GEI Consultants

Geotechnical
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Ecological

CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report

Gowanus Canal Superfund Site

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Acronyms and Abbreviations

ABSd	Dermal Absorption Factor
ADD	Average Daily Dose
ADI	Accepatable Daily Intake
AF	Adherence Factor
ASI	Analytical Services, Inc.
AT	Averaging Time
AV	Acute Value
AWQC	Ambient Water Quality Criteria
BCF	Bio-concentration Factor
BW	Body Weight
CAS	Columbia Analytical Services, Inc.
CCME	Canadian Council of Minister of the Environment
CF	Units Conversion Factor
CH2M	CH2MHill
ChV	Chronic Value
CLP	Contract Laboratory Program
CSO	Combined Sewer Overflow
COPC	Contaminants of Potential Concern
DGPS	Differential Global Positioning System
DO	Dissolved Oxygen
D_{ow}	Octanol-Water Distribution Coefficient
EC	Effect Concentration
ECOSAR	Ecological Structure Activity Relationship
ED	Exposure Duration
EDC	Endocrine Disruptor Compounds
EF	Exposure Frequency
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESB	Equilibrium Partitioning Sediment Benchmark
FS	Feasibility Study
FSP	Field Sampling Plan
f_o	Fraction of Organic Carbon
g	gram
GEI	GEI Consultants, Inc.
GI	Gastrointestinal
GPS	Global Positioning System
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient

IRs	Daily Sediment Ingestion Rate
IRw	Daily Water Ingestion Rate
ISCO	In-Site Chemical Oxidation
kg	killigrams
K_{oc}	Organic Carbon Partitioning Coefficient
Kow	Octanol-Water Partition Coefficient
L	liter
LDTD	Lowest Daily Therapeutic Dose
LOEC	Lowest-Observable Effect Concentration
LOEL	Lowest Observed Effect Level
MATC	Maximum Acceptable Toxicant Concentrations
MCL	Maximum Contaminant Level
mg	milligrams
mL	milliliters
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MPN	Most Probable Number
NOEC	No-Observable Effect Concentration
NOEL	No Observed Effect Level
NYCDEP	New York City Department of Environmental Protection
NYSDEC	New York State Department of Environmental Conservation
NYCRR	New York Code of Rules and Regulations
ODEQ	Oregon Department of Environmental Quality
OPP	Office of Pesticide Program
ORP	Oxidation Reduction Potential
OSI	Ocean Surveys, Inc.
ppb	parts per billion
PPCP	Pharmaceutical and Personal Care Products
ppm	parts per million
QA/QC	Quality Assurance/Quality Control
RI	Remedial Investigation
SA	Surface Area
SAR	Structure-Activity Relationship
SLERA	Screening Level Risk Assessment
SMAV	Species Mean Acute Value
SMCV	Species Mean Chronic Value
SOP	Standard Operating Procedure
SV	Screening Value
TestAmerica	TestAmerica Laboratories, Inc.
THI	Total Hazard Index
ug	microgram
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WPCP	Water Pollution Control Plant

Executive Summary

On behalf of National Grid, GEI Consultants, Inc. (GEI) has prepared this *CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report*. The work was done in accordance with a work scope transmitted to United States Environmental Protection Agency (USEPA) on July 8, 2010. The work was performed by GEI between June 30 and October 1, 2010 and was done in accordance with National Grid's Administrative Order and Settlement Agreement for Investigation, Sampling and Evaluation with USEPA pertaining to the Gowanus Canal Superfund Site (Comprehensive Environmental Response Compensation and Liabilities Act (CERCLA)-02-2010-2009). This investigation was designed to supplement USEPA's Remedial Investigation (RI) by identifying ongoing sources to the Gowanus Canal that may pose significant human health and ecological risk.

Samples were collected from combined sewers at the combined sewer overflow (CSO) regulators, surface water adjacent to CSO outfalls, and CSO sediment mounds and analyzed for pathogens, endocrine disruptor compounds (EDCs), and other pharmaceutical and personal care products (PPCPs) that are potentially associated with sewage discharges to water bodies. The investigation was designed to supplement the USEPA CSO sampling scope of work by generating data to meet the following objectives:

- Identify ongoing sources to the canal, including pathogens, EDCs, and PPCPs associated with sewage discharges, that should be considered in evaluating background risk levels and the risk reduction and effectiveness of remedial alternatives in the CERCLA process.
- Conduct a preliminary screening-level evaluation of the potential human and ecological exposure pathways and risk from pathogens, EDCs, and other PPCPs, if detected.

The analytical data collected during this investigation revealed that pathogens, PPCPs, and ammonia were detected in CSO water, canal surface water, canal sediment during both dry and wet weather conditions. Free cyanide was not detected in any sample collected as part of this investigation.

Pathogens were detected in every sample collected, and PPCPs were detected in many of the samples collected. Pathogen and some PPCPs concentrations were typically higher in CSO water samples and canal surface water samples collected during wet weather events than canal surface water samples collected during dry weather. Elevated pathogen concentrations were detected in the sediment sample collected near the head of the canal (GC-SD-RH-034) relative to other sediment samples. Additionally, PPCPs were detected more often in sediment sample GC-SD-RH-034 relative to other sediment samples.

A preliminary screening level ecological risk assessment (SLERA) and human health risk assessment (HHRA) were performed using the analytical results from sampling each media (CSO water, canal surface water, and canal sediments). Risk assessments were performed to gain a better understanding of whether potential ecological and human health risks are presented by pathogens, PPCPs, and ammonia found in CSO waters that discharge into the canal, canal surface water adjacent to CSO outfalls, and CSO related sediment deposits within the canal. Given the screening-level nature of these risk assessments, their results are primarily intended to focus future investigations on CSO related contaminants that pose the greatest potential risks to human health and the aquatic environment.

Overall, many PPCPs were not detected in canal surface water, canal sediments, or CSO water. The majority of hazard quotients HQs) calculated for detected PPCPs were less than one, indicating that most PCPPs have no potential for risk to ecological receptors. In addition, we concluded that there is no potential for risk to the survival of pelagic and benthic fish, plants, zooplankton, and epibenthic and benthic invertebrates due to direct PPCP exposure in canal surface water and sediment. However, there is a potential for risk to the survival of these receptors due to direct exposure to the PPCPs listed below in CSO water. Additionally, the potential for adverse ecological effects, as measured by growth or reproduction, also exists from direct exposure to the PPCPs listed below in canal surface water, sediment, and CSO water. Specifically, this SLERA concluded the following:

Nonylphenol was detected at concentrations in canal surface water that pose the potential for ecological risks, particularly to the growth and reproduction of plants, zooplankton, and epibenthic and benthic invertebrates.

The following PPCPs were detected at concentrations in canal sediment that pose the potential for ecological risks, particularly to the growth and reproduction of benthic invertebrates:

- Nonylphenol,
- Nonylphenol Monoethoxylate,
- alpha-Estradiol,
- Estradiol, and
- Fluoxetine

The following PPCPs were detected at concentrations in CSO water that pose the potential for ecological risk to the survival of pelagic and benthic fish, plants, zooplankton, and epibenthic and benthic invertebrates:

- Nonylphenol,
- Nonylphenol Diethoxylate, and
- Nonylphenol Monoethoxylate

The following PCPPs were detected at concentrations in CSO water that pose the potential for ecological risk to the growth and reproduction of plants, zooplankton, and epibenthic and benthic invertebrates:

- Nonylphenol,
- Nonylphenol Diethoxylate,
- Nonylphenol Monoethoxylate,
- Estradiol,
- Estriol, and
- Ammonia

The conclusions drawn in this SLERA indicate a potential for adverse ecological effects primarily from the PPCPs listed above in canal sediment and CSO water. It is important to note that while only these few PPCPs were determined to pose the potential for ecological risks, there was a relatively high degree of confidence in the SV for most of these same PPCPs. Ultimately, given the screening-level analyses used in this assessment, a more rigorous investigation of these contaminants in canal surface water, canal sediment and CSO water will be required to more fully understand the likelihood for ecological risk to the receptors expected to come into direct contact with these media.

Based on the screening level HHRA, we concluded that there is a potential risk of adverse health effects for a child and an adult recreational visitor from exposure to pathogens and PCPPs in canal surface water and CSO water based on this report's data set. Specifically, this screening level HHRA concluded the following:

- There is no risk of potential adverse health effects for a child and an adult recreational visitor from exposure to contaminants of potential concern (COPCs) in Gowanus Canal sediment.
- There is a risk of potential adverse health effects for an outdoor worker from exposure to estrone in Gowanus Canal sediment. This risk is associated with dermal absorption of estrone in sediment.
- There is a risk of potential adverse health effects for a child and an adult recreational visitor from exposure to methadone in Gowanus Canal surface water. This risk is associated with exposure to methadone from consumption of fish. However, there is uncertainty associated with bio-concentration factors (BCFs) used to model concentrations of COPCs in fish, which were estimated based on model-estimated octanol-water partition coefficient (Kow) values.
- There is a risk of potential adverse health effects for a child and an adult recreational visitor from exposure to estrone, estriol, and nonylphenol in Gowanus Canal CSO water (if exposed to concentrations similar to those measured in CSO

water). This risk is associated with exposure to estrone, estriol and nonylphenol from consumption of fish. However, there is uncertainty associated with BCFs used to model concentrations of COPCs in fish, which were estimated based on Kow values.

- There is a significant risk to a child and an adult recreational visitor and an outdoor worker from exposure to pathogens measured in canal sediment, surface water and CSO water, including exposures to canal water limited to light use contact.

1. Introduction

On behalf of National Grid, GEI Consultants, Inc (GEI) has prepared this *CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report*. The report provides analytical data and field observations collected during the pathogen sampling events to supplement the Remedial Investigation (RI) of the Gowanus Canal (the Canal) being performed by the United States Environmental Protection Agency (USEPA). The report also presents preliminary screening-level human health and ecological risk assessment findings based on the samples collected.

The work was done in accordance with the *CSO/Gowanus Canal Pathogen Sampling Scope of Work* transmitted to USEPA on July 8, 2010 by GEI on behalf of National Grid. The work was performed by GEI between June 30 and October 1, 2010, in accordance with Paragraph 46 of National Grid's Administrative Order and Settlement Agreement for Investigation, Sampling and Evaluation with USEPA pertaining to the Gowanus Canal Superfund Site (Comprehensive Environmental Response Compensation and Liabilities Act (CERCLA)-02-2010-2009)CERCLA-02-2010-2009). This report is being submitted to USEPA for inclusion in the Administrative Record for the Gowanus Canal.

Grab samples were collected from combined sewers at the CSO regulators, surface water adjacent to CSO outfalls, and CSO sediment mounds and analyzed for pathogens, endocrine disruptor compounds (EDCs), and other pharmaceutical and personal care products (PPCPs) that are associated with sewage discharges to water bodies. These grab samples reflect a snapshot of conditions at a specific sampling location and time and do not necessarily represent all discharge conditions from the CSO system. As such, the data may underestimate both the discharges and the resulting risk.

This investigation was designed to supplement the USEPA CSO sampling scope of work (USEPA; 2010a) by generating data to meet the following objectives:

- Identify ongoing sources to the canal, including pathogens, EDCs, and PPCPs associated with sewage discharges, that should be considered in evaluating background risk levels and the risk reduction and effectiveness of remedial alternatives in the CERCLA process.

- Conduct a preliminary screening-level evaluation of the potential human and ecological exposure pathways and risk from pathogens, EDCs, and other PPCPs, if detected.

This report summarizes data collected during the CSO sampling events and provides a screening level assessment of ecological and human health risks potentially associated with the contaminants found in CSO water (i.e. a mixture of sewage and stormwater) and canal surface water and sediment collected adjacent to CSO outfalls located within the Gowanus Canal study area.

CSO water samples collected as part of this study were collected cooperatively with USEPA and were collected at the same time and location as the CSO water samples collected as part of USEPA's RI. CSO-related surface water and canal sediment samples were collected under the supervision of USEPA.

This report is organized as follows. Section 2 provides an overview of the Gowanus Canal Watershed. Section 3 discusses the scope of work and methods employed during the field investigation. Section 4 presents a summary of the observations and findings of the investigation. Section 5 presents a Screening Level Ecological Risk Assessment (SLERA). Section 6 presents a screening level Human Health Risk Assessment (HHRA). Section 7 summarizes key findings and conclusions.

2. Gowanus Canal Watershed Overview

The Gowanus Canal is 1.8 mile long, man-made canal located in Brooklyn, New York constructed in the mid-1800s (**Figure 1**). In a non-urban setting a watershed defined by the surrounding topography represents the upland area which contributes runoff to a waterbody. The area around the Gowanus Canal has been urbanized, and as a result, the upland area contributing runoff is defined by the combined sewer system which does not follow the surrounding topography (New York City Department of Environmental Protection (NYCDEP), 2008). In addition to stormwater discharges, this manmade watershed (shown in **Figure 1**) has always and continues to receive discharges of sewage.

The Gowanus Canal and surrounding area are currently serviced by combined sewer systems which convey sewage and stormwater to the Red Hook Water Pollution Control Plant (WPCP) and Owls Head WPCP. During wet weather, the combined sewer system becomes overwhelmed, and a mixture of sewage and stormwater is discharged into the canal via 11 CSO outfalls (NYCDEP, 2008). However, only 10 CSO outfalls are within the study area defined by the USEPA (CSO outfall OH-024 is located south of the study area) (USEPA, 2011a). The 11 CSO outfalls are shown in **Figure 1**. A small portion of the watershed, six percent, does not contain sanitary sewers and stormwater drains directly to the canal (NYCDEP, 2008).

The Red Hook WPCP services the areas to the north and west of the Gowanus Canal (**Figure 1**). Currently, there are seven CSOs associated with the Red Hook WPCP (RH-031, RH-033, RH-034, RH-035, RH-036, RH-037, RH-038), and one active stormwater outfall (RH-601 formerly RH-032) that discharge to the Gowanus Canal. These outfalls drain approximately 935 acres (approximately half) of the Gowanus Canal watershed (NYCDEP, 2008).

The Gowanus Pumping Station, located within the Red Hook WPCP watershed at the head of the canal on Douglass Street, was designed to convey flow to the Columbia Street Interceptor via a force main within the Flushing Tunnel (a tunnel constructed in 1911 connecting the East River to the canal to reduce stagnation and introduce fresher waters) (NYCDEP, 2008). This force main was taken out of service because of reoccurring failures; therefore, flow is currently diverted to the interceptor via the Bond-Lorraine Street Sewer (NYCDEP, 2008). The Flushing Tunnel, Gowanus Pumping Station, and Bond-Lorraine Street Sewer are shown in **Figure 1**.

The Owls Head WPCP services 719 acres to the south and east of the Gowanus Canal (**Figure 1**) (NYCDEP, 2008). The Owls Head system has four CSOs (OH-005, OH-006,

OH-007, OH-024) and three stormwater outfalls (OH-601, OH-602, OH-607 (formerly OH-008)) that discharge to the canal.

According to NYCDEP, the greatest annual discharges occur from outfalls RH-034 at the Gowanus Pumping Station, RH-035, and OH-007 (NYCDEP, 2008).

3. Sampling and Analysis

Sampling activities were conducted in accordance with the *CSO/Gowanus Canal Pathogen Sampling Scope of Work* provided to USEPA on July 8, 2010. This work was performed in accordance with the NYSDEC-approved Health and Safety Plan (HASP) and Field Sampling Plan (FSP) dated September 2005 for National Grid's Canal Investigation (GEI, 2005a and 2005b). The ten CSO outfalls within the study area and sampling locations of the CSO water, surface water, and sediment samples are shown in **Figure 2**.

Samples were collected from within the combined sewer system and from the canal in areas near the CSO outfalls. CSO samples collected from within the combined sewer system consisted of only CSO water, whereas, samples collected from the canal included both surface water and sediments in areas near the CSO outfalls.

The CSO water samples, canal surface water samples, and canal sediment samples were collected both during wet weather events when there was active CSO discharge into the canal and during dry weather when there was no CSO discharge into the canal. The samples were not composited over time and reflect a snapshot of conditions at a specific sampling location and time. Combined sewer systems are dynamic and are affected by many different parameters including periods of peak sanitary use that typically occur during morning and evening hours as well as rainfall and snowmelt distribution and intensity which can affect CSO flow rates, therefore, the snapshot samples do not accurately represent all discharge conditions from the CSO system. To evaluate CSO loadings to the Canal, time-integrated sampling would be required, which was not possible during this investigation.

Samples were analyzed for a variety of pathogens, EDCs, PPCPs, free cyanide and ammonia. Three laboratories completed the analyses included in **Table 1**:

- Analytical Services, Inc. (ASI) of Williston, VT analyzed pathogens. ASI performed the analyses both at their Williston, VT laboratory and at the Waterborne Disease Laboratory at University of New Hampshire in Durham, NH.
- Columbia Analytical Services, Inc. (CAS) of Kelso, WA analyzed PPCPs.
- TestAmerica Laboratories, Inc. (TestAmerica) of Shelton, CT analyzed free cyanide and ammonia. TestAmerica also analyzed fecal coliform for CSO water samples collected during the dry weather sampling event.

3.1 Sampling and Analysis Rationale

Pathogens, EDCs, PPCPs, free cyanide, and ammonia were analyzed to provide the USEPA additional information regarding constituents potentially associated with CSO discharges to

the Gowanus Canal, which should be considered in evaluating background risk levels and the risk reduction and effectiveness of remedial alternatives in the CERCLA process. The findings could be used by the USEPA to further assess current and future risks posed to users of the Canal and to further assess ecological risks. Pathogens and biological disease producing agents (e.g. viruses, bacterium, and protozoan), are commonly found in human and animal waste. EDCs and PPCPs have been documented in surface waters susceptible to urban and agricultural pollution (Kolpin et al. 2002). EDCs and PPCPs are a class of contaminants that have only recently gained significant attention in scientific and public forums because of their potential and observed effects on aquatic life. For the purposes of this report, EDCs, regardless of use, will be categorized together with PPCPs.

Pathogens in sewage effluent can be quantified directly or via surrogate indicator organisms. Both direct pathogens and indicator organisms were included in the list of CSO sampling analyses to better understand the correlation at this site between the indicator species that are commonly measured, and the specific pathogens which are of concern. **Table 1** includes the list of pathogens analyzed. This list was developed to include those from the relevant groups of microorganisms identified as indicators of sanitary water quality as well as pathogenic viruses and organisms, some of which are used to track sewage in sediments and bulk phase water (Ballester, 2005).

