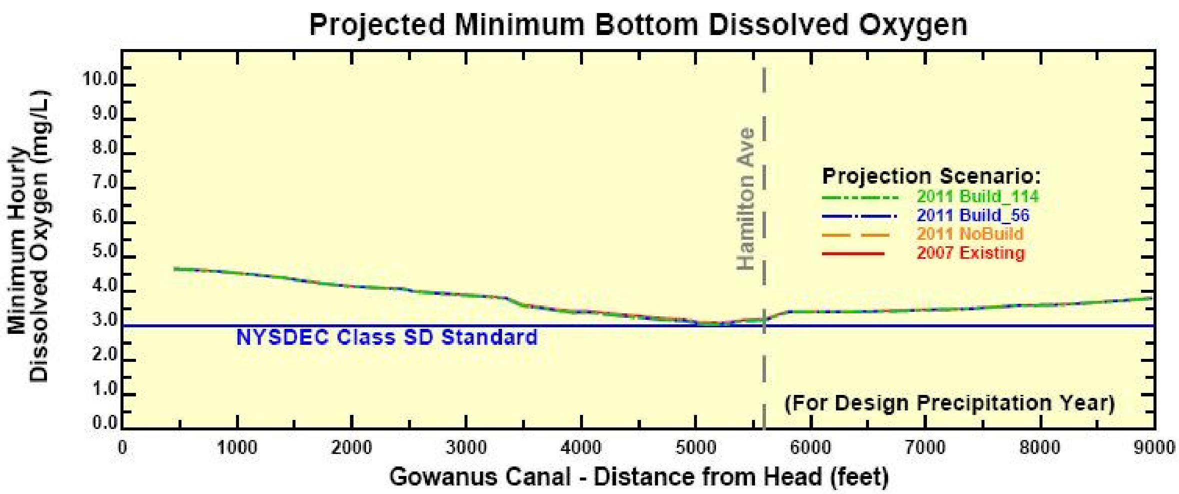


Figure 1
Projected Average and Minimum Dissolved Oxygen Concentrations

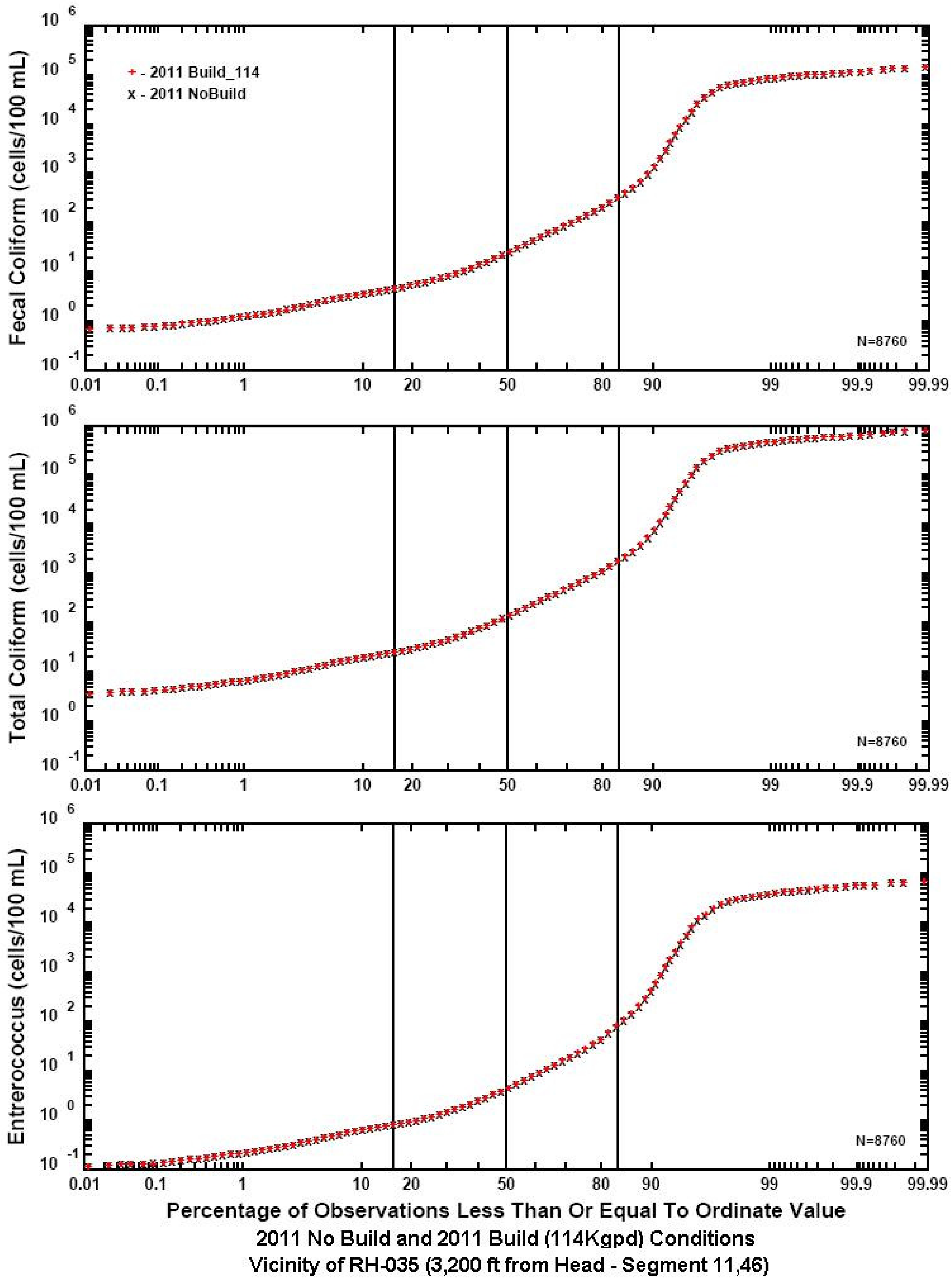