The list of analyzed PPCPs was developed based on reports of chemicals that have been detected most frequently in surface waters during a nationwide reconnaissance conducted by the U.S. Geological Survey (USGS) (Kolpin et al. 2002), a study conducted by the City of New York on the occurrence of such chemicals in the source water of the city's water supply (NYCDEP, 2010), and other studies conducted on surface waters within the northeast tri-state region (Associated Press, 2008; Alvarez et al. 2004). Chemicals that were detected most frequently and that have the greatest potential for biological effects or bioaccumulation were included in the list of analyzed PPCPs (**Table 1**). Some chemicals associated with industrial and domestic uses that are not currently known to disrupt the endocrine system are included on this list because of their potential toxicity. In addition, antibiotics were included in this list, as their presence in sediments may select for antibiotic resistant bacteria, which can pose a threat to human and ecological health. One PPCP, triclosan, was not analyzed in sediment because the sediment analysis for this compound was not available with the subcontracted laboratories at the time of sampling.

Class SD waterbody standards have been issued by New York State Department of Environmental Conservation (NYSDEC) for free cyanide and ammonia. These contaminants were not analyzed as part of the USEPA's CSO sampling program, but were analyzed as part of the work described in this report because they could be associated with sewage and industrial discharges. These analytes are also included in **Table 1**.

3.2 CSO Water Sampling and Analysis

CSO water samples were collected concurrently with USEPA's contractor CH2MHill (CH2M) who gained access to the combined sewer system through NYCDEP. These samples were collected at the same time and with the same frequency as the USEPA's CSO sampling program. The USEPA's CSO sampling program also included the collection of sediment samples from the combined sewer system; however, CSO sediment samples were not collected as part of the National Grid program. **Figure 2** depicts the locations where the CSO samples were collected.

CSO water samples were collected during both dry and wet weather. Dry weather was defined by the USEPA's CSO sampling program as sampling after a minimum of 2 to 3 days following a CSO discharge event. Wet weather samples could be collected within a 3 to 6 hour period after a minimum of 0.10 inches of rainfall fell within an hour. Rainfall was monitored by CH2M with on site meteorological stations and local weather stations. CH2M also contacted both the Red Hook and Owls Head WPCPs to verify that CSO discharges were occurring in the system. Wet weather conditions were also monitored by visual evidence of active discharges into the Gowanus Canal at the CSO outfalls. Efforts were made to sample CSO water soon as CSO discharges occurred; however, sampling logistics (e.g. establishment of traffic control at each location) prohibited this for most samples. CSO water samples were typically collected within the first few hours of a wet weather event.

CSO water samples were collected from the combined sewer system during four events which consisted of one dry weather sampling event (June 30 and July 1, 2010) and three wet weather sampling events (July 13, September 28, and September 30 to October 1, 2010). A summary of the samples collected, analyses performed, and Quality Assurance and Quality Control (QA/QC) samples collected is provided in **Table 2**. Field measurements of salinity, pH, specific conductance, dissolved oxygen (DO), oxygen reduction potential (ORP), temperature, and turbidity were recorded by CH2M for each sample.

3.2.1 Sampling Methods

Typically, CSO water samples were collected by using a Nasco Swing Sampler with a certified clean polyethylene collection bottle or by using a disposable 5 quart polyethylene bucket and a disposable nylon rope. In one instance, during the sampling of location RH-035 on October 1, 2010, the pressure head within the combined sewer had built up to the point that the manhole cover was displaced and the sample was collected from the flow that discharged onto the street. All ten outfalls were targeted for sampling; however, within the Gowanus Canal Pump Station, outfall RH-034 was not accessible to National Grid during any of the CSO water sampling events because an in-site chemical oxidation (ISCO) composite sampler was used to collect samples as part of the USEPA's sampling program.

3.2.2 Dry Weather Sampling Event

A subset of analytes (fecal coliform, free cyanide, and ammonia) was tested for on the samples collected during the dry weather event (June 30 and July 1, 2010).

3.2.3 Wet Weather Sampling Events

During the first wet weather sampling event on July 13, 2010 samples were collected from five of the nine accessible CSO locations (RH-036, RH-037, RH-038, OH-005, and OH-006). The remaining 4 accessible CSO locations could not be sampled because the rain event ceased and flow in the combined sewer system returned to dry-weather flow rates. CH2M verified that the combined sewer systems returned to dry-weather conditions by contacting the WPCPs. CH2M reported that 1.02 inches of rainfall was recorded at the on-site weather station between 12:15 and 2:00 pm (USEPA, 2011a).

During the second wet weather sampling event on September 28, 2010, samples were collected from two of the nine accessible CSO locations (RH-035 and RH-031). Again, the remaining 7 accessible CSO locations could not be sampled because the rain event ceased and the WPCPs verified that flow in the combined sewer system had returned to dry-weather flow rates. CH2M reported that 0.21 inches of rainfall were recorded at the on-site weather station between 11:30 am and 12:30 pm (USEPA, 2011a).

Samples from all nine accessible CSO locations were collected on September 30 and October 1, 2010 during the third wet weather sampling event. Two samples (OH-006 and OH-007) were collected on September 30, but the remaining samples could not be collected on this date since the flow in the combined sewers had returned to dry-weather flow conditions. CH2M reported that approximately 1 inch of rainfall was recorded with the on-site weather station between 5:30 and 7:30 am (USEPA, 2011a). Significant rainfall resumed again the morning of October 1, 2010 and the remaining seven accessible samples were collected. At a local weather station located in an adjacent neighborhood of Brooklyn, Park Slope, approximately 4 inches of rainfall was recorded between 4:30 and 9:30 am (Weather station KNYBROOK22, 2011).

3.3 CSO-Related Sediment and Surface Water Sampling and Analysis

Samples of canal surface water and sediment were collected adjacent to the CSO outfalls from a small vessel on July 13 and 14, 2010. These samples were collected by GEI with USEPA oversight provided by CH2M. USEPA has documented that the Flushing Tunnel was turned off on July 19, 2010 (USEPA, 2011a). However, during the collection of these samples it appeared that the Flushing Tunnel may not have been functioning or was

functioning on a limited basis because of the observed turbidity and lack of current near the head of canal.

Ocean Surveys, Inc. (OSI) of Old Saybrook, CT was subcontracted by GEI to provide and navigate the sampling vessel. The sampling vessel was equipped with a Differential Global Positioning System (DGPS) with positioning accuracy of 1 meter, HYPACK navigation system, and a Ponar sediment sampler, which was used to collect surficial sediment samples as described below. DGPS allowed for the measurement of each sampling location to a greater degree of accuracy than standard Global Positioning Systems (GPS) by using a network of fixed stations with known positions to broadcast the difference of the satellite systems and the fixed stations. This difference was then used to refine the satellite positioning, therefore, refine the vessels position and sampling location.

A summary of the samples collected, analyses performed, QA/QC samples collected, and surveyed sample locations provided by OSI are included in **Table 2**.

3.3.1 CSO-Related Sediment Sampling

Sediment samples were collected from the top six inches of mounded sediments located adjacent to each CSO outfall with a Ponar sediment sampler. The distance of the mounded sediment from each CSO outfall appeared to be related to the relative discharge of CSO outfall. The majority of sediment mounds were located within twenty feet of the CSO outfalls. At outfall locations where relatively larger flows of CSO water are discharged during wet weather (e.g. RH-034, RH-035, and OH-006), mounded sediment was typically located approximately 40 feet or more away from the outfall. Access to the sample locations near eastern CSO outfalls within the upper reach, RH-033, RH-038, RH-037, RH-036, and OH-005, was at times limited by NYCDEP's temporary oxygenation system.

After each sediment sample was collected, the Ponar sampler and sample processing table was decontaminated by disinfecting the equipment with a 5% bleach solution for a minimum of 5 minutes and rinsing with deionized water.

3.3.2 CSO-Related Surface Water Sampling

Surface water samples were collected at the mid-point of the water column at each sediment sampling location. Surface water samples were collected with a Waterra Inertial Pump with a reusable check valve and disposable Teflon® tubing or a peristaltic pump with disposable tubing.

The reusable check valve was decontaminated by the same methods used to decontaminate the sediment sampling apparatuses.

Eight of the ten surface water samples were collected during dry weather events; however, two samples, GC-SW-RH-035 and GC-SW-RH-031, were collected during a wet weather (active CSO discharge) event on July 13, 2010. Outfalls RH-035 and RH-031 were observed discharging considerable flow during the sample collection. Outfall OH-006 located at the mouth of the canal was not visibly discharging when sample GC-SW-OH-OO6 was collected shortly after the wet-weather event, but the surface water at that location was observed to be very turbid with a seaward current produced by stormwater and CSO discharges upstream. CH2M reported that 1.02 inches of rainfall was recorded at the onsite weather station between 12:15 and 2:00 pm (USEPA, 2011a).

3.4 Sample QA/QC

3.4.1 Sample Handling

All samples were collected in certified clean bottles provided by the laboratories. Some analyses required the use of preservatives which were also provided by the laboratory. The preservatives used are listed in **Table 1**. After collection, all samples were packed in coolers and immediately chilled with ice to approximately 4 degrees Celsius. Samples were then express shipped or transported via courier to the laboratories to minimize holding times.

Viruses and plaque-forming viruses were not analyzed for the CSO water sample collected at OH-005A during the third wet weather sampling event on October 1, 2010 because the bottle broke at the laboratory during sample preparation.

3.4.2 QA/QC Sampling

In addition to the QA/QC samples prepared by the laboratories, QA/QC samples were collected in the field for PPCPs, ammonia, and free cyanide analyses. The QA/QC samples consisted of blind duplicate samples, matrix spike and matrix spike duplicate (MS/MSD) samples, and equipment rinsate blank samples. QA/QC samples were collected at a targeted frequency of 1 set of QA/QC samples per 20 samples collected for each matrix. Due to time and sample volume constraints, QA/QC samples were not collected during the first two CSO water wet weather sampling events. A list of QA/QC samples collected is included in **Table 2**.

3.4.3 Data Validation

Data from the laboratories were validated by GEI. Data validation was performed in accordance with the USEPA Region II *Standard Operating Procedure for the Evaluation of Metals for the Contract Laboratory Program,* Standard Operating Procedure (SOP) HW-2, Revision 13 (September 2006a), *USEPA Region II Functional Guidelines for Evaluating Organic Analyses* (September 2006b), and the *USEPA Contract Laboratory Program*

National Functional Guidelines for Inorganic Data Review, EPA 540/R-04/004 (October 2004a), modified as necessary to accommodate the non-Contract Laboratory Program (CLP) methodology used. The validation reports and laboratory form 1s are included in **Appendix A**.

A number of results were rejected for some samples as discussed in **Appendix A**. Trimethoprim, an antibiotic, results were rejected in all sediment samples due to poor surrogate recovery.

4. Summary of Observations and Findings

This section presents a summary of observations and analytical results of the CSO water, canal sediment, and canal surface water samples.

4.1 Physical Observations and Measurements

The CSO water and canal surface water samples were typically a clear, faintly brown liquid with suspended organics and debris. An increase in suspended organic matter was apparent in surface water samples collected during the wet weather event on July 13, 2010. Canal sediment samples were typically black or dark gray very fine silt and sand deposits intermingled with organic matter such as leaves and hair. The sediment samples typically exhibited a sulfide odor and spotty sheens.

For each CSO water sample, field measurements of salinity, pH, specific conductance, DO, ORP, temperature, and turbidity were taken by CH2M for each CSO water sample. These field measurements are summarized in **Table 3**. Most parameters were fairly consistent between wet and dry sampling events. However, DO concentrations measured during the wet weather sampling events were typically higher than DO concentrations collected during the dry weather sampling event.

4.2 Analytical Findings

The analytical sampling results for the CSO water, canal surface water, and canal sediment are shown in **Tables 4**, **5**, and **6**. Pathogens, PPCPs, and ammonia were detected in CSO water, canal surface water, and canal sediment samples. Free cyanide was not detected in any sample during this investigation. A brief description of the associated use or relevance of all analytes is included in **Table 1**. A brief description of selected analytes specifically discussed in this section is included below in **Table 7**.

Table 7 - Description of Selected Analytes

Pathogens	
Analyte	**Description or Use**
Clostridium perfringens	Bacterium associated with gastrointestinal illness
Coliphages	Bacterium associated with gastrointestinal illness
Enterococcus	Bacterium associated with gastrointestinal illness
Fecal coliforms	Bacterium associated with gastrointestinal illness
E. coli	Bacterium associated with gastrointestinal illness
Enteroviruses	Viruses associated with disease
Giardia	Protozoan associated with gastrointestinal illness
EDC/PPCP	
Analyte	**Description or Use**
Acetominophen	Analgesic
alpha-Estradiol	Estrogen
Bisphenol A	Industrial Chemical
Estradiol	Estrogen
Estriol	Estrogen
Estrone	Estrogen
Fluoxetine	Antidepressant
Gemfibrozil	Lipid Regulator
Methadone	Opiate
Naproxen	Anti-inflammatory
Nonylphenol	Industrial Chemical
Nonylphenol Diethoxylate	Industrial Chemical
Nonylphenol Monoethoxylate	Industrial Chemical
Other	
Analyte	**Description or Use**
Ammonia	Naturally Occurring, Associated with Sewage, and Industrial Chemical

Pathogens were detected in every sample collected. Bacteria and coliform indicators associated with gastrointestinal illness (GI) including *Clostridium perfringens*, *Enterococci*, fecal coliform, and *E. coli* were detected in all samples which analyzed them. *Giardia*, a protozoan pathogen and also associated with gastrointestinal illness, was detected in nearly every CSO water sample collected. Viruses were detected in CSO water samples, but not in surface water or sediment samples.

PPCPs were also detected frequently and typically at concentrations on the order of one part per billion (ppb) or less in aqueous samples and at concentrations on the order of one part per million (ppm) or less in sediment samples. Naproxen, Acetaminophen, Bisphenol A,

Gemfibrozil, and Nonylphenol were detected in over half of the samples. The following compounds were not detected in any samples:

- Nonylphenol Monoethoxylate
- 4-tert-Octylphenol
- Androstenedione
- Atrazine
- Diazepam
- Diethylstilbestrol
- Ethinyl Estradiol
- Hydrocodone
- Meprobamate

Ammonia, which is associated with sewage and is naturally occurring in sediment, was detected in over 90% of the aquatic samples and 80% of the sediment samples.

4.2.1 Aquatic Analytical Findings

Table 8 contains the frequency of detection, maximum detected concentration, minimum detected concentration, and average concentrations for each analyte detected within the CSO water samples and canal surface water samples. Analytes were typically detected at higher concentrations within the CSO water samples than the canal surface water samples as illustrated in **Table 8**. For example, the average concentrations of fecal coliform and acetaminophen, which were detected in nearly every sample, were detected at levels approximately an order of magnitude higher in the CSO water samples than in the Canal surface water samples. The average concentration of acetaminophen detected in CSO water samples was 5.11 ppb versus 0.724 ppb in surface water samples and the average concentration of fecal coliform detected in CSO water samples were 983,000 Most Probable Number per 100 milliliters (MPN/100 mL)[1] versus 46,000 MPN/100 mL in surface water. Strains of the adenovirus and enterovirus were detected in CSO water samples, but not in the canal surface water samples. Additionally, most analytes were detected more frequently within the CSO water samples than the canal surface water samples. However, a few PPCP analytes such as Ibuprofen, Iopromide, and Salicylic Acid were detected more frequently in surface water samples than in CSO water samples.

Limited analyses were performed on samples collected during the dry weather CSO water sampling event, and only two wet weather canal surface water samples were collected. The specific temporal nature of the data and small dataset limits comparison between the dry weather and wet weather sampling events. However, the data from the two surface water samples collected during wet weather (GC-SW-RH-035 and GC-SW-RH-031) contained pathogens and volatile PPCPs such as Bisphenol A at greater concentrations than surface water samples collected during the dry weather event. Bacteria pathogens were detected at

[1] The MPN method is used to estimate microbial populations in soils, waters, and agricultural products where many times the quantitative measurement of individual cells is not possible (van Elsas et. al., 1997). The MPN method has the ability to estimate a microbial population on the basis of a functional characteristic of that population (van Elsas et. al., 1997).

concentrations approximately two orders of magnitude higher within the wet weather surface water samples when compared to the dry weather surface water samples. Furthermore, Bisphenol A and Nonylphenol were detected in both wet weather surface water samples but were not detected in dry weather surface water samples.

Fecal coliform and enterococci were detected in multiple CSO water samples collected during the wet weather events at levels exceeding typical concentrations found in sanitary sewage (not combined sewage) used by NYCDEP in the CSO system models, (NYCDEP, 2008). The fecal coliform and enterococci concentrations used by NYCDEP in the CSO system models are reported as 2.7×10^6 MPN per 100 mL and 1.0×10^6 MPN/mL, respectively (NYCDEP, 2008).

As discussed further in Section 5, Nonylphenol, Nonylphenol Diethoxylate, and Nonylphenol Monoethoxylate were detected in CSO water samples collected during wet weather sampling events at concentrations exceeding the SLERA acute screening values (SV). Nonylphenol was also detected in one of the two canal surface water samples collected during a wet weather event at a concentration exceeding the SLERA chronic screening value. Estradiol, estriol, and ammonia were detected in CSO water samples collected during the wet weather events at concentrations that exceed the SLERA chronic SV.

As discussed further in Section 6, enterococci and fecal coliforms were detected at concentrations in CSO water samples and surface water samples that exceeded the USEPA Ambient Water Quality Criteria (AWQC) screening levels used by the HHRA. (USEPA, 1986). The geometric mean of the eight dry weather canal surface water samples and all CSO water samples exceeded bathing criteria used in the HHRA for both enterococci and fecal coliform. Methadone was detected in one surface water sample at a concentration of 0.21 ppb that exceeded the screening level criteria for incidental ingestion and ingestion of fish determined by the HHRA. Estrone, estriol, and nonylphenol also were detected at concentrations in CSO water samples which exceeded the screening level criteria for incidental ingestion and ingestion of fish determined by the HHRA.

4.2.2 Sediment Analytical Findings

Table 9 contains the frequency of detection, maximum detected concentration, minimum detected concentration, and average concentrations for each analyte in the canal sediment samples. Pathogens, Nonylphenol, Bisphenol A, Fluoxetine, Naproxen, and ammonia were among the analytes that were detected in at least one half of the samples.