Figure 2
Pathogen Distributions for 2011 No Build and Build Scenarios

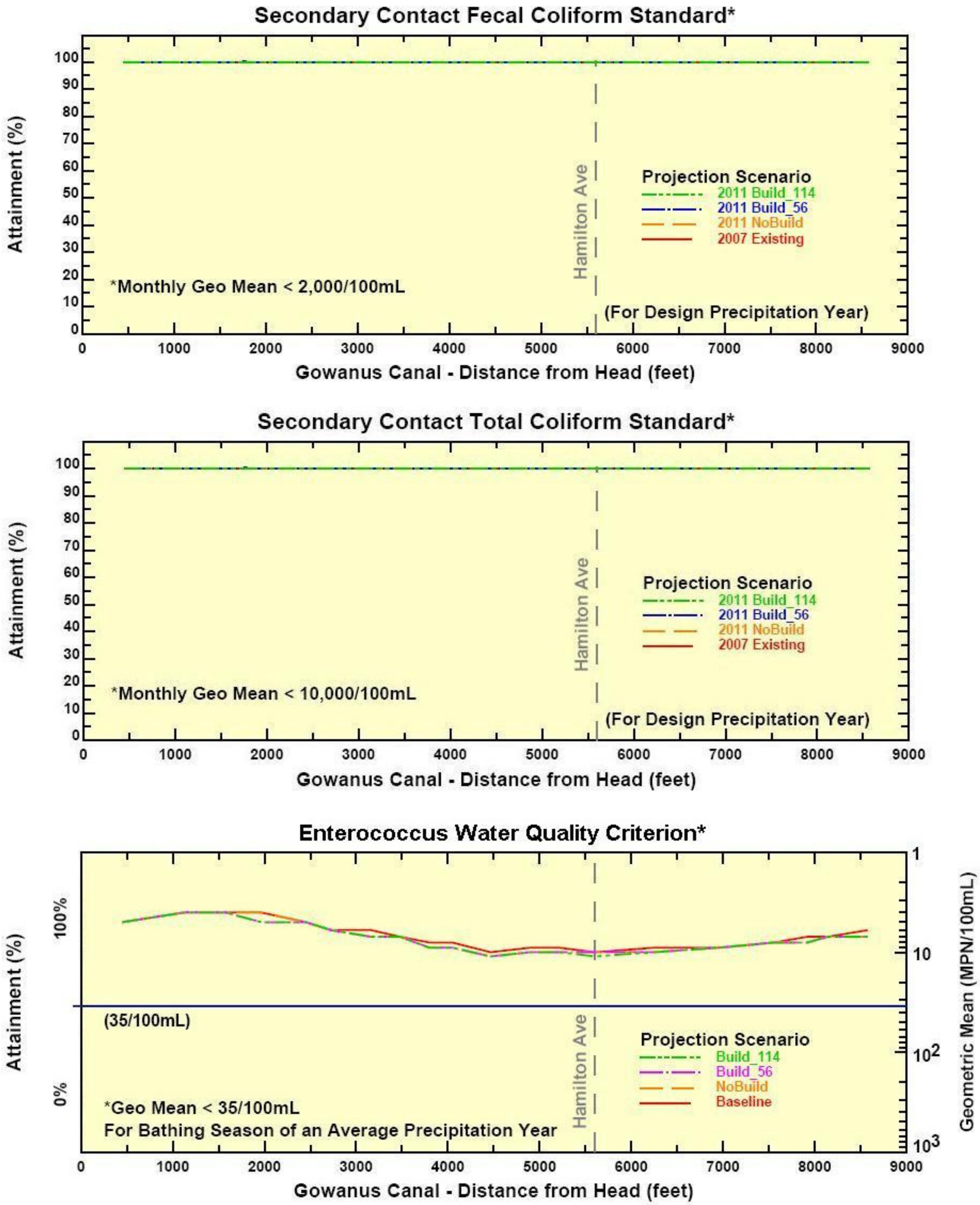


Figure 3