The pathogens or coliform indicators detected within the sediment samples included *Clostridium perfringens*, *Enterococci*, fecal coliform, and *E. coli*. Unlike the CSO water and surface water samples, coliphages, and *Giardia* were not detected in the sediment samples.

The sediment sample collected near the head of the Canal (GC-SD-RH-034) contained elevated pathogen concentrations when compared to other samples collected within the sediment sample data set. Fecal coliform was detected at a concentration of 12,000 most probable number/gram (MPN/g) in GC-SD-RH-034 which is over an order of magnitude greater than any concentrations detected within other sediment sample collected. *Enterococci* and *E. coli* in GC-SD-RH-034 were also detected at concentrations over two times greater than concentrations detected in the complete sediment sample data set. Elevated pathogen concentrations relative to the sample set were also detected in samples GC-SD-RH-031 and GC-SD-RH-037.

Nonylphenol, Nonylphenol Monoethoxylate, alpha-Estradiol, Estradiol, and Fluoxetine were detected at concentrations in sediment samples exceeding the SLERA chronic SV. These results are discussed further in Section 5. Nonylphenol was detected in half of the sediment samples at concentrations exceeding the SLERA chronic SV. Analytes were detected at concentrations exceeding the SLERA chronic SV more frequently than the other samples in the sediment sample collected near the head of the Canal (GC-SD-RH-034 and associated duplicate). At this location, four of the five analytes that exceeded the SLERA chronic SV were detected.

As discussed further in Section 6, estrone was detected in one sediment sample (GC-SD-RH-038) at a concentration that exceeded the SV determined by the HHRA for ingestion and dermal absorption for an outdoor construction worker. Additionally, concentrations of enterococci and fecal coliform were detected in sediment samples at levels exceeding the criteria determined by the HHRA for recreational visitors and outdoor construction workers.

5. Screening-Level Ecological Risk Assessment

The Ecological Risk Assessment (ERA) described herein reflects a preliminary, screening-level evaluation of the potential for ecological risks in the Gowanus Canal due to PPCP exposure. Pathogens were not considered as part of this assessment, but ammonia was included along with PPCPs given that this can be a chemical of ecological concern related to untreated wastewater discharges from CSOs. The objective of this analysis was to provide an ecological risk-based context for the data collected as described in Section 3 (Sampling and Analysis) and summarized in Section 4 (Summary of Observations and Findings) of this report. More rigorous investigation of these data will be required in the future to more fully understand the likelihood for ecological risks; however, this initial assessment will help focus receptors, pathways, and contaminants of potential concern (COPCs) to be further considered in subsequent evaluations.

5.1 Problem Formulation

For the purposes of this SLERA, a streamlined problem formulation was prepared to describe the conceptual site model and measurement and assessment endpoints considered in this preliminary PPCP risk characterization.

5.1.1 Conceptual Site Model

This SLERA focused on the three exposure media most closely associated with likely sources of PCPPs and ammonia linked to CSO discharges to Gowanus Canal. These media included water samples collected from the combined sewers that discharge to the Canal, and surface waters and sediments collected within the canal near each corresponding CSO discharge point.

As previously discussed, the specific PPCPs evaluated were selected based on published reports of detected chemicals in surface waters (e.g. Kolpin et al. 2002). Chemicals that were detected most frequently and that have the greatest potential for biological effects or bioaccumulation were targeted for inclusion in this study. In addition, antibiotics were included, as their presence in sediments may result in the selective growth of antibiotic resistant bacteria, which can pose a threat to human and animal health.

Toxicity associated with direct contact of these PCPPs was the only exposure pathway considered for this preliminary assessment. Ecological receptors anticipated to come into contact with exposure media via this pathway include: aquatic plants, zooplankton, benthic invertebrates, epibenthic invertebrates, benthic fish, pelagic fish, and semi-aquatic birds and

mammals. However, risks to wildlife were not explicitly evaluated in this SLERA because exposure to PCPPs also occurs via the food web and a dietary assessment was beyond the scope of this assessment. Similarly, risks associated with PPCP bioaccumulation were also not considered in this preliminary SLERA.

5.1.2 Assessment Endpoints

Assessment endpoints were selected based on the assumption that the expected future condition of the Canal would be one in which Class SD criteria (6 New York Code of Rules and Regulations (NYCRR) § Part 703; NYSDEC 2001) are more consistently met. It should be noted that the actual end-use of the Gowanus Canal remedy has not yet been determined, and a higher class use category may ultimately be desired. If this is the case, more stringent criteria and further study would be warranted. The best usage of Class SD water bodies is fishing (6 NYCRR Part §701.14; NYSDEC 2001); therefore, assessment endpoints for pelagic and benthic fish were limited to protection of survival (i.e., not growth or reproduction). Because, in order to survive, fish and wildlife likely forage on local populations of plants, zooplankton, and benthic and epibenthic invertebrates, assessment endpoints for these receptors were more complete and included survival, growth, and reproduction.

5.1.3 Measurement Endpoints

Measurement endpoints were defined as a comparison of a media-specific exposure metrics against a media-specific conservative screening threshold. Consistent with the exposure media and pathways and assessment endpoints discussed above, measurement endpoints were as follows:

1. Pelagic fish: Comparison of canal surface water and CSO water concentrations to acute SV
2. Benthic fish: Comparison of canal surface water, CSO water, and Canal sediment concentrations to acute SV
3. Plants, zooplankton, epibenthic invertebrates: Comparison of canal surface water and CSO water concentrations to acute and chronic SV
4. Benthic invertebrates: Comparison of canal surface water, CSO water, and Canal sediment concentrations to acute and chronic SV

Based on these measurement endpoints, selection of both acute and chronic SV, for both surface water and sediments, was necessary. The process for deriving the SV is discussed in detail below.

5.2 Exposure Assessment

Exposure point concentrations (EPCs) for use in the SLERA were derived from PPCP and ammonia concentrations measured in CSO, surface water, and sediment samples as further described in Section 3 (methods) Section 4 (results). Any chemical not detected across all samples for a given media was not quantitatively evaluated in this SLERA (i.e., no quantitative effects assessment and subsequent risk characterization were conducted). These non-detected chemicals are summarized in **Table 10**. To ensure that reporting limits were likely to be low enough to detect PPCPs at possible risk threshold concentrations, the aquatic reporting limits (**Tables 11** through **17**) were compared to model-predicted thresholds for aquatic toxicity as estimated by USEPA's Ecological Structure Activity Relationship (ECOSAR) model (**Table 10**; USEPA 2003). All of the reporting limits were well below ECOSAR-predicted toxicity thresholds[2], and so analytical detection limits were likely low enough to detect concentrations that might impose ecological risk should they have been detected (**Table 10**). For chemicals that were detected in at least one sample for a given media, EPCs for the SLERA were defined as the maximum detected concentration observed.

It should be noted that even though aquatic organisms are not expected to exist within the CSO collection system, we used CSO grab samples as EPCs to represent exposure concentrations that could occur in the Canal immediately adjacent to the CSO outfall during a significant discharge event. The EPCs from CSO samples thus represent a conservative estimate of the maximum possible exposure of aquatic organisms to PPCPs in the Canal. This was also important because most grab samples were taken during dry conditions when the CSOs were not discharging, so there was no other means of estimating maximum EPCs that could occur in the Canal surface water during significant wet discharge events.

5.3 Effects Assessment

5.3.1 Approach

In order to complete the effects assessment, conservative SV were derived for PCPPs detected at least once in each media sampled. Derivation of new SV was needed because formal USEPA -approved risk thresholds are not available for most PPCPs owing to the general lack of toxicity data for these chemicals of emerging concern. Therefore, a hierarchical process was identified to select SV for each PPCP that takes maximal advantage of the types and amounts of data available for each chemical. Very few such processes have been developed for PPCPs or other compounds of emerging concern, but the Oregon

[2] For each chemical, the lowest predicted chronic value (ChV) across all test species (fish, daphnids, or algae), all chemical classes, and for both baseline and excess toxicity (excluding values with solubility limit or acute-to-chronic ratio flags) was used for this comparison. The preference was for marine ChVs; however, freshwater ChVs were used if they were the only ones available.

Department of Environmental Quality (ODEQ) recently developed ecological risk thresholds (termed "Initiation Levels") for the state's Priority Persistent Pollutant List (P3L; Hope 2009, Hope et al. 2010). The chemicals included on the Oregon P3L were largely different than those used in the present study because ODEQ's mandate was specifically to evaluate chemically persistent and bioaccumulative chemicals. However, the threshold selection process used by ODEQ was a scientifically robust method for chemicals with limited toxicity databases, and underwent significant public comment and review. Therefore, the ODEQ threshold derivation process was considered to be the most relevant for use with the Gowanus Canal PPCP SLERA.

To select SV, the following information sources were first reviewed for the presence of existing thresholds, which were then compiled (**Table 10**). Next, the hierarchical selection process developed by ODEQ was followed except that the USEPA Maximum Contaminant Levels (MCLs) were not considered since they establish national primary drinking water regulations (USEPA 2009a), and so are not relevant to ecological risk. The hierarchical screening value selection process generally proceeded in decreasing order of overall scientific reliability and relevance using steps 1 -5 below. However, in some limited cases it was determined that a threshold or value from a lower step in the hierarchy was determined to be more relevant ecologically based on the species or endpoints tested. For all PPCPs, the final basis for selecting each screening value is recorded in **Table 10**.

1. **USEPA National Recommended AWQC** – Establish water quality criteria for the protection of aquatic life and human health in surface water (USEPA 2009b). These were considered to be of the highest scientific reliability and relevance to aquatic life protection, and so if criteria existed for any PPCP, this was used for the screening value. If national criteria differed from NYSDEC promulgated criteria, then the NYSDEC value was used. If neither of these criteria were available for any given PPCP, then step 2 of the hierarchy was evaluated for relevant values.
2. **USEPA Office of Pesticide Programs' (OPP) Aquatic Life Benchmarks**– Establish aquatic life benchmarks for freshwater species based on toxicity values reviewed by USEPA and used in the Agency's most recent risk assessments developed as part of the decision-making process for pesticide registration (USEPA 2011a). If no OPP benchmarks were available for a given PPCP, then step 3 of the hierarchy was evaluated for relevant values.
3. **Canadian Council of Minister of the Environment (CCME) Water Quality and Sediment Quality Guidelines for the Protection of Aquatic Life** – Establish nationally endorsed science based goals for the quality of aquatic ecosystems (CCME 2011). If no CCME guidelines were available for a given PPCP, then step 4 of the hierarchy was evaluated for relevant values.

5. **ODEQ P3L Initiation Levels**. Because our selection was modeled after that used by ODEQ, before proceeding to reviewing individual toxicity studies from the literature (step 5), P3L Initiation Levels were checked for any PPCPs that were the same as those used in this SLERA. If no ODEQ Initiation Levels were available for a given PPCP, then step 5 of the hierarchy was followed.
6. **Primary Scientific Literature Review**. For PPCPs without any existing thresholds (i.e., steps 1-4), threshold values were selected from the primary scientific literature as described further below.
7. **USEPA's ECOSAR Model**. If data were not available from steps 1-5, thresholds of toxicity as predicted by USEPA's ECOSAR model (USEPA 2003) were used as SV for the SLERA. This process is described further below.

For PCPPs without existing thresholds (e.g., step 5 above), the primary literature was searched for relevant toxicity data. The starting point for this literature search was a USEPA compilation of "Published Literature Relevant to the Issues Surrounding PPCPs as Environmental Contaminants", which was last updated January 21, 2011 (USEPA 2011b). This list was queried for any papers describing a study of any detected PPCP without existing thresholds, and those papers were obtained and reviewed for relevancy. Studies cited within those papers were also obtained and reviewed for relevancy if they appeared to contain useful information. If USEPA's 2011 reference compilation did not yield any relevant studies, USEPA's ECOTOX database (USEPA 2007) was also searched and any papers not previously identified were obtained and reviewed for relevancy. Relevancy was determined by the following criteria:

- Study examined toxicology of PPCP (i.e., not presence, absence, biotransformation, biodegradation in environmental media, bioaccumulation, or metabolic elimination in exposed organisms)
- Exposure route was aquatic or sediment (i.e., not oral or intraperitoneal injection/other parenteral exposure)
- Exposure was to a single chemical (i.e., not mixtures)
- Species tested was whole organism (i.e., not hepatocyte tests or other *in vitro* system)
- Species tested was freshwater or marine organism (i.e., not terrestrial)

Reliability was not evaluated explicitly since all data were obtained from the peer-reviewed literature and/or a USEPA-generated database. Thus, each study was considered equally, regardless of its "quality".

Although endpoints relating to known ecological impairment (i.e., survival, growth, and reproduction) were the most desirable, many studies only or also reported physiological, biochemical, behavioral and other types of sublethal endpoints (i.e., "biomarkers"). All

studies meeting the initial relevancy criteria, including those with non-traditional sublethal toxicological endpoints, were considered. Key information from each paper (i.e., data describing test organism, exposure regime, resulting endpoints) was then compiled into a database (**Appendix C**), which was used to derive SV. Studies that tested both freshwater and marine organisms were considered since there was an overall paucity of data and the Canal is generally mesohaline. However, priority was given to marine data where possible.

The approach used to derive SV depended on the amount of relevant toxicity data available for a given PPCP. In general, for most of the PPCPs for which information was limited, the sequence described below was followed. In a few cases, many data for several species were available, and so additional screening criteria were applied. When possible, USEPA criteria derivation guidelines (Stephan et al. 1985) were considered when determining if data were acceptable for screening value derivation.

1. Data describing short-term, acute effects (e.g., short-term survival) were separated from those describing long-term, chronic effects (i.e., growth, reproduction, long-term survival). Generally, only short-term survival was considered as an acute endpoint for fish and other aquatic vertebrates, whereas other effects, such as survival, growth, and immobility were considered acute endpoints for certain invertebrates (e.g., sea urchin) and algae.
2. Data describing other non-traditional sublethal endpoints (e.g., physiological, behavioral, and biochemical) were also identified and separated into their own group ("Other Data"). If either acute or chronic data were available, these non-traditional data were not considered further.
3. For the acute and chronic data groups, maximum acceptable toxicant concentrations (MATC) were calculated as the geometric mean of no-observable effect concentration (NOEC) and lowest-observable effect concentration (LOEC) values wherever possible (i.e., where both a NOEC and LOEC were reported for a given endpoint).
4. For each group, calculated and reported results were sorted by species. If multiple MATCs and/or acute or chronic values (e.g., LC_{50}, EC_{10}, LOEC) were available for a given species, species mean acute values (SMAVs) or species mean chronic values (SMCVs) were calculated, as appropriate.
5. For each group, the lowest among the species values was selected as the screening value for the SLERA. The following endpoints were considered unacceptable and were not considered in this step to select the lowest species value:
    - Unbounded NOECs - where no effects were observed even at the highest concentration tested (i.e., NOECs without a paired LOEC)

- Unbounded Effect Concentrations (EC) - where ECs were reported as greater than a value (e.g., EC_{50} >100 microgram per liter (µg/L)
- ECs associated with no effects (EC_0) or complete effects (EC_{100})
- Sublethal (i.e., reproduction, growth) chronic endpoints associated with ECs greater than 25 percent (EC_{25})
- Results based on studies where only one concentration was tested in addition to a negative control

While these unacceptable endpoints were not incorporated into the screening value derivation process explicitly, they were still considered to determine to what extent the selected SV may be under- or over-estimating risk. Additionally, if no data that met these criteria were available, exceptions were allowed and the uncertainties acknowledged so that SV could be derived.

1. If only acute or chronic data were available for a given PPCP, an assessment factor of ten was applied to establish both types of SV (Abt Associates, 1995; USEPA, 1991). Specifically, acute values were divided by ten to derive chronic values and chronic values were multiplied by ten to derive acute values.

If data were not available from the literature, thresholds of toxicity as predicted by USEPA's ECOSAR model (USEPA 2003) were used as SV for the SLERA (step 6 in the hierarchical selection process above). ECOSAR uses structure-activity relationships (SARs) to predict the aquatic toxicity of chemicals based on their similarity in structure to chemicals for which aquatic toxicity has been previously measured. For each chemical, the lowest predicted ChV across all test species (fish, daphnids, or algae), and for all chemical classes with excess toxicity and neutral organic or baseline toxicity (excluding values with solubility limit or acute-to-chronic ratio flags), was used as the screening value. The preference was for marine ChVs; however, freshwater ChVs were used if they were the only ones available.

In general, sediment toxicity data were far less available than those for surface water, so sediment SV could only be derived from available toxicity data for a couple of chemicals. Therefore, to determine the potential for risks to benthic organisms, sediment SV were generally estimated from surface water SV using organic carbon partition coefficients (K_{oc}) and the fraction of organic carbon (f_{oc}) to predict equilibrium partitioning between sediment and overlying water. The calculations followed procedures outlined in USEPA Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESB) for the Protection of Benthic Organisms: Compendium of Tier 2 Values for Non-ionic Organics (USEPA 2008a). It is important to note that PPCP chemicals were not included among the 32 narcotic, nonionic, organic chemicals used to derive the methodology in the USEPA (2008a) document, and so the theory governing the ESB approach was assumed to apply to each of the PPCPs for which sediment SV were modeled. The extent to which this is actually the case is unknown, so these benchmarks are somewhat uncertain. K_{oc} values were

estimated using KOCWIN in USEPA's EpiSuite model (USEPA 2011c), and f_{oc} was held constant at the site-wide average of total organic carbon (0.054) measured in canal sediments by USEPA (2011d).

5.3.2 Results

The final SV are compiled in **Table 10**. Additionally, for each chemical, the data used and screening value-derivation process employed are described in **Appendix B**. The corresponding database of information obtained from the literature search is provided in **Appendix C**.

5.4 Risk Characterization

For the risk characterization, a hazard quotient (HQ) approach was followed wherein the EPCs developed in the exposure assessment were compared to the SV developed in the effects assessment per the measurement endpoints identified in the problem formulation:

$$HQ = EPC / SV,$$

where:

HQ = hazard quotient,
EPC = exposure point concentration, and
SV = screening value.

For a given PPCP, if the ratio of these two values was greater than one, there is the potential for risk due to direct contact with that chemical. If the HQ was less than one, risk is not anticipated.

HQs were calculated for each PPCP detected at least once among all of the samples collected for a given media type (CSO water, canal surface water, and canal sediment). The potential for ecological risks to each receptor species (pelagic fish, benthic fish, plants, zooplankton, epibenthic invertebrates, and benthic invertebrates) was then determined based on the media to which each receptor is likely exposed and the level of protection desired (i.e., survival [acute SV], growth and reproduction [chronic SV]), consistent with the measurement endpoints.

Canal surface water and sediment samples were divided into two groups, defined by the active discharge from the CSO nearest the sampling locations (Wet Event) or the absence of active discharge (Dry Event). CSO water samples were divided into groups based on sample date (Wet Event 1: July 13, 2010; Wet Event 2: September 28, 2010; Wet Event 3: September 30 – October 1, 2010). All CSO water data analyzed for PCPPs of interest for

this SLERA were collected during Wet Events, defined by the observed presence of active discharge of CSO water to the canal.

The risk characterization is shown in **Tables 11** through **17**. For each media, the following chemicals listed in **Table 18** had ChV or acute value (AV) HQs greater than one. Data are not presented for canal surface water collected during the dry event because no PPCPs exceeded either their acute or chronic SV for this media. The same is true for acute SV for canal surface waters collected during the wet event and acute SV for canal sediments collected during both the wet and dry event.

Table 18 - PPCPs with ChV and AV HQs greater than one, by media and sampling event

	CSO Water						Canal Surface Water	Canal Sediment	
	ChV HQ			AV HQ			ChV HQ	ChV HQ	ChV HQ
	Event 1 (n=4)	Event 2 (n=2)	Event 3 (n=9)	Event 1 (n=4)	Event 2 (n=2)	Event 3 (n=9)	Wet Event (n=2)	Dry Event (n=8)	Wet Event (n=2)
Nonylphenol	15.882	5.294	14.118	3.857	1.286	3.429	3.176	9.100	7.600
Nonylphenol Diethoxylate	5.882	-	-	1.429	-	-	-	-	-
Nonylphenol Monoethoxylate	2.941	5.000	-	-	1.214	-	-	9.300	-
Estradiol	1.050	-	-	-	-	-	-	5.429	-
alpha-Estradiol	-	-	-	-	-	-	-	1.347	-
Estriol	1.100	4.600	4.700	-	-	-	-		-
Fluoxetine	-	-	-	-	-	-	-	33.333	-
Ammonia	5.481	3.370	1.593	-	-	-	-	-	-

- Not Applicable

The following sections present the results of the risk characterization for each of the assessment endpoints identified in problem formulation. This information is also summarized in **Table 19**.

5.4.1 Assessment Endpoint 1

The assessment endpoint for pelagic fish was as follows:

> *Survival of pelagic fish populations in the canal.*

The measurement endpoint associated with this assessment endpoint was as follows:

> *Comparison of canal surface water and CSO water concentrations to acute screening values.*

Canal surface water HQs calculated using acute SV were all below one, indicating no potential for risk to the survival of pelagic fish due to PPCP exposure in canal surface water.

CSO water HQs calculated using acute SV for Nonylphenol, Nonylphenol Diethoxylate, and Nonylphenol Monoethoxylate were all greater than one. Therefore, these PCPPs were detected at concentrations in CSO water that pose potential for risk to the survival of pelagic fish.

5.4.2 Assessment Endpoint 2

The assessment endpoint for benthic fish was as follows:

> *Survival of benthic fish populations in the canal.*

The measurement endpoint associated with this assessment endpoint was as follows:

> *Comparison of canal surface water, CSO water, and canal sediment concentrations to acute screening values.*

Canal surface water and sediment HQs calculated using acute SV were all below one, indicating no potential for risk to the survival of benthic fish due to PPCP exposure in canal surface water or sediment.

CSO water HQs calculated using acute SV for Nonylphenol, Nonylphenol Diethoxylate, and Nonylphenol Monoethoxylate were all greater than one. Therefore, these PCPPs were detected at concentrations in CSO water that pose the potential for risk to the survival of benthic fish.

5.4.3 Assessment Endpoint 3

The assessment endpoint for plants, zooplankton, and epibenthic invertebrates was as follows:

> *Survival, growth and reproduction of plants, zooplankton, and epibenthic invertebrates in the canal.*

The measurement endpoint associated with this assessment endpoint was as follows:

> *Comparison of canal surface water and CSO water concentrations to acute and chronic screening values.*

Canal surface water HQs calculated using acute SV were all below one, indicating no potential for risk to the survival of plants, zooplankton, or epibenthic invertebrates due to PPCP exposure in canal surface water. Canal surface water HQs calculated using chronic SV were all below one except for Nonylphenol, indicating this is the only PPCP among those evaluated that poses the potential for risk to the growth and reproduction of plants, zooplankton, and epibenthic invertebrates.

CSO water HQs calculated using acute SV for Nonylphenol, Nonylphenol Diethoxylate, and Nonylphenol Monoethoxylate were all greater than one. Therefore, these PCPPs were detected at concentrations in CSO water that pose the potential for risk to the survival of plants, zooplankton, and epibenthic invertebrates. CSO water HQs calculated using chronic SV for Nonylphenol, Nonylphenol Diethoxylate, Nonylphenol Monoethoxylate, Estradiol, Estriol, and Ammonia were all greater than one. Therefore, these PCPPs were detected at concentrations in CSO water that pose the potential for risk to the growth and reproduction of plants, zooplankton, and epibenthic invertebrates.

5.4.4 Assessment Endpoint 4

The assessment endpoint for benthic invertebrates was as follows:

> *Survival, growth and reproduction of benthic invertebrates in the canal.*

The measurement endpoint associated with this assessment endpoint was as follows:

> *Comparison of canal surface water, CSO water, and canal sediment concentrations to acute and chronic screening values.*

Canal surface water HQs calculated using acute SV were all below one, indicating no potential for risk to the survival of benthic invertebrates due to PPCP exposure in canal surface water. Canal surface water HQs calculated using chronic SV were all below one

except for Nonylphenol, indicating this is the only PPCP among those evaluated that poses the potential for risk to the growth and reproduction of benthic invertebrates.

CSO water HQs calculated using acute SV for Nonylphenol, Nonylphenol Diethoxylate, and Nonylphenol Monoethoxylate were all greater than one. Therefore, these PCPPs were detected at concentrations in CSO water that pose the potential for risk to the survival of benthic invertebrates. CSO water HQs calculated using chronic SV for Nonylphenol, Nonylphenol Diethoxylate, Nonylphenol Monoethoxylate, Estradiol, Estriol, and Ammonia were all greater than one. Therefore, these PCPPs were detected at concentrations in CSO water that pose the potential for risk to the growth and reproduction of benthic invertebrates.

Canal sediment HQs calculated using acute SV were all below one. Canal sediment HQs calculated using chronic SV for Nonylphenol, Nonylphenol Monoethoxylate, alpha-Estradiol, Estradiol, and Fluoxetine were all greater than one. Therefore, these PCPPs were detected at concentrations in canal sediment that pose the potential for risk to the growth and reproduction of benthic invertebrates.

Table 19 - Summary of Risk Characterization

Assessment Endpoint		Measurement Endpoint Components		Risk Characterization Results*	
		Measure of Exposure	Measure of Effect	Acute SV HQ>1	Chronic SV HQ>1
1	Survival of pelagic fish populations in the Canal	Maximum PPCP concentrations in Canal surface water and CSO water	Exceedance of surface water and CSO water acute SVs	Canal surface water • No Exceedances CSO water • Nonylphenol (1.286 – 3.857) • Nonylphenol Diethoxylate (1.429) • Nonylphenol Monoethoxylate (1.214)	Not applicable
2	Survival of benthic fish populations in the Canal	Maximum PPCP concentrations in Canal surface water, CSO water, and Canal sediment	Exceedance of surface water, CSO water, and sediment acute SVs	Canal surface water • No Exceedances CSO water • Nonylphenol (1.286 – 3.857) • Nonylphenol Diethoxylate (1.429) • Nonylphenol Monoethoxylate (1.214) Canal sediment • No Exceedances	Not applicable
3	Survival, growth, and reproduction of plants, zooplankton, and epibenthic invertebrates in the Canal	Maximum PPCP concentrations in Canal surface water and CSO water	Exceedance of surface water and CSO water acute and chronic SVs	Canal surface water • No Exceedances CSO water • Nonylphenol (1.286 – 3.857) • Nonylphenol Diethoxylate (1.429) • Nonylphenol Monoethoxylate (1.214)	Canal surface water • Nonylphenol (3.176) CSO water • Nonylphenol (5.294 – 15.882) • Nonylphenol Diethoxylate (5.882) • Nonylphenol Monoethoxylate (2.941 – 5.000) • Estradiol (1.050) • Estriol (1.100 – 4.700) • Ammonia (1.593 – 5.481)
4	Survival, growth, and reproduction of benthic invertebrates in the Canal	Maximum PPCP concentrations in Canal surface water , CSO water, and Canal sediment	Exceedance of surface water, CSO water, and sediment acute and chronic SVs	Canal surface water • No Exceedances CSO water • Nonylphenol (1.286 – 3.857) • Nonylphenol Diethoxylate (1.429) • Nonylphenol Monoethoxylate (1.214) Canal sediment • No Exceedances	Canal surface water • Nonylphenol (3.176) CSO water • Nonylphenol (5.294 – 15.882) • Nonylphenol Diethoxylate (5.882) • Nonylphenol Monoethoxylate (2.941 – 5.000) • Estradiol (1.050) • Estriol (1.100 – 4.700) • Ammonia (1.593 – 5.481) Canal Sediment • Nonylphenol (7.600 – 9.100) • Nonylphenol Monoethoxylate (9.300) • alpha-Estradiol (1.347) • Estradiol (5.429) • Fluoxetine (33.333)

*Range of hazard quotients (HQs) calculated across multiple events, where applicable, is included in parentheses following PPCP.

5.5 Uncertainty Analysis

Estimates of risk in any ecological risk assessment inevitably contain a level of uncertainty. Risk estimates are based on a number of assumptions regarding exposure and effects. Sources of uncertainty include, but are not limited to, sampling error, the representative nature of the chosen sampling locations, data analyses, the conceptual site model, representativeness of SV, and natural variation (USEPA 1998). A thorough understanding of the uncertainties associated with risk estimates is critical to understanding predicted risks and placing them in proper perspective for risk management. Important sources of uncertainty associated with each component of this SLERA are presented below, along with the potential implications on the outcome of the risk characterization.

5.5.1 Uncertainties Associated with Problem Formulation

Only risks due to direct contact exposure were estimated in this SLERA. However, it is expected that wildlife may also be exposed to PPCPs via the food web and many receptors may also be exposed via bioaccumulation pathways. Since neither dietary nor bioaccumulation exposure was addressed herein, the potential for ecological risks to wildlife receptors as well as any receptors expected to bioaccumulate PPCPs was not estimated and should be considered in future investigations.

Plants, zooplankton, and epibenthic invertebrates were grouped together within one assessment endpoint, with the associated measurement endpoint being comparison of canal surface water and CSO water concentrations to acute and chronic SV. The receptors included in this group have broad life histories, as well as physiological and behavioral differences. For example, epibenthic invertebrates may burrow in sediments while overwintering; therefore additional exposure media (i.e., sediments) not considered in this measurement endpoint may be relevant to this receptor. Although the amount of time epibenthic invertebrates may be exposed to sediments is expected to be minimal, the potential for risk to this receptor may have been underestimated in the SLERA.

Additionally, the potential for ecological risk was determined using SV that were not necessarily receptor-specific. That is, aquatic SV were used to estimate the specific likelihood for risk to pelagic and benthic fish, plants, zooplankton, and epibenthic and benthic invertebrates, although the SV were derived based on all of the available data in the literature. The SV were further based on the most sensitive species identified, and so depending on whether or not these species are expected to be more or less sensitive than the receptors being evaluated in this SLERA, the potential for ecological risks may have been either under or overestimated.

5.5.2 Uncertainties Associated with Exposure Assessment

Detection Limits

Reporting limits of non-detected chemicals were compared to model-predicted thresholds for aquatic toxicity as estimated by USEPA's ECOSAR model (USEPA 2003). All of the reporting limits were well below ECOSAR-predicted toxicity thresholds and so analytical detection limits were likely low enough to detect concentrations that might impose ecological risk. However, the true potential for ecological risks associated with PCPPs that were below reporting limits cannot be fully evaluated and, consequently, risks associated with these chemicals may have been either under or overestimated in the SLERA.

Exposure Point Concentrations

The exposure point concentrations used in the SLERA were defined as maximum detected concentrations observed within each media. Though this conservative approach is consistent with a screening-level assessment, it does not take into account differences across spatial and temporal gradients. Additionally, CSO grab samples were used to represent maximum possible EPCs in canal surface waters specifically to provide a conservative estimate of exposure. Therefore, the risks associated with detected PCPPs may have been overestimated in the SLERA.

5.5.3 Uncertainties Associated with Effects Assessment

Overall process

Lack of consideration of study reliability represents an uncertainty in the overall screening value derivation process. Although all data were obtained from the peer-reviewed primary literature and/or a USEPA-generated database, some data may be considered "higher quality" than others, depending on the reliability criteria used to make such a determination. Thus risks associated with HQ exceedances of SV based on "low quality" data may have been over or underestimated in the SLERA.

Additionally, it may be useful to further refine the process by grouping the compounds by known information about mode of action and likely effects on non-target organisms. For example, antibiotics typically are more toxic to unicellular organisms such as algae than to fish, while antiparasitics are more toxic to invertebrates. Because mode of action was not considered explicitly in the SLERA, the impacts of this uncertainty on the risk characterization are unknown.

Literature-derived Screening Values

For many PCPPs, few acute or chronic data points from toxicity studies were identified. It is possible, especially for PCPPs with few available data, that the derived screening value may be over or underconservative. That is, when few data are available to allow comparisons among and within species, it is unknown whether the reported toxicity values represent

values that are higher or lower than what would be expected for the most sensitive species. In addition, when data are only available for a single endpoint (e.g., juvenile growth, frequency of deformities, reproductive success), it is unknown whether this endpoint is a relatively sensitive or tolerant endpoint for a given species.

Another source of uncertainty related to the aquatic screening value derivation process was the lack of evaluation of water quality parameters reported with toxicity values. That is, there is uncertainty whether certain water quality parameters may increase or decrease the toxicity of a given PPCP. Therefore, the impacts of this uncertainty to the risk characterization are unknown.

ESB-derived Sediment Screening Values

Sediment SV were generally estimated from surface water SV using K_{oc} and the f_{oc} to predict equilibrium partitioning between sediment and overlying water. The calculations followed procedures outlined in USEPA Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks for the Protection of Benthic Organisms: Compendium of Tier 2 Values for Non-ionic Organics (USEPA 2008a). It is important to note that PPCP chemicals were not included among the 32 narcotic, nonionic, organic chemicals used to derive the methodology in the USEPA (2008a) document, and so the theory governing the ESB approach was assumed to apply to each of the PPCPs for which sediment SV were modeled. The extent to which this is actually the case is unknown, and so these benchmarks are somewhat uncertain. According to the USEPA (2008a) guidance document: "The EqP approach assumes that:

1. the partitioning of the chemical between sediment organic carbon and interstitial water is at or near equilibrium;
2. the concentration in either phase can be predicted using appropriate partition coefficients and the measured concentration in the other phase (assuming the freely-dissolved interstitial water concentration can be accurately measured);
3. Organisms receive equivalent exposure from water-only exposures or from any equilibrated phase: either from interstitial water via respiration, from sediment via ingestion or other sediment integument exchange, or from a mixture of exposure routes;
4. for nonionic chemicals, effect concentrations in sediments on an organic carbon basis can be predicted using the K_{OC} and effects concentrations in water;
5. the screening level concentration is an appropriate effects concentration for freely-dissolved chemical in interstitial water; and
6. ESBs derived as the product of the K_{OC} and screening level are protective of benthic organisms."

Potential violations of these assumptions introduce uncertainties associated with ESB_{Tier2}-predicted SV. Beyond consideration of method assumptions, uncertainties include the

unknown effects of antagonism, synergism and additivity, occurrence of chemical disequilibria, and presence of unusual types of sedimentary carbon (i.e., black carbon or large particles). Uncertainties for the ESB_{Tier2} values can be reduced by conducting additional acute and chronic water-only and spiked sediment toxicity tests to refine water-only effect concentrations and confirm predictions of sediment toxicity, respectively. It is uncertain whether estimation of the sediment SV using this approach resulted in the under- or overestimation of risks in the SLERA.

EpiSuite Modeled Parameters and Screening Values

ECOSAR and WINKOC, two programs contained within USEPA EPISuite (USEPA 2011c), were used in the SLERA to provide environmental fate estimations based on physical/ chemical properties of PCPPs. Overall, as identified by USEPA, these screening-level methods of prediction are based on general chemical properties and, therefore, have inherent uncertainties. In particular, ECOSAR was developed for industrial chemicals and is based upon octanol-water partition coefficient (K_{ow}), whereas the term octanol-water distribution coefficient (D_{ow})is more applicable for many PPCPs. Using ECOSAR, Madden et al. (2009), ranked the likelihood of pharmaceuticals falling within the applicability domain of the SAR for a particular class of compound on a scale of one to three, with three indicating the lowest confidence of predictability of the SAR. In their analysis, many of the chemicals evaluated in this SLERA were ranked three. However, it is important to note that only for two PPCPs (i.e., iopromide and pentoxifylline) was it necessary to use ECOSAR-based SV. Nevertheless, measured data from properly conducted studies should be used over EPISuite predicted values where possible. Therefore, the risks associated with EpiSuite modeled parameters and SV PCPPs may have been either under or overestimated.

5.6 Conclusions

This SLERA provides a preliminary evaluation of the potential for ecological risks in the Gowanus Canal due to PPCP and ammonia exposure. Summaries of the risk characterization results are provided in **Tables 18** and **19**. Overall, many PPCPs were not detected in canal surface water, canal sediments, or CSO water. The majority of HQs calculated for detected PPCPs were less than one, indicating that most PCPPs have no potential for risk to ecological receptors.

In particular, canal surface water HQs calculated using acute SV were all less than one, indicating no potential for risk to the survival of pelagic and benthic fish, plants, zooplankton, and epibenthic and benthic invertebrates due to PPCP exposure in canal surface water. However, canal surface water HQs calculated using chronic SV were greater than one for:

- Nonylphenol

Therefore this PPCP was detected at concentrations in canal surface water that pose the potential for ecological risks, particularly to the growth and reproduction of plants, zooplankton, and epibenthic and benthic invertebrates.