Projected Attainment of Potentially Applicable Pathogen Criteria

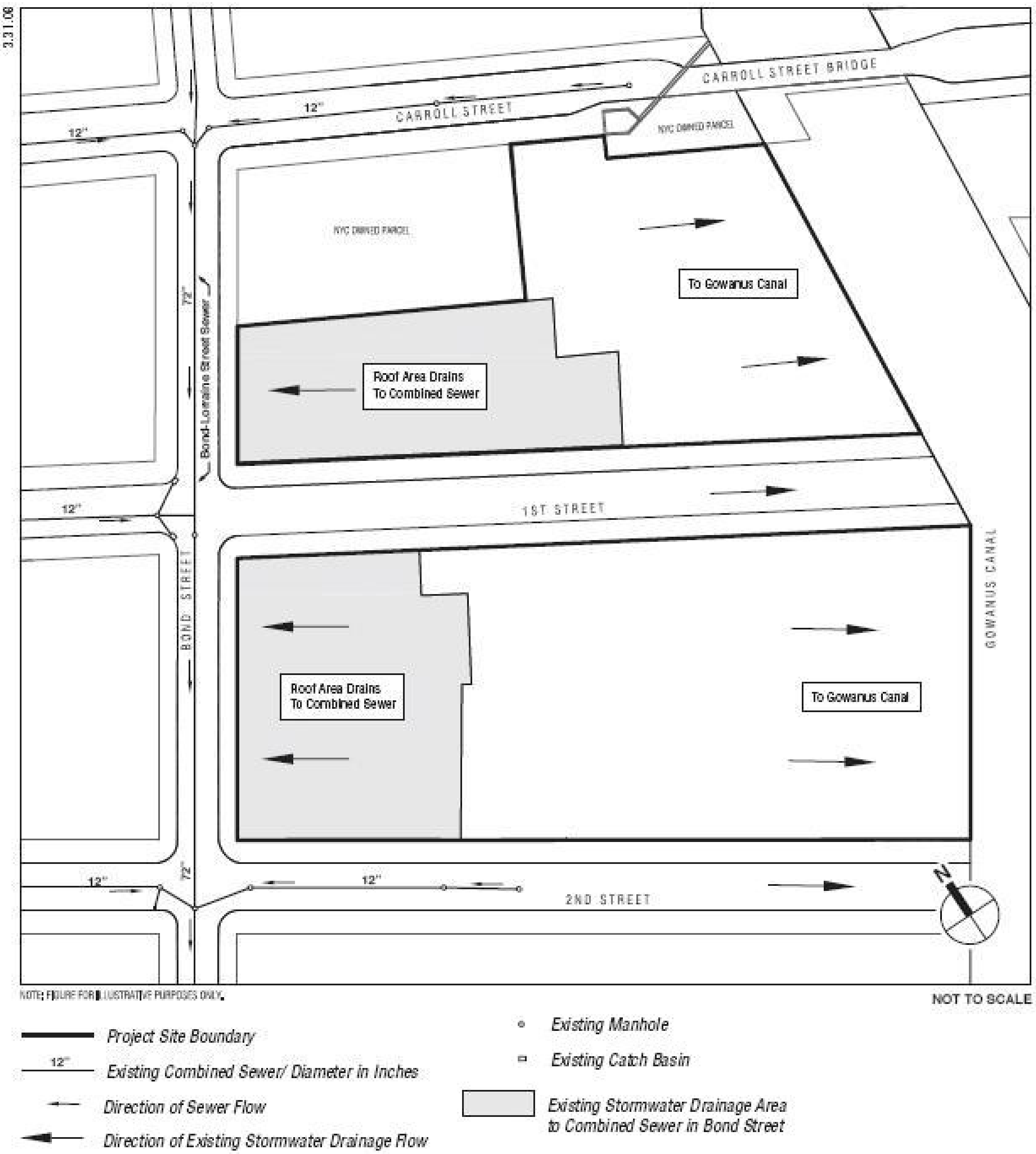


Figure 4. Existing Stormwater Flow Pattern at Project Site