Canal sediment HQs calculated using acute SV were also all less than one although canal sediment HQs calculated using chronic SV were greater than one for:

- Nonylphenol
- Nonylphenol Monoethoxylate
- alpha-Estradiol
- Estradiol
- Fluoxetine

Therefore, these PPCPs were detected at concentrations in canal sediment that pose the potential for ecological risks, particularly to the growth and reproduction of benthic invertebrates.

Finally, CSO water contained the greatest number of HQs greater than one. CSO water HQs calculated using acute SV were greater than one for:

- Nonylphenol
- Nonylphenol Diethoxylate
- Nonylphenol Monoethoxylate

Therefore, these PPCPs were detected at concentrations in CSO water that pose the potential for ecological risk to the survival of pelagic and benthic fish, plants, zooplankton, and epibenthic and benthic invertebrates. In addition, CSO water HQs calculated using chronic SV were greater than one for:

- Nonylphenol
- Nonylphenol Diethoxylate
- Nonylphenol Monoethoxylate
- Estradiol
- Estriol
- Ammonia

Therefore, these chemicals were detected at concentrations in CSO water that pose the potential for ecological risk to the growth and reproduction of plants, zooplankton, and epibenthic and benthic invertebrates.

The conclusions drawn in this SLERA indicate a potential for adverse ecological effects primarily from the PPCPs listed above in canal sediment and CSO water. It is important to note that, while only these few PPCPs were determined to pose the potential for ecological risks, there was a relatively high degree of confidence in the SV for most of these same PPCPs. For example, USEPA AWQC were used as the aquatic SV for nonylphenol and its ethoxylates (USEPA 2005) as well as ammonia (USEPA 1989); CCME sediment quality

guidelines were used as the sediment SV for nonylphenol and its ethoxylates (CCME 2011); estradiol and alpha-estriadiol aquatic SV were derived from an extensive USEPA data compilation (USEPA 2008b); and the fluoxetine aquatic and sediment SV were based on toxicity data from a large number of papers (**Appendix B** and **C**) from the primary literature. Only the sediment SV for estradiol and estriol, which were predicted using ESB theory, and the aquatic SV for estriol, which were based on very little data (**Appendix B** and **C**), were considered to be of lower confidence.

The PPCPs (along with ammonia) identified above can, therefore, be considered COPCs and a more rigorous investigation of these contaminants in canal sediment and CSO water would be needed to more fully understand the likelihood for ecological risk to the receptors expected to come into direct contact with these media.

6. Human Health Risk Assessment

This screening level HHRA presents a preliminary screening level evaluation of the potential for human health risks from exposure to pathogens, PPCPs, free cyanide, and ammonia in the Gowanus Canal. Specifically, this screening level HHRA evaluated the potential for adverse human health effects from exposure to detected concentrations of pathogens, PPCPs, free cyanide and ammonia in Gowanus Canal sediment, surface water and CSO water. Analytical data for PPCPs and pathogens used in this screening level HHRA are described in Section 3 (Sampling and Analysis) and summarized in Section 4 (Summary of Observations and Findings) of this report. This assessment of human health risk was prepared in accordance with risk assessment guidance developed by USEPA (2008c).

6.1 Background

The vast majority of the canal is bordered by industrial and commercial properties. Residential neighborhoods are present within approximately two blocks of the canal along most of its length. The presence of industrial and commercial properties bordering the length of the canal limit the potential for land-side access to the canal; however, a number of streets dead-end at the canal, which provide points of access to the canal including a canoe/kayak launch at one location. Under current land use, the Gowanus Canal is used for recreational purposes, including canoeing, swimming/diving, and fishing. As stated in the USEPA RI Report (USEPA, 2011a), there are fish consumption advisories for the Gowanus Canal; however, there are no warning signs describing the fish-consumption advisories posted along the canal. Signs are posted at CSO outfalls with a phone number to call for information. According to the USEPA RI Report (USEPA, 2011a), caution signs are posted at CSO discharges that state during wet weather the CSOs may discharge harmful bacteria to the canal and that people should not swim, boat, or fish during these periods.

PPCPs enter waste water through: flushing unused medications down the toilet or sink; excreting unabsorbed medications into the sewage system; and commercial improper disposal methods, while other chemicals enter wastewater as a result of residential household use (Anderson et al., 2008). For example, nonylphenol and nonylphenol ethoxylates are used in detergents and cleaning products while bisphenol A is used in plastic food and drink containers. Bisphenol A, nonylphenol, nonylphenol ethoxylates, and many of the PPCPs evaluated in this screening level HHRA are classified as EDCs. Compounds classified as endocrine disruptors can mimic the body's own hormones. As a result, exposure to EDCs may result in adverse health effects. This risk assessment focused on the three exposure media most likely impacted by PCPP contamination linked to CSO discharges to Gowanus Canal. These exposure media included water samples collected from the combined sewer

system that discharge into the canal, and surface waters and sediments collected near each corresponding CSO discharge point.

6.2 Hazard Identification

The Hazard Identification section summarizes the type and concentrations of PPCPs and pathogens detected in sediment, surface water, and CSO water in Gowanus Canal. Summary statistics for PPCPs and pathogens analytical data included in the risk assessment are presented in **Tables 8** and **9**. PPCP results below detection limits are referred to as non-detects. We conservatively assumed that PPCPs not detected in a sample were present at the detection limit for the purpose of calculating summary statistics. A total of 28 PPCPs were detected in Gowanus Canal sediment, surface water, and CSO water, with the highest number of PPCPs detected in CSO water. Pathogens were also detected in canal surface water, sediment and CSO water, with the highest concentrations detected in CSO water.

All PPCPs and pathogens detected at least once in sediment, surface water, or CSO water and ammonia were evaluated in this screening level HHRA. Free cyanide was not evaluated because it was not detected in any media of concern. PPCPs that were never detected in any media were not evaluated further in this screening level HHRA. PPCPs and pathogens included as COPCs in this assessment in sediment, surface water, and CSO water are presented in **Table 20**.

6.3 Exposure Assessment

The types of human populations (i.e., receptors) that may come into contact with COPCs and pathogens present in sediment, surface water and CSO water in Gowanus Canal are identified and described below. This screening level HHRA presents a separate risk characterization for pathogens in canal sediment, surface water, and CSO water because of the differences between exposure to pathogens and chemicals and resulting risk. Risk from exposure to pathogens is characterized by the probability of infection, which depends on a person's immune system. In addition, infected individuals may not have symptoms and different pathogens have different abilities to cause disease, which can evolve and change as the pathogen passes through various infected individuals (World Health Organization (WHO), 2009).

This chemical exposure assessment consists of several steps. First, potentially complete exposure pathways and exposure profiles are characterized for each human receptor. Next, exposure scenarios are developed to represent conservative estimates of exposure by sensitive receptor groups. These scenarios describe the specific amount, frequency, duration, and route of each receptor group's exposure to each chemical COPC. The exposure scenario and EPCs for each chemical COPC are then integrated to yield exposure doses. Exposure

doses are not calculated for pathogens because pathogens are evaluated separately in the risk characterization based on a comparison to AWQC for human health.

It should be noted that even though CSO water was collected from within the CSO collection system where there would be very limited human exposure (i.e., workers conducting maintenance or sampling), we used CSO grab samples as EPCs to represent exposure concentrations that could occur in the canal immediately adjacent to the CSO outfall during a significant discharge event. The EPCs from CSO samples thus represent a conservative estimate of the maximum possible exposure of human receptor groups to PPCPs and pathogens in the canal. This was also important because most grab samples were taken during dry conditions when the CSOs were not discharging, so there was no other means of estimating maximum EPCs that could occur in canal surface water during significant wet discharge events.

6.3.1 Identification of Human Receptor Populations under Current and Future Site Activities and Uses

Human receptor populations and their potential exposures to COPCs in sediment, surface water, and CSO water are described below. The Gowanus Canal is used for recreational activities such as boating, swimming/diving, fishing, and crabbing. In addition, workers are present at the canal associated with the following: industrial and commercial activities along the canal; commercial barge activity; utility and construction activities at bulkheads along the canal; and remediation and dredging activities along the canal. Future use of the canal is likely to remain the same as current use (USEPA, 2011a). Therefore, the human receptor populations evaluated in this screening level HHRA include a child recreational visitor and an adult recreational visitor exposed to COPCs in sediment, surface water, CSO water, and fish and an outdoor worker exposed to COPCs in sediment.

6.3.2 Exposure Scenarios

In the following, we describe potential exposure pathways for a child and adult recreational visitor evaluated in this assessment:

A child and adult recreational visitor at Gowanus Canal may be exposed to sediment, surface water, and CSO water while visiting the canal. We evaluated a 0 to 6-year old child exposed to sediment, surface water and CSO water for 2.6 hours per day, 26 days per year (which equates to 1 day a week for the 6 warmer months), for 6 years; and an adult exposed to sediment, surface water, and CSO water for 2.6 hours per day, 26 days per year for 30 years (USEPA, 2011a). We evaluated both a child's and adult's exposure to COPCs in sediment from incidental ingestion and dermal absorption; surface water from incidental ingestion; and CSO water from incidental ingestion. We also evaluated a child's and adult's exposure to

COPCs from consumption of fish. We assumed a child and adult visitor consumed fish caught in the Gowanus Canal 365 days per year (USEPA, 2011a).

6.3.3 Exposure Point Concentrations

An exposure point refers to a location of potential contact between a human receptor and contamination. We evaluated the following exposure points:

- Sediment
- Surface water
- CSO water
- Fish consumption

We assumed that a child and adult recreational visitor may be exposed to COPCs in sediment, surface water, CSO water, and fish in Gowanus Canal. We evaluated these media as separate exposure points.

We set exposure point concentrations equal to maximum detected concentrations for each PPCP in sediment, surface water, and CSO water, consistent with a screening level evaluation. We modeled EPCs for fish tissue using maximum detected concentrations of COPCs in surface water and CSO water based on and available COPC specific bio-concentration factors (BCFs). Calculated EPCs for each COPC are presented in **Table 20** for sediment, surface water, and CSO water.

6.3.4 Quantitative Estimates of Exposure

Quantitative exposure estimates represent the average daily exposure to each COPC by a receptor for each exposure pathway. Average daily exposures are averaged over 6 years for a child recreational visitor and 30 years for an adult recreational visitor. Doses for ingestion and dermal pathways are presented in this risk characterization as a daily dose rate per unit body weight (BW) (milligrams per kilogram per day [mg/kg-day]). The "Average Daily Dose" (ADD) was used to quantify exposure doses for the ingestion and dermal pathways. General equations for exposure estimates are the same for the child and adult recreational visitor for each exposure route. However, the exposure assumptions used to describe contact with COPCs for these receptors are different. Exposure assumptions for a child and adult recreational visitor are presented in **Table 21**. These factors are based on guidance from USEPA, including the Baseline Risk Assessment for Gowanus Canal prepared as part of the RI (USEPA, 2011a). The following equations were used to quantify exposure.

Incidental Ingestion of Sediment

The ADD in units of milligrams/kilograms-day (mg/kg-day) was calculated for incidental ingestion of sediment using the following equation:

$$ADD = \frac{EPC \times IRs \times EF \times ED \times CF}{BW \times AT}$$

where:

EPC = Chemical Concentration in Sediment (mg/kg)
IRs = Daily Sediment Ingestion Rate (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
CF = Units Conversion Factor (1×10^{-6} kg/mg)
BW = Body Weight (kg)
AT = Averaging Time (days)

Incidental Ingestion of Surface Water and CSO Water

The ADD in units of mg/kg-day was calculated for incidental ingestion of surface water and CSO water using the following equation:

$$ADD = \frac{EPC \times IRw \times EF \times ED \times CF}{BW \times AT}$$

where:

EPC = Chemical Concentration in Water (ug/L)
IRw = Daily Water Ingestion Rate (L/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
CF = Units Conversion Factor (1×10^{-3} mg/ug)
BW = Body Weight (kg)
AT = Averaging Time (days)

Dermal Contact with Sediment

The ADD in units of mg/kg-day was calculated for dermal absorption of sediment using the following equation:

$$ADD = \frac{EPC \times SA \times AF \times ABSd \times EF \times ED \times CF}{BW \times AT}$$

where:

EPC = Chemical Concentration in Sediment (mg/kg)
SA = Skin Surface Area Exposed (cm^2/day)
AF = Sediment to skin Adherence Factor (mg/cm^2)
ABSd = Dermal Absorption Factor (unitless)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
CF = Units Conversion Factor (1×10^{-6} kg/mg)
BW = Body Weight (kg)
AT = Averaging Time (days)

Ingestion of Fish

The ADD in units of mg/kg-day was calculated for ingestion of fish using the following equation:

$$ADD = \frac{EPC \times IRf \times EF \times ED \times BCF \times CF}{BW \times AT}$$

where:

EPC = Chemical Concentration in Water (ug/L)
IRs = Daily fish Ingestion Rate (kg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BCF = Bio-concentration Factor (L/kg))
CF = Units Conversion Factor (1×10^{-3} mg/ug)
BW = Body Weight (kg)
AT = Averaging Time (days)

6.4 Health Endpoint Assessment

The Health Endpoint Assessment results in a quantitative estimate or index of toxicity for each COPC. This risk assessment used the Acceptable Daily Intake (ADI) to estimate toxicity for each COPC, with the exception of pathogens, which are discussed below in Sub-section 6.4.1. For some COPCs, surrogate ADIs were calculated using the Lowest Daily Therapeutic Dose (LDTD) divided by safety factors. The ADI represents an estimate of the

daily amount of a chemical that can be ingested for a lifetime that should not result in an adverse health effect in a population, including particularly sensitive individuals (USEPA, 2008c). However, for PPCPs, the process of developing ADIs recognizes that a certain amount of risk in the form of side effects may be acceptable to receive the therapeutic benefits. This is not the case for incidental exposure to PPCPs in recreational water or through fish consumption, where therapeutic effects are considered undesirable in the exposed individuals. Therefore, safety factors are applied to LDTDs to derive an ADI for which there is reasonable certainty that no effect will occur.

ADIs or LDTDs for each COPC were identified in the literature. LDTDs are generally available from pharmaceutical databases. This screening level HHRA conservatively used the lowest ADI value identified in the literature when more than one ADI was identified for a COPC. Varying ADIs for a COPC are presented in the literature because different safety factors were applied depending on the study. LDTDs were divided by safety factors ranging from 1,000 to 10,000. In one study, LDTDs were divided by a safety factor of 10,000 (IL USEPA, 2008c). This safety factor of 10,000 took into account the following four safety factors each with a value of 10: extrapolation from a lowest observed effect level (LOEL) to a no observed effect level (NOEL); intra-human variability (adult vs. children); short-term vs. long-term effects; and therapeutic use vs. non-therapeutic need. A different study divided LDTDs by a safety factor ranging from 1,000 to 10,000 (Australian Guidelines, 2008). The safety factor of 1,000 consisted of a 10-fold factor for sensitive humans, a 10-fold factor for infants and children, and a 10-fold factor for extrapolation from a LOEL to a NOEL. An additional 10-fold factor was applied for hormonally active steroids, on the grounds that potential effects on hormonal function and fertility are unwanted in those not being treated. A third study used varying safety factors ranging from 1 to 100 depending on the adequacy of the data (Schwab et al., 2005). For COPCs with no derived ADI, the maximum recommended therapeutic dose divided by a safety factor of 10,000 was used as a surrogate ADI. An ADI was not identified for oxybenzone, a PPCP used in sunscreen. Because this COPC is applied dermally, therapeutic doses based on ingestion are not readily available.

The ADI approach used to assess risk to human health in this assessment does not take into account differing mechanisms of action of the pharmaceuticals. ADIs may be based on either cancer or non-cancer endpoints. The uncertainty associated with this approach is discussed in Sub-section 6.6. **Table 22** presents ADIs and BCFs for each COPC evaluated in this screening level HHRA. BCFs were calculated using USEPA (2010b) Estimation Programs Interface (EPI). Specifically, the BCFBAF program was used to estimate BCF values using chemical-specific Kow values.

6.4.1 Pathogens

Analytical results for pathogens in sediment, surface water and CSO water were compared to USEPA AWQC for human health derived for recreational use of marine waters in order to characterize risk from exposure to pathogens. According to USEPA (1986), Enterococcus is the indicator organism used to screen bacterial contamination in marine waters. The human health AWQC for marine water is based on an acceptable swimming associated gastro-enteritis rate of 19 cases per 1,000 swimmers. The AWQC for human health are developed to be protective of both adults and children. In general, children and the ederly are at a greater risk of developing life-threatening complications associated with exposure to pathogens from recreational waters.

Marine water AWQC are available for enterococci and fecal coliform, which are used as bacterial pathogen indicators by USEPA. For enterococci and fecal coliform, marine water AWQC are available for comparison to the geometric mean concentration based on not less than 5 samples spaced over a 30-day period. In addition, for enterococci, marine water AWQC are available for comparison to a measured single sample maximum concentration identified for a range of recreational water contact. Only fresh water AWQC are available for *Escherichia coli*. USEPA has not developed AWQC for viral pathogens, including *Giardia*, detected in surface water and CSO water; *Clostridium perfringes* detected in sediment, surface water, and CSO water; or coliphage detected in surface water and CSO water, discussed further in the Uncertainty Section (6.6).

In accordance with USGS (2010), we assumed that bacterial densities in 100 milliliters of water and 100 grams of sediment were equal in order to compare analytical results for bacterial densities in water and sediments and characterize risk. Therefore, analytical results for enterococci and fecal coliform in sediment were converted from CFU per gram sediment to CFU per 100 grams sediment, which was assumed to equal a water density in units of CFU per 100 mL. These sediment results were then compared to AWQC for human health to characterize risk from exposure to pathogens in sediment.

6.4.2 Route-to-Route Extrapolation

ADIs based on oral exposure were used to evaluate dermal exposure to chemical COPCs in sediment, consistent with USEPA guidance (1989). Following the absorption of chemicals via the oral or dermal routes, their distribution, metabolism, and elimination patterns (biokinetics) are usually assumed independent of the route of absorption. However, in order to use oral toxicity values (i.e., extrapolate toxicological effects from the oral route to the dermal route), it is necessary to adjust the estimated dermal absorbed dose to account for differences in a chemical's absorption between the oral and dermal routes of exposure. For this screening level HHRA, we assumed 100 percent of chemical COPCs would be absorbed

by the GI tract. Therefore we used the ADI values without any adjustment to evaluate the dermal exposure route.

In addition, for the dermal exposure route, ABSd are used to account for differences in the absorption of a chemical COPC under assumed exposure conditions at a site (via direct contact with sediment) relative to the absorption of the chemical COPC under the experimental conditions upon which a toxicity value is based. The default dermal absorption factor for semivolatile organic compounds of 10 percent was used for all chemical COPCs in this screening level HHRA to evaluate risk from dermal exposure to sediment (USEPA, 2004b).

6.5 Risk Characterization

The characterization of risk is the final step in the risk assessment process. In this step, the health endpoint and exposure assessments were combined into quantitative estimates of risk for a child and adult recreational visitor and an outdoor worker from exposure to chemical COPCs at Gowanus Canal. A separate assessment of risk from exposure to pathogens in sediment, surface water and CSO water is presented in Subsection 6.5.4.

Human health risk from exposure to chemical COPCs was estimated by dividing the ADD estimated for each exposure pathway by the ADI. This ratio is called the Hazard Index (HI). HIs are calculated for each chemical COPC for each exposure route. For pathogens, HIs were calculated by dividing detected pathogen concentrations in water and sediment by the available AWQC. An HI is considered acceptable if it is below 1.0. Human health risk-based screening criteria for individual chemical COPCs are often conservatively set at an HI of 0.1 to account for potential additive effects for multiple COPCs.

HIs for ingestion, dermal absorption, and fish consumption exposure routes were calculated using the following equation:

$$HI = ADD / ADI$$

where:

ADD = Average Daily Dose from Exposure Route of Concern (mg/kg-day)

ADI = Acceptable Daily Dose (mg/kg-day)

HIs for a receptor are summed for all exposure routes to derive a Total Hazard Index (THI) for each COPC for all exposure routes of concern. A THI above one indicates that exposure could be higher than the "no-effect" dose or exposure represented by the ADI. In this screening level HHRA, we applied a THI limit of 0.1 to conservatively indentify COPCs that have THIs approaching the no effect dose represented by the ADI. This conservative

approach accounts for some of the uncertainty inherent in the derivation of the ADI and potential additive effects of PPCPs.

6.5.1 Child Recreational Visitor Risk Estimates

Tables 23 through **25** provide HI calculations for each exposure route of concern and THIs for a child recreational visitor exposed to chemical COPCs in sediment (**Table 23**), surface water (**Table 24**), and CSO water (**Table 25**). A separate assessment of risk from exposure to pathogens in sediment, surface water and CSO water is presented in Subsection 6.5.4.

THIs for a child recreational visitor exposed to COPCs in sediment from incidental ingestion and dermal absorption are below 0.1. Exposure to estrone, an estrogen compound, is associated with the highest THI (0.04). Dermal absorption of estrone in sediment accounts for the majority of this THI.

THIs for a child recreational visitor exposed to COPCs in surface water from incidental ingestion and ingestion of fish are below 0.1, with the exception of methadone, which has a THI of 0.5. This risk is associated with exposure to methadone from consumption of fish. Methadone was not detected in sediment or CSO water. Exposure to nonylphenol is associated with the next highest THI (0.08). The majority of this THI is associated with ingestion of fish.

THIs for a child recreational visitor exposed to COPCs in CSO water from incidental ingestion and ingestion of fish exceed the limit of 0.1 for estrone (4), an estrogen compound; estriol (0.8); and nonylphenol (0.4). For all of these COPCs, risk is associated with exposure from consumption of fish. As a result, exposure to estrone, estriol, and nonylphenol from consumption of fish (if exposed to concentrations similar to those measured in CSO water) may be associated with adverse health effects. However, this is a conservative estimate of risk because a child recreational visitor and fish in the canal are more likely to be exposed over the long-term to surface water concentrations of COPCs as opposed to detected concentrations of COPCs in CSO water, since these concentrations would be diluted following discharge to the canal. Estrone was not detected above detection limits in canal surface water; however, estrone was detected in sediment. Estriol was not detected in sediment or surface water. Nonylphenol was also detected in sediment and surface water. All other THIs for a child recreational visitor exposed to COPCs in CSO water from incidental ingestion and ingestion of fish are below 0.1.

6.5.2 Adult Recreational Visitor Risk Estimates

Tables 26 through **28** provide calculations of HIs for each exposure route of concern and THIs for an adult recreational visitor exposed to COPCs in sediment (**Table 26**), surface

water (**Table 27**), and CSO water (**Table 28**). A separate assessment of risk from exposure to pathogens in sediment, surface water and CSO water is presented in Subsection 6.5.4.

THIs for an adult recreational visitor exposed to COPCs in sediment from incidental ingestion and dermal absorption are below 0.1. Exposure to estrone, an estrogen compound, is associated with the highest THI (0.02). The majority of this THI is associated with dermal absorption of estrone in sediment.

THIs for an adult recreational visitor exposed to COPCs in surface water from incidental ingestion and ingestion of fish are below 0.1, with the exception of methadone, which has a THI of 0.3. This risk is associated with exposure to methadone from consumption of fish. Methadone was not detected in sediment or CSO water. Exposure to nonylphenol is associated with the next highest THI (0.05). The majority of this THI is associated with ingestion of fish.

THIs for an adult recreational visitor exposed to COPCs in CSO water from incidental ingestion and ingestion of fish exceed the limit of 0.1 for estrone (2), an estrogen compound; estriol (0.5); and nonylphenol (0.2). For all of these COPCs, risk is associated with exposure from consumption of fish. As a result, exposure to estrone, estriol, and nonylphenol from consumption of fish (exposed to CSO water) may be associated with adverse health effects. However, this is a conservative estimate of risk because an adult recreational visitor and fish in the canal are more likely to be exposed over the long-term to surface water concentrations of COPCs as opposed to detected concentrations of COPCs in CSO water, since these concentrations would be diluted following discharge to the canal. Estrone was not detected above detection limits in canal surface water; however, estrone was detected in sediment. Estriol was not detected in sediment or surface water. Nonylphenol was also detected in sediment and surface water. All other THIs for an adult recreational visitor exposed to COPCs in CSO water from incidental ingestion and ingestion of fish are below 0.1.

6.5.3 Outdoor Worker Risk Estimates

Table 29 provides calculations of HIs for each exposure route of concern and THIs for an outdoor worker exposed to COPCs in sediment. A separate assessment of risk from exposure to pathogens in sediment, surface water and CSO water is presented in Subsection 6.5.4.

THIs for an outdoor worker exposed to COPCs in sediment from incidental ingestion and dermal absorption are below 0.1, with the exception of estrone, which has a THI of 0.1. This risk is primarily associated with exposure to estrone from dermal absorption of sediment. Estrone was also detected in CSO water but was not detected in canal surface water above detection limits. Exposure to nonylphenol is associated with the next highest THI (0.008). The majority of this THI is associated with dermal absorption of sediment.

6.5.4 Pathogen Risk Characterization

For the pathogen risk characterization, a HI approach was followed wherein the EPCs identified in the exposure assessment were compared to the USEPA Human Health AWQC developed for recreational contact with marine water:

$$HI = EPC / AWQC$$

where:

HI	=	hazard index
EPC	=	exposure point concentration
AWQC	=	screening value

For a given pathogen, if the ratio of these two values was greater than one, there is the potential for risk due to direct contact with canal sediment, surface water and CSO water. The USEPA AWQC for human health are developed to be protective of both adults and children.

Table 30 presents HIs calculated for exposure to enterococci and fecal coliform in sediment, surface water and CSO water. HIs from exposure to enterococci range from 5 to 12 for surface water, 1,816 to 5,072 for CSO water, and 1,008 to 1,920 for sediment. HIs from exposure to fecal coliform are 1 for surface water, 331 for CSO water, and 138 for sediment. The highest HI was associated with exposure to enterococci in CSO water. Elevated HIs calculated for pathogens indicate an unacceptable risk of gastro-enteritis from recreational contact with canal water, including light use contact. Therefore, this screening level HHRA identified a significant risk to a child and an adult recreational visitor and an outdoor worker from exposure to pathogens measured in canal sediment, surface water and CSO water.

6.6 Uncertainty Analysis

Numerical estimates of risk to human health presented in this report are only as good as the data and information upon which they are based. General sources of variability and uncertainty in the risk assessment include measurement errors in the site assessment process, variability in natural system and human behavior, limitations in model simplifications and assumptions, limitations in literature-derived data, and professional judgment used to select parameters.

A discussion of the uncertainty and conservatism associated with these risk estimates is provided in this section to facilitate an understanding of the strengths and limitations of this risk assessment.

6.6.1 Uncertainties in Hazard Identification

The number and distribution of samples collected in the canal are considered spatially representative of contamination. These data are considered reasonable for the selection of COPCs. We conservatively included all chemicals detected in sediment, surface water, and CSO water as COPCs although several chemicals were detected at very low concentrations and frequencies.

6.6.2 Uncertainties in Exposure Assessment

Conservative exposure parameters are incorporated in the exposure assessment. The assessment evaluated exposure to canal media for a child recreational visitor even though a young child is likely not present at the canal for recreational activities. Therefore, risk estimates provided here likely overestimate actual risks for most child visitors.

BCFs used to model concentrations of COPCs in fish are associated with uncertainty in this assessment. BCFs were estimated based on Kow values, which may result in the under or overestimation of risk. Ideally, COPC concentrations measured in fish would be used to estimate risk from ingestion of fish in order to minimize uncertainty associated with modeling this exposure route based on surface water and CSO water concentrations.

We did not evaluate exposure to COPCs in water from dermal absorption due to significant uncertainties associated with estimating dermal permeabilities for PPCPs. This may underestimate risk from exposure to water.

6.6.3 Health Endpoint Assessment Uncertainty

The effects observed in one species or by one route of exposure may not occur in another species or by another route, or they may occur at a higher or lower dose due to differences in the biokinetics of a compound in different species. The uncertainty in these assumptions is taken into account in the development of ADIs using safety or uncertainty factors. These factors reflect uncertainty associated with species-to-species extrapolation and include safety factors to protect sensitive individuals. The uncertainty factors incorporated in the ADIs are conservative (health protective) in nature. The use of these toxicity values, therefore, may overestimate the potential for adverse health effects for a given exposure route.

Route-to-route extrapolation of ADI values adds an additional source of uncertainty to the risk assessment. Such extrapolation may result in either under or overestimation of the true risks for the extrapolated route. Although this practice adds uncertainty to the risk evaluation, it is preferable to omitting exposure to a COPC by a route for which no acceptable daily dose value is available thus avoiding the potential underestimation of risk. This extrapolation, therefore, is likely to provide a conservative estimation of overall risk.

There are a number of pathogens for which human health criteria are not available. Therefore, risk from exposure to pathogens may be underestimated. However, this screening level HHRA concluded significant risk from exposure to pathogens that were quantitatively evaluated in this assessment.

6.6.4 Uncertainties in Risk Characterization

Risk estimates do not consider the mechanism of action used to derive the ADI. Therefore, risk estimates are not assumed to be additive, which may under-estimate risk given that some chemical effects may have synergistic effects.

6.7 Conclusions

We conducted a screening level assessment of human health risk at the request of National Grid to evaluate the potential for human health risks from exposure to PPCPs and pathogens in the Gowanus Canal located in Brooklyn, New York. We included chemical data collected at the canal from sediment, surface water and CSO water located at CSO discharge points. COPCs included 23 PPCPs, alkyphenols, ammonia, and pathogens. A summary of significant risk estimates is presented below in **Table 31**.

This screening level HHRA concluded the following:

- THIs for a child and an adult recreational visitor exposed to COPCs in sediment from ingestion and dermal absorption do not exceed the limit of 0.1. Therefore, this screening level HHRA concluded that there is no risk of potential adverse health effects for a child and an adult recreational visitor from exposure to COPCs in Gowanus Canal sediment.
- The THI for an outdoor worker exposed to estrone in sediment from ingestion and dermal absorption is at the limit of 0.1. Therefore, this screening level HHRA concluded that there is a risk of potential adverse health effects for an outdoor worker from exposure to estrone in Gowanus Canal sediment. This risk is primarily associated with exposure to estrone from dermal absorption.
- The THI for a child and an adult recreational visitor exposed to methadone in surface water from incidental ingestion and ingestion of fish exceed the limit of 0.1. Therefore, this screening level HHRA concluded that there is a risk of potential adverse health effects for a child and an adult recreational visitor from exposure to methadone in Gowanus Canal surface water. This risk is associated with exposure to methadone from consumption of fish. However, there is uncertainty associated with BCFs used to model concentrations of COPCs in fish, which were estimated based on Kow values.

- THIs for a child and an adult recreational visitor exposed to estrone, estriol, and nonylphenol in CSO water from incidental ingestion and ingestion of fish exceed the limit of 0.1. Therefore, this screening level HHRA concluded that there is a risk of potential adverse health effects for a child and an adult recreational visitor from exposure to estrone, estriol, and nonylphenol in Gowanus Canal CSO water. This risk is associated with exposure to estrone, estriol and nonylphenol from consumption of fish. However, there is uncertainty associated with BCFs used to model concentrations of COPCs in fish, which were estimated based on Kow values. Furthermore, using CSO grab samples to represent exposure levels in Gowanus Canal may be a conservative estimate of maximum possible exposure during significant wet weather discharge events.

HIs calculated for a recreational visitor and worker exposed to pathogens in surface water and CSO water are significantly elevated above 1. HIs from exposure to enterococci range from 5 to 12 for surface water, 1,816 to 5,072 for CSO water, and 1,008 to 1,920 for sediment. HIs from exposure to fecal coliform are 1 for surface water, 331 for CSO water, and 138 for sediment. The highest HI was associated with exposure to enterococci in CSO water. Elevated HIs calculated for pathogens indicate an unacceptable risk of gastro-enteritis from recreational contact with canal surface water and CSO water, including exposures to canal water limited to light use contact, which may characterize a potential worker exposure. Therefore, this screening level HHRA identified a significant risk to a child and an adult recreational visitor and an outdoor worker from exposure to pathogens measured in canal sediment, surface water and CSO water.

Table 31 - Summary of Human Health Risk Assessment

Surface Water Risk				
COPC	**Child Recreational Visitor THI**	**Adult Recreational Visitor THI**	**Adult / Child HI**	**Shellfish Harvesting HI**
EDCs and PPCPs				
Methadone	0.5	0.3		
Pathogen				
Enterococci			5 to 12	
Fecal Coliform			1	20

CSO Water Risk			
COPC	**Child Recreational Visitor THI**	**Adult Recreational Visitor THI**	**Adult / Child HI**
EDCs and PPCPs			
Estrone	4	2	
Estriol	0.8	0.5	
Nonylphenol	0.4	0.2	
Pathogen			
Enterococci			1,816 to 5,072
Fecal Coliform			331

Sediment Risk		
COPC	**Outdoor Worker THI**	**Adult / Child HI**
EDCs and PPCPs		
Estrone	0.1	
Pathogen		
Enterococci		1,008 to 1,920
Fecal Coliform		138

Only THIs at or above 0.1 are presented, indicating the potential for adverse health effects as a result of exposure.

7. Conclusions

The analytical data collected during this investigation revealed that pathogens, PPCPs, and ammonia were detected in CSO water, canal surface water, canal sediment during both dry and wet weather conditions. Free cyanide was not detected in any sample collected as part of this investigation.

Pathogens were detected in every sample collected and PPCPs were detected in many of the samples collected. Pathogen and some PPCPs concentrations were typically higher in CSO water samples and canal surface water samples collected during wet weather events than canal surface water samples collected during dry weather. Elevated pathogen concentrations were detected in the sediment sample collected near the head of the canal (GC-SD-RH-034) relative to other sediment samples. Additionally, PPCPs were detected more often in sediment sample GC-SD-RH-034 relative to other sediment samples.

An initial SLERA and HHRA were performed using the data presented in this report. This data has been used to gain a better understanding of what kind of ecological and human health risks are presented by pathogens, PPCPs, and ammonia found in CSO waters that discharge into the canal, canal surface water adjacent to CSO outfalls, and CSO related sediment deposits within the canal. These risks assessments may be used to focus future investigations on CSO related contaminants that pose the greatest risks to people and for canal ecology. The screening level risks assessments may also be used to aid in the refinement of future risk assessments and in evaluating background risk levels and the risk reduction and effectiveness of remedial alternatives.

7.1 SLERA

Overall, many PPCPs were not detected in canal surface water, canal sediments, or CSO water. The majority of HQs calculated for detected PPCPs were less than one, indicating that most PCPPs have no potential for risk to ecological receptors. In addition, we concluded that there is no potential for risk to the survival of pelagic and benthic fish, plants, zooplankton, and epibenthic and benthic invertebrates due to direct PPCP exposure in canal surface water and sediment. However, there is a potential for risk to the survival of these receptors due to direct exposure to the PPCPs listed below in CSO water. Additionally, the potential for adverse ecological effects as measured by growth or reproduction also exists from direct exposure to the PPCPs listed below in canal surface water, sediment, and CSO water. Specifically, this SLERA concluded the following:

Nonylphenol was detected at concentrations in canal surface water that pose the potential for ecological risks, particularly to the growth and reproduction of plants, zooplankton, and epibenthic and benthic invertebrates.

The following PPCPs were detected at concentrations in canal sediment that pose the potential for ecological risks, particularly to the growth and reproduction of benthic invertebrates:

- Nonylphenol,
- Nonylphenol Monoethoxylate,
- alpha-Estradiol,
- Estradiol, and
- Fluoxetine

The following PPCPs were detected at concentrations in CSO water that pose the potential **f**or ecological risk to the survival of pelagic and benthic fish, plants, zooplankton, and epibenthic and benthic invertebrates:

- Nonylphenol,
- Nonylphenol Diethoxylate, and
- Nonylphenol Monoethoxylate

The following chemicals were detected at concentrations in CSO water that pose the potential for ecological risk to the growth and reproduction of plants, zooplankton, and epibenthic and benthic invertebrates:

- Nonylphenol,
- Nonylphenol Diethoxylate,
- Nonylphenol Monoethoxylate,
- Estradiol,
- Estriol, and
- Ammonia

The conclusions drawn in this SLERA indicate a potential for adverse ecological effects primarily from the PPCPs listed above in canal sediment and CSO water. It is important to note that, while only these few PPCPs were determined to pose the potential for ecological risks, there was a relatively high degree of confidence in the SV for most of these same PPCPs.