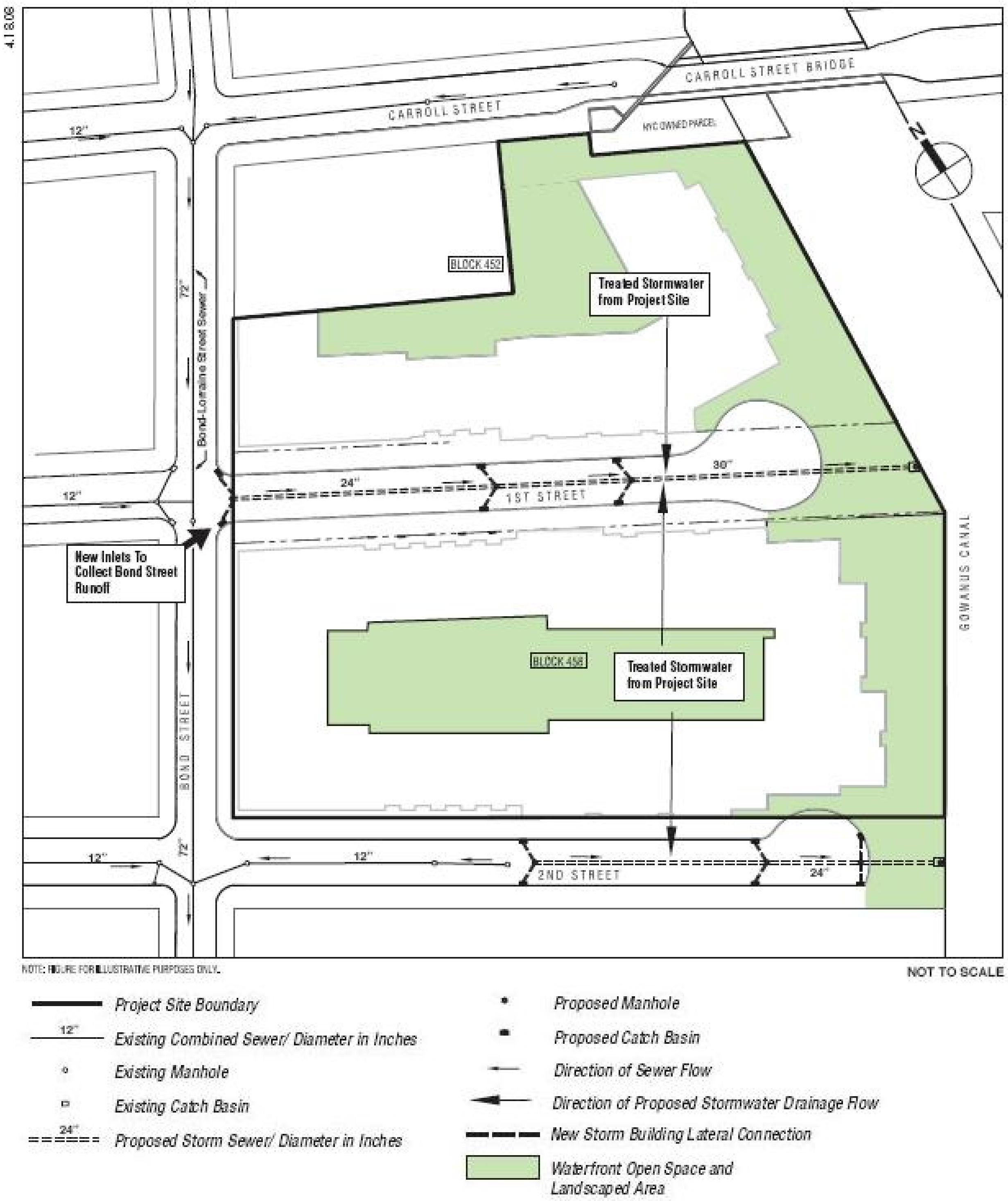


Figure 5. Proposed Stormwater Flow Pattern At Project Site

Figure 6. Water-Quality Model Grid