A more rigorous investigation of these contaminants in canal surface water, canal sediment and CSO water will be required to more fully understand the likelihood for ecological risk to the receptors expected to come into direct contact with these media.

7.2 HHRA

Based on the screening level HHRA, we concluded that there is a potential risk of adverse health effects for a child and an adult recreational visitor and an outdoor worker from exposure to pathogens and PCPPs in canal sediment, surface water and CSO water based on this report's data set. Because of limitations on the data set, the risks may be understated, but the results suggest the need for a baseline risk assessment. Specifically, this screening level HHRA concluded the following:

- There is no risk of potential adverse health effects for a child and an adult recreational visitor from exposure to COPCs in Gowanus Canal sediment.
- There is a risk of potential adverse health effects for an outdoor worker from exposure to estrone in Gowanus Canal sediment. This risk is associated with dermal absorption of estrone in sediment.
- There is a risk of potential adverse health effects for a child and an adult recreational visitor from exposure to methadone in Gowanus Canal surface water. This risk is associated with exposure to methadone from consumption of fish. However, there is uncertainty associated with BCFs used to model concentrations of COPCs in fish, which were estimated based on Kow values.
- There is a risk of potential adverse health effects for a child and an adult recreational visitor from exposure to estrone, estriol, and nonylphenol in Gowanus Canal CSO water. This risk is associated with exposure to estrone, estriol and nonylphenol from consumption of fish. However, there is uncertainty associated with BCFs used to model concentrations of COPCs in fish, which were estimated based on Kow values.
- There is a significant risk to a child and an adult recreational visitor and an outdoor worker from exposure to pathogens measured in canal sediment, surface water and CSO water, including exposures to canal water limited to light use contact.

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Tables

Table 1
Summary of Analytes
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

Target Analyte	Method	Description or Use	Preservation	Holding Time	Laboratory
Pathogens					
Clostridium perfringens	mCP[3]	Bacterium associated with gastrointestinal illness	cool to 4°C±2°C	6-12 hours or freeze	ASI
Coliphages	EPA Method 1602	Bacterium associated with gastrointestinal illness	cool to 4°C±2°C	48-72 hours, indefinite at -80 C	ASI
Enterococcus[1]	Standard Methods 9230	Bacterium associated with gastrointestinal illness	cool to 4°C±2°C	6-12 hours	ASI
Fecal coliforms[1]	Standard Methods 9222	Bacterium associated with gastrointestinal illness	cool to 4°C±2°C	6-12 hours	ASI/TA
E. coli[1]	Standard Plate Count with ID	Bacterium associated with gastrointestinal illness	cool to 4°C±2°C	6-12 hours	ASI
Enteroviruses[2]	ICC/nPCR	Viruses associated with disease	cool to 4°C±2°C	48-72 hours, indefinite at -80 C	ASI
Giardia	EPA Method 1623	Protozoan associated with gastrointestinal illness	cool to 4°C±2°C	6-12 hours	ASI
Cryptosporidium	EPA Method 1623	Protozoan associated with gastrointestinal illness	cool to 4°C±2°C	6-12 hours	ASI
EDC/PPCP					
Bisphenol A	ASTM-D7065-06M	Industrial Chemical	pH<2 w/H2SO4; cool to 4°C±2°C	28 days to extraction	CAS
Nonylphenol	ASTM-D7065-06M	Industrial Chemical	pH<2 w/H2SO4; cool to 4°C±2°C	28 days to extraction	CAS
Nonylphenol Diethoxylate	ASTM-D7065-06M	Industrial Chemical	pH<2 w/H2SO4; cool to 4°C±2°C	28 days to extraction	CAS
Nonylphenol Monoethoxylate	ASTM-D7065-06M	Industrial Chemical	pH<2 w/H2SO4; cool to 4°C±2°C	28 days to extraction	CAS
4-tert-Octylphenol	ASTM-D7065-06M	Industrial Chemical	pH<2 w/H2SO4; cool to 4°C±2°C	28 days to extraction	CAS
Acetominophen	EPA Method 1694M	Analgesic	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
alpha-Estradiol	EPA Method 1694M	Estrogen	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Androstenedione	EPA Method 1694M	Androgen	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Atrazine	EPA Method 1694M	Herbicide	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Bisphenol A	EPA Method 1694M	Industrial Chemical	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Caffeine	EPA Method 1694M	Stimulant	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Carbamazepine	EPA Method 1694M	Anti-seizure	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Diazepam	EPA Method 1694M	Muscle Relaxer	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Diclofenac	EPA Method 1694M	Anti-arthritic	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Diethylstilbestrol	EPA Method 1694M	Synthetic Estrogen	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	EPA Method 1694M	Anticonvulsant	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Estradiol	EPA Method 1694M	Estrogen	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Estriol	EPA Method 1694M	Estrogen	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Estrone	EPA Method 1694M	Estrogen	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Ethinyl Estradiol	EPA Method 1694M	Synthetic Ovulation Inhibitor	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Fluoxetine	EPA Method 1694M	Antidepressant	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Gemfibrozil	EPA Method 1694M	Lipid Regulator	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS

Table 1
Summary of Analytes
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
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Target Analyte	Method	Description or Use	Preservation	Holding Time	Laboratory
Hydrocodone	EPA Method 1694M	Analgesic	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Ibuprofen	EPA Method 1694M	Anti-inflammatory	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
EDC/PPCP - Continued					
Iopromide	EPA Method 1694M	Contrast Enhancer	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Meprobamate	EPA Method 1694M	Anti-anxiety	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Methadone	EPA Method 1694M	Opiate	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Naproxen	EPA Method 1694M	Anti-inflammatory	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
DEET (N,N-Diethyl-3-Methyl Benzamide)	EPA Method 1694M	Insect Repellent	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Oxybenzone	EPA Method 1694M	Sun Screen	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Pentoxifylline	EPA Method 1694M	Improve Blood Flow	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Progesterone	EPA Method 1694M	Ovulation Inhibitor/Estrogen	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Salicylic Acid	EPA Method 1694M	Skin Care	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Sulfamethoxazole	EPA Method 1694M	Antibiotic	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Testosterone	EPA Method 1694M	Androgen	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Triclosan	EPA Method 1694M	Antimicrobial	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Trimethoprim	EPA Method 1694M	Antibiotic	pH<2 w/H2SO4; cool to 4°C±2°C; Na2S2O3 if residual chlorine present	7 days to extraction	CAS
Free Cyanide & Ammonia					
Free Cyanide	D4282-02	Industrial Chemical	cool to 4°C±2°C, NaOH	14 days	TA
Ammonia	SM4500NH3	Naturally Occurring, Associated with Sewage, and Industrial Chemical	cool to 4°C±2°C, H2SO4	28 days	TA

Notes:

ASI - Analytical Services, Inc.
CAS - Columbia Analytical Services
TA - TestAmerica
NA - Not applicable
CFU - colony-forming unit
PFU - plaque forming unit
EDC - Endocrine disruptor compounds
PCPPs - Pharmaceutical and personal care products

[1] Indicator constituents
[2] Such as adenovirus, hepatitis A, polio virus 1-3, coxsackievirus A, B
[3] Bisson and Cabelli, 1979; U.S. EPA, 1995 (EPA/600/R95/03)

Table 2
Sample Locations and Analyses
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

CSO Sample Location	CSO Sample ID	Date	Sampling Event Type	Northing, ft	Easting, ft	Depth of Water Column, ft	Pathogens	EDCs/PPCPs	Free Cyinide and Ammonia	QA/QC Sample
CSO Water										
RH-034	Not Collected	NA	NA	Not Collected	Not Collected	NA	Not Collected	Not Collected	Not Collected	NA
RH-033	MH-RH-033	6/30/2010	Dry	Not Surveyed	Not Surveyed	NA	x[1]	Not Collected	x	None
	MH-RH-033	7/13/2010	Wet #1				x	x	x	None
	MH-RH-033	10/1/2010	Wet #3				x	x	x	Duplicate
RH-038	MH-RH-038	7/1/2010	Dry	Not Surveyed	Not Surveyed	NA	x[1]	Not Collected	x	None
	MH-RH-038	7/13/2010	Wet #1				x	x	x	None
	MH-RH-038	10/1/2010	Wet #3				x	x	x	None
RH-037	MH-RH-037	6/30/2010	Dry	Not Surveyed	Not Surveyed	NA	x[1]	Not Collected	x	None
	MH-RH-037	7/13/2010	Wet #1				x	x	x	None
	MH-RH-037	10/1/2010	Wet #3				x	x	x	None
RH-036	MH-RH-036	6/30/2010	Dry	Not Surveyed	Not Surveyed	NA	x[1]	Not Collected	x	None
	MH-RH-036	7/13/2010	Wet #1				x	x	x	None
	MH-RH-036	10/1/2010	Wet #3				x	x	x	MS/MSD
OH-005	MH-OH-005A	6/30/2010	Dry	Not Surveyed	Not Surveyed	NA	x[1]	Not Collected	x	None
	MH-OH-005	7/13/2010	Wet #1				x	x	x	None
	MH-OH-005A	10/1/2010	Wet #3				x	x[2]	x	None
OH-007	MH-OH-005	6/30/2010	Dry	Not Surveyed	Not Surveyed	NA	x[1]	Not Collected	x	None
	MH-OH-005	9/30/2010	Wet #3				x	x	x	None
RH-035	MH-RH-035	6/30/2010	Dry	Not Surveyed	Not Surveyed	NA	x[1]	Not Collected	x	None
	MH-RH-035	9/28/2010	Wet #2				x	x	x	None
	MH-RH-035	10/1/2010	Wet #3				x	x	x	None
RH-031	MH-RH-031	6/30/2010	Dry	Not Surveyed	Not Surveyed	NA	x[1]	Not Collected	x	None
	MH-RH-031	9/28/2010	Wet #2				x	x	x	None
	MH-RH-031	10/1/2010	Wet #3				x	x	x	None
OH-006	MH-OH-006	6/30/2010	Dry	Not Surveyed	Not Surveyed	NA	x[1]	Not Collected	x	None
	MH-OH-006	9/30/2010	Wet #3				x	x	x	None
CSO Related Canal Sediment and Surface Water										
RH-034	GC-SD-RH-034	7/14/2010	Dry	673568	634399	5.1	x	x	x	Duplicate
	GC-SW-RH-034						x	x	x	Duplicate
RH-033	GC-SD-RH-033	7/14/2010	Dry	673544	634398	4.9	x	x	x	MS/MSD
	GC-SW-RH-033						x	x	x	MS/MSD
RH-038	GC-SD-RH-038	7/14/2010	Dry	673307	634285	5.2	x	x	x	None
	GC-SW-RH-038						x	x	x	None
RH-037	GC-SD-RH-037	7/14/2010	Dry	673049	634144	10.5	x	x	x	None
	GC-SW-RH-037						x	x	x	None
RH-036	GC-SD-RH-036	7/13/2010	Dry	672605	633930	10.8	x	x	x	None
	GC-SW-RH-036						x	x	x	None
OH-005	GC-SD-OH-005	7/13/2010	Dry	672323	633798	14.0	x	x	x	None
	GC-SW-OH-005						x	x	x	None
OH-007	GC-SD-OH-007	7/13/2010	Dry	671460	633303	11.7	x	x	x	None
	GC-SW-OH-007						x	x	x	None
RH-035	GC-SD-RH-035	7/13/2010	Wet	671563	632868	9.4	x	x	x	None
	GC-SW-RH-035						x	x	x	None
RH-031	GC-SD-RH-031	7/13/2010	Wet	669874	631115	5.6	x	x	x	None
	GC-SW-RH-031						x	x	x	None
OH-006	GC-SD-OH-006	7/13/2010	Dry	668480	630591	24.1	x	x	x	None
	GC-SW-OH-006						x	x	x	None

Notes:

EDC - Endocrine disruptor compounds

PCPPs - Pharmaceutical and personal care products

QA/QC - Quality assurance and quality control

NA - Not applicable

Duplicate - Blind duplicate sample

MS/MSD - Matrix spike and matrix spike duplicate sample

[1] Sample was only analyzed for one pathogen, fecal coliform. Analysis was performed by Test America

[2] Sample was not analyzed for viruses and plaque forming viruses because of a bottleware fracture during analysis preparation

Northings and eastings reference New York East Zone (3101) North American Datum of 1983 (NAD83)

Field rinsate blanks were collected for each matrix (cso water, surface water, and sediment). The CSO water rinsate blank was collected on 10/1/2010 and the surface water and sediment rinsate blanks were collected on 7/14/10

Table 3
Summary of CSO Water Field Parameters
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

CSO Sample Location	Date	Dissolved Oxygen, mg/L	pH, SU	Temperature, C	Salinity, %	Specific Conductance, mS/cm^3	Turbidity, NTU	Oxygen Reduction Potential, mV
Dry Event								
OH-005	6/30/10	3.76	6.09	24.77	0.3	0.661	Over Range	-96
OH-006	6/30/10	3.98	7.03	22.53	0.6	1.22	177	-42
OH-007	7/1/10	0.99	8.00	23.36	0.15	3.95	64.2	-85
RH-031	6/30/10	4.63	7.08	26.46	0.8	1.54	260	-101
RH-033	6/30/10	8.62	6.20	22.58	0.7	1.40	514	6
RH-034	7/1/10	4.85	6.75	12.05	0.7	1.49	82.0	104
RH-035	6/30/10	2.59	7.15	26.52	0.4	0.778	286	-74
RH-036	6/30/10	4.55	6.97	23.29	0.4	0.851	118	145
RH-037	6/30/10	7.90	7.62	21.29	0.3	0.677	72.2	49
RH-038	7/1/10	4.95	10.35	25.80	0.17	4.46	106	-48
1st Wet Event								
OH-005	7/13/10	5.47	7.18	27.01	0.2	0.426	103	157
RH-033	7/13/10	5.04	6.15	26.03	0.2	0.320	123	244
RH-034	7/14/10	Not Recorded	Not Recorded	Not Recorded	Not Recorded	Not Recorded	Not Recorded	Not Recorded
RH-036	7/13/10	8.04	7.07	25.03	0.4	0.801	47.2	122
RH-037	7/13/10	5.14	6.83	25.23	0.3	0.664	486	78
2nd Wet Event								
RH-031	9/28/10	2.34	6.89	23.45	0.7	1.35	449	41
RH-035	9/28/10	6.15	7.15	23.61	0.1	244	209	81
3rd Wet Event								
OH-006	9/30/10	8.72	5.60	21.26	0.232	0.354	275	333
OH-007	9/30/10	9.22	6.93	22.45	0.235	0.362	116	152
RH-031	10/1/10	9.87	7.33	20.17	0.0	0.058	148	189
RH-033	10/1/10	8.68	11.12	26.65	0.9	1.79	295	-37
RH-034	10/1/10	Not Recorded	Not Recorded	Not Recorded	Not Recorded	Not Recorded	Not Recorded	Not Recorded
RH-035	10/1/10	8.13	6.92	21.17	0.1	0.123	107	199
RH-036	10/1/10	16.20	7.69	19.53	0.1	0.143	101	235
RH-037	10/1/10	10.88	7.98	19.86	0.1	0.170	217	143
RH-038	10/1/10	7.31	9.05	20.51	0.2	0.338	86.1	73
OH-005	10/1/10	14.63	7.44	19.78	0.1	0.155	85.6	271

Notes:

Field parameters were measured by CH2MHill on behalf of the EPA. Field parameters are as reported in Appendix D-07 of the EPA's *Draft Gowanus Canal Remedial Investigation Report* .

mg/L - milligrams per liter
SU - Standard Units
ppt - parts per thousand
mS/cm^3 - miliSiemens per cubic centimeter
NTU - nephelometric turbidity units
mV - millivolts

Validated

Table 4
Summary of CSO Water Results
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

Location Name:	MH-OH-005A	MH-OH-006	MH-OH-007	MH-RH-031	MH-RH-033	MH-RH-035	MH-RH-036	MH-RH-037	MH-RH-038	MH-OH-005	MH-RH-033	MH-RH-036	MH-RH-037	MH-RH-038	MH-RH-031	MH-RH-035
Sample Depth (Feet):	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5
Sample Date:	6/30/2010	6/30/2010	7/1/2010	6/30/2010	6/30/2010	6/30/2010	6/30/2010	6/30/2010	7/1/2010	7/13/2010	7/13/2010	7/13/2010	7/13/2010	7/13/2010	9/28/2010	9/28/2010
Sampling Event:	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet #1	Wet #1	Wet #1	Wet #1	Wet #1	Wet #2	Wet #2
EDCs and PPCPs via ASTM-D7065-06M (ug/L)																
Bisphenol A	NA	NA	NA	NA	NA	NA	NA	NA	NA	**1 J**	**1.3 J**	0.4 UJ	**0.88 J**	0.4 UJ	0.40 UJ	0.45 U
Nonylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	**27 J**	**14 J**	2 UJ	**4.2 J**	**9.1 J**	**9.0 J**	**4.7**
Nonylphenol Diethoxylate	NA	NA	NA	NA	NA	NA	NA	NA	NA	8 UJ	8 UJ	8 UJ	8 UJ	**10 J**	8.0 UJ	8.9 U
Nonylphenol Monoethoxylate	NA	NA	NA	NA	NA	NA	NA	NA	NA	4 UJ	4 UJ	4 UJ	4 UJ	**5 J**	**8.5 J**	4.5 U
EDCs and PPCPs via EPA Method 1694M (ug/L)																
Acetaminophen	NA	NA	NA	NA	NA	NA	NA	NA	NA	**4**	**0.35**	**0.88**	**0.091**	**0.96**	**18**	**2.1**
Bisphenol A	NA	NA	NA	NA	NA	NA	NA	NA	NA	1 U	**0.6**	0.1 U	0.043 U	**0.64 J**	**0.71**	**0.66**
Caffeine	NA	NA	NA	NA	NA	NA	NA	NA	NA	12 U	3.1 U	11 U	0.32 U	5.6 U	**22**	0.05 U
Carbamazepine	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1 U	0.02 U	0.01 U	0.0011 U	0.02 U	**0.2**	**0.027**
Estradiol	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2 U	0.0039 U	0.02 U	0.0023 U	**0.0063**	0.05 U	0.05 U
Estriol	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2 U	0.0039 UJ	**0.022**	0.0023 U	0.004 U	**0.092**	0.02 U
Estrone	NA	NA	NA	NA	NA	NA	NA	NA	NA	1 U	0.02 U	**0.1**	0.011 U	0.02 U	0.1 U	0.1 U
Fluoxetine	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2 U	0.039 U	0.02 U	0.0023 U	0.004 U	**0.025**	0.02 U
Gemfibrozil	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1 U	0.02 U	**0.063 J**	**0.015 J**	0.02 U	**0.098**	**0.023**
Ibuprofen	NA	NA	NA	NA	NA	NA	NA	NA	NA	2 U	0.39 U	**1 J**	0.023 U	0.4 U	**1.9**	0.25 U
Iopromide	NA	NA	NA	NA	NA	NA	NA	NA	NA	1 U	0.2 U	0.1 U	**0.031**	0.2 U	0.1 U	0.1 U
Naproxen	NA	NA	NA	NA	NA	NA	NA	NA	NA	**0.97**	**0.072**	**1.6 J**	**0.014 J**	**2.6**	**2.3**	**0.21**
Pentoxifylline	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1 U	0.02 U	0.01 U	0.0011 U	0.02 U	**0.024**	0.01 U
Salicylic Acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.5 U	**1.7**	**5.6**	**0.24**	**6.1**	**14 J**	1.4 UJ
Sulfamethoxazole	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1 U	0.02 U	0.01 U	**0.0028**	0.02 U	**0.056**	**0.021**
Trimethoprim	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.5 U	0.0098 U	0.05 U	R	0.01 U	**0.12 J**	0.05 U
Pathogen																
C. perfringens (CFU/100 ml)	NA	NA	NA	NA	NA	NA	NA	NA	NA	**21000**	**3300 J**	**3100 J**	**5200 J**	**7100 J**	**90000 J**	**160000 J**
Coliphage, Male Specific (PFU/100 ml)	NA	NA	NA	NA	NA	NA	NA	NA	NA	**6336**	**1792**	R	**150**	**270**	**82400 J**	**64000 J**
Coliphage, Somatic (PFU/100 ml)	NA	NA	NA	NA	NA	NA	NA	NA	NA	0 U	**906**	0 U	0 U	**72**	**4180 J**	R
Enterococci (MPN/100 ml)	NA	NA	NA	NA	NA	NA	NA	NA	NA	**37000**	**26000**	**37000**	**58000**	**46000**	**1400000 J**	**1300000 J**
Fecal Coliform (MPN/100 ml)	**> 20000 J**	**200000 J**	**200000 J**	**200000 J**	**> 20000 J**	**> 20000 J**	**> 20000 J**	**> 20000 J**	**200000 J**	**240000 J**	**170000 J**	**14000**	**240000 J**	**10000 J**	**3100000 J**	**3300000 J**
E.Coli (MPN/100 ml)	NA	NA	NA	NA	NA	NA	NA	NA	NA	**240000 J**	**55000**	**160000**	**130000**	**73000**	**4400000 J**	**4400000 J**
Giardia (Cysts/L)	NA	NA	NA	NA	NA	NA	NA	NA	NA	**517.10 J**	**0.09 J**	0 U	**2.04 J**	**3.35 J**	**300.8 J**	**170 J**
Viruses (pos/neg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	neg	neg	neg	neg	neg	**pos**[1]	neg
Other (mg/L)																
Ammonia	**14**	**16.2**	**23.8**	**14.7**	**13.8**	**14.1**	**7.4**	**2.7**	**3.8**	**5.3**	**2.1**	**14.8**	**5.1**	**2**	**7.5**	**9.1**

Table 4
Summary of CSO Water Results
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

Location Name:	MH-OH-005A	MH-OH-006	MH-OH-007	MH-RH-031	MH-RH-033	Duplicate of MH-RH-033	MH-RH-035	MH-RH-036	MH-RH-037	MH-RH-038
Sample Depth (Feet):	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5
Sample Date:	10/1/2010	9/30/2010	9/30/2010	10/1/2010	10/1/2010	10/1/2010	10/1/2010	10/1/2010	10/1/2010	10/1/2010
Sampling Event:	Wet #3	Wet #3	Wet #3	Wet #3	Wet #3	Wet #3	Wet #3	Wet #3	Wet #3	Wet #3
EDCs and PPCPs via ASTM-D7065-06M (ug/										
Bisphenol A	0.45 U	**0.67 J**	0.4 UJ	**0.56**	0.45 U	0.45 U	0.40 UJ	0.4 U	0.4 U	0.45 U
Nonylphenol	**4.1**	**24 J**	**9 J**	**12**	**2.4**	**2.8**	**4.2 J**	2 U	**2.2**	**2.5**
Nonylphenol Diethoxylate	8.9 U	8.3 UJ	8 UJ	8.9 U	8.9 U	9 U	8.0 UJ	8 U	8 U	8.9 U
Nonylphenol Monoethoxylate	4.5 U	4.2 UJ	4 UJ	4.5 U	4.5 U	4.5 U	4.0 UJ	4 U	4 U	4.5 U
EDCs and PPCPs via EPA Method 1694M (u										
Acetaminophen	**0.54**	**2.8**	**7.3**	**0.11**	**0.44 J**	**0.2 J**	**22**	**1.9**	0.1 U	**1**
Bisphenol A	**0.58**	**0.65**	**1.3**	**0.82**	**0.4 J**	**0.65 J**	**0.62**	**0.46**	**0.51**	**0.51**
Caffeine	**3.9**	0.05 U	**15**	0.05 U	0.05 U	**1.8**	**30**	**20**	**3.5**	**9.1**
Carbamazepine	0.01 U	0.01 U	**0.015**	0.01 U	0.01 U	0.01 U	**0.24**	0.01 U	**0.01**	0.01 U
Estradiol	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Estriol	0.02 U	0.02 U	**0.022**	0.02 U	0.02 U	0.02 U	**0.094**	0.02 U	0.02 U	0.02 U
Estrone	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Fluoxetine	R	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	**0.022**	0.02 U	0.02 U	0.02 U
Gemfibrozil	**0.01**	**0.019**	**0.17 J**	0.01 U	0.01 U	0.01 U	**0.079**	**0.027**	**0.03**	**0.018**
Ibuprofen	0.2 U	0.2 U	**1.5**	0.2 U	0.2 U	0.2 U	**2.5**	0.2 U	0.2 U	0.2 U
Iopromide	0.1 U	0.1 U	**0.25 J**	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Naproxen	**0.032**	**0.54**	**1.2**	**0.028**	**0.025 J**	**0.012 J**	**2.9**	**0.09**	**0.033**	**0.13**
Pentoxifylline	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	**0.021**	0.01 U	0.01 U	0.01 U
Salicylic Acid	2.7 UJ	0.45 UJ	0.45 UJ	0.45 UJ	0.45 UJ	0.47 UJ	**16 J**	1.3 UJ	0.45 UJ	0.45 UJ
Sulfamethoxazole	0.01 U	0.01 U	**0.085**	0.01 U	0.01 U	0.01 U	**0.18**	0.01 U	0.01 U	0.01 U
Trimethoprim	R	R	**0.099 J**	R	0.05 U	0.05 U	**0.16 J**	0.05 U	0.05 U	0.05 U
Pathogen										
C. perfringens (CFU/100 ml)	**1600 J**	**1300000 J**	**16000 J**	**3700 J**	**1500 J**	NA	**29000 J**	**17000 J**	**1000 J**	**3400 J**
Coliphage, Male Specific (PFU/100 ml)	**183**	**1490**	**12180**	**1086**	**375**	NA	**390**	**361**	**246**	**1810**
Coliphage, Somatic (PFU/100 ml)	**232**	**80**	**1100**	**15730 J**	**850**	NA	**1087**	**24440 J**	**5690 J**	**17700 J**
Enterococci (MPN/100 ml)	**9100 J**	**49000 J**	**130000 J**	**55000 J**	**8800 J**	NA	**170000 J**	**52000 J**	**24000 J**	**69000 J**
Fecal Coliform (MPN/100 ml)	**24000**	**150000 J**	**3700000 J**	**130000 J**	**9600 J**	NA	**330000 J**	**52000**	**34000**	**49000**
E.Coli (MPN/100 ml)	**25000**	**120000 J**	**3400000 J**	**120000 J**	**9600 J**	NA	**150000 J**	**37000**	**30000**	**87000**
Giardia (Cysts/L)	**8.8 J**	**17 J**	**3.82 J**	**2 J**	**13**	NA	**234.4 J**	**20.6 J**	**0.8 J**	**4.8 J**
Viruses (pos/neg)	NA	neg	neg	neg	neg	NA	**pos[2]**	**pos[2]**	neg	neg
Other (mg/L)										
Ammonia	**0.37**	**2.1**	**4.3**	0.15 U	**0.2**	**0.22**	**0.65**	**0.23**	**0.26**	**0.41**

Table 4
Summary of CSO Water Results
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

Notes:

CFU - colony forming units
L - liters
mg/L - milligrams per liter or parts per billion (ppm)
mL - mililiter
MPN - most probably number
neg - negative
PFU - plaque forming units
pos - positive
ug/L - micrograms per liter or parts per billion (ppb)
EDC - Endocrine disruptor compounds
PCPPs - Pharmaceutical and personal care products
SVOCs - semivolatile organic compounds
[1] - positive for Adenovirus (Ad41)
[2] - positive for Enterovirus 30
NE - not established
NA - not analyzed

Bolding indicates a detected concentration

Validation Qualifiers:

J - estimated value
U - indicates not detected to the reporting limit for organic analysis and the method detection limit for inorganic analysis
UJ - not detected at or above the reporting limit shown and the reporting limit is estimated
R - rejected

Sampling Events:

The dry event was conducted on June 30 and July 1, 2010
Wet #1 was conducted on July 13, 2010
Wet #2 was conducted on Setember 28, 2010
Wet #3 was conducted on September 30 and October 1, 2010

Validated

Table 5
Summary of Surface Water Results
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

Location Name:	GC-SW-OH-005	GC-SW-OH-006	GC-SW-OH-007	GC-SW-RH-031	GC-SW-RH-033
Sample Depth (Feet):	6.75 - 7.25	11.85 - 12.35	5.6 - 6.1	2.55 - 3.05	2.2 - 2.7
Sample Date:	7/13/2010	7/13/2010	7/13/2010	7/13/2010	7/14/2010
Sampling Event:	Dry	Dry	Dry	Wet	Dry
EDCs and PPCPs via ASTM-D7065-06M (ug/L)					
Bisphenol A	0.4 UJ	0.43 UJ	0.4 UJ	0.4 UJ	0.4 UJ
Nonylphenol	2 UJ	2.2 UJ	2 UJ	**4 J**	2 UJ
EDCs and PPCPs via EPA Method 1694M (ug/L)					
Acetaminophen	**0.039**	**0.021**	**0.041**	**1**	**0.066**
Bisphenol A	0.039 U	0.01 U	0.074 U	**0.26**	0.04 U
Caffeine	0.31 U	**0.21**	0.31 U	2.6 U	0.37 U
Carbamazepine	**0.0067**	0.0051 U	**0.007**	0.015 UJ	**0.008**
Diclofenac	0.002 U	0.002 U	0.002 U	0.02 U	0.002 U
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	0.005 U	0.005 U	0.005 U	0.05 U	0.005 U
Estradiol	**0.0023**	0.002 U	0.002 U	0.02 U	**0.0021**
Gemfibrozil	**0.035 J**	**0.016 J**	**0.0095 J**	**0.055 J**	**0.028**
Ibuprofen	**0.038 J**	**0.022 J**	**0.049**	0.2 U	**0.041 J**
Iopromide	**0.1**	**0.087**	**0.11**	**0.17**	**0.11**
Methadone	0.005 U	0.005 U	0.005 U	0.05 U	0.005 U
Naproxen	**0.045 J**	**0.027 J**	**0.046 J**	**0.14 J**	**0.057 J**
DEET (N,N-Diethyl-3-Methyl Benzamide)	0.036 UJ	0.027 UJ	0.037 UJ	**0.24**	0.039 UJ
Pentoxifylline	0.001 U	0.001 U	0.001 U	0.01 U	**0.0012**
Salicylic Acid	**0.063**	**0.072**	**0.095**	**2.9**	**0.06**
Sulfamethoxazole	**0.0086**	**0.0011**	**0.015**	0.01 U	**0.0073**
Pathogens					
C. perfringens (CFU/100 mL)	**700 J**	**400 J**	**1100 J**	**5600 J**	**81 J**
Coliphage, Male Specific (PFU/100 mL)	0 U	0 U	0 U	**2452**	**7**
Coliphage, Somatic (PFU/100 mL)	0 U	0 U	0 U	**1039**	0 U
Enterococci (MPN/100 mL)	**164 J**	**1300**	**179 J**	**77000**	**1100 J**
Fecal Coliform (MPN/100 mL)	**29.1**	**2600**	**31.8**	**73000**	**727**
E.Coli (MPN/ 100 mL)	**310**	**4600**	**2400**	**140000**	**1280**
Giardia (Cysts/L)	0 U	0 U	0 U	R	0 U
Other (mg/L)					
Ammonia	**0.44 J**	0.33 U	0.33 U	**0.71**	**0.37**

Validated

Table 5
Summary of Surface Water Results
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

Location Name:	GC-SW-RH-034	Duplicate of GC-SW-RH-034	GC-SW-RH-035	GC-SW-RH-036	GC-SW-RH-037	GC-SW-RH-038
Sample Depth (Feet):	2.3 - 2.8	2.3 - 2.8	4.45 - 4.95	5.15 - 5.65	5 - 5.5	2.35 - 2.85
Sample Date:	7/14/2010	7/14/2010	7/13/2010	7/13/2010	7/14/2010	7/14/2010
Sampling Event:	Dry	Dry	Wet	Dry	Dry	Dry
EDCs and PPCPs via ASTM-D7065-06M (ug/L)						
Bisphenol A	0.4 UJ	0.43 UJ	**0.85 J**	0.4 UJ	0.4 UJ	0.4 UJ
Nonylphenol	2 UJ	2.2 UJ	**5.4 J**	2 UJ	2 UJ	2 UJ
EDCs and PPCPs via EPA Method 1694M (ug/L)						
Acetaminophen	**0.064**	**0.059**	**1.8**	**0.053**	**0.045**	**0.05**
Bisphenol A	0.02 U	0.042 U	**1.2 J**	0.01 U	0.011 U	0.037 U
Caffeine	0.4 U	0.35 U	4.5 U	0.36 U	0.31 U	0.31 U
Carbamazepine	**0.0085**	**0.0078**	0.029 U	**0.0077 J**	**0.0068**	**0.0068**
Diclofenac	0.002 U	0.002 U	0.057 U	**0.0026**	0.002 U	0.002 U
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	**0.0079 J**	**0.0069**	0.14 U	**0.0059 J**	**0.0066 J**	0.005 U
Estradiol	0.002 U	0.002 U	R	0.002 U	0.002 U	0.002 U
Gemfibrozil	**0.014 J**	**0.019 J**	0.029 U	**0.026 J**	**0.018**	**0.0063**
Ibuprofen	**0.036**	**0.05**	0.57 U	**0.037 J**	**0.033 J**	**0.049**
Iopromide	**0.12**	**0.099**	0.29 U	**0.14**	**0.083**	**0.096**
Methadone	0.005 U	0.005 U	**0.21**	0.005 U	0.005 U	0.005 U
Naproxen	**0.059 J**	**0.055 J**	**0.49**	**0.057 J**	**0.042 J**	**0.043**
DEET (N,N-Diethyl-3-Methyl Benzamide)	0.04 UJ	0.036 UJ	1.2 UJ	0.048 UJ	0.033 UJ	0.033 UJ
Pentoxifylline	0.001 U	0.001 U	0.029 U	0.001 U	0.001 U	0.001 U
Salicylic Acid	**0.11**	**0.062**	**0.91 J**	**0.12**	**0.082**	**0.05**
Sulfamethoxazole	**0.0019 J**	**0.009 J**	**0.043**	**0.0024**	**0.0013**	**0.016**
Pathogens						
C. perfringens (CFU/100 mL)	**100 J**	NA	**15000 J**	**100 J**	**69 J**	**90 J**
Coliphage, Male Specific (PFU/100 mL)	**20**	NA	**8069**	0 U	0 U	0 U
Coliphage, Somatic (PFU/100 mL)	0 U	NA	**7049**	0 U	0 U	0 U
Enterococci (MPN/100 mL)	**770 J**	NA	**120000 J**	**250 J**	**501 J**	**291 J**
Fecal Coliform (MPN/100 mL)	**687**	NA	**110000**	**47.3 J**	**308**	**240**
E.Coli (MPN/ 100 mL)	**2100**	NA	**240000 J**	**630 J**	**1600**	**860**
Giardia (Cysts/L)	**0.10 J**	NA	R	0 U	0 U	0 U
Other (mg/L)						
Ammonia	**0.37**	**0.41**	**0.71**	**0.43 J**	**0.38**	**0.38**

Table 5
Summary of Surface Water Results
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

Notes:

CFU - colony forming units
L - liters
mg/L - milligrams per liter or parts per billion (ppm)
mL - milliliters
MPN - most probably number
neg - negative
PFU - plaque forming units
pos - positive
ug/L - micrograms per liter or parts per billion (ppb)
EDC - Endocrine disruptor compounds
PCPPs - Pharmaceutical and personal care products
SVOCs - semivolatile organic compounds
NE - not established
NA - not analyzed

Bolding indicates a detected concentration

Validation Qualifiers:

J - estimated value
U - indicates not detected to the reporting limit for organic analysis and the method detection limit for inorganic analysis
UJ - not detected at or above the reporting limit shown and the reporting limit is estimated
R - rejected

Validated

Table 6
Summary of CSO-Related Canal Sediment Results
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

Location Name:	GC-SD-OH-005	GC-SD-OH-006	GC-SD-OH-007	GC-SD-RH-031	GC-SD-RH-033	GC-SD-RH-034	Duplicate of GC-SD-RH-034	GC-SD-RH-035	GC-SD-RH-036	GC-SD-RH-037	GC-SD-RH-038
Sample Depth (Feet):	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5	0 - 5
Sample Date:	7/13/2010	7/13/2010	7/13/2010	7/13/2010	7/14/2010	7/14/2010	7/14/2010	7/13/2010	7/13/2010	7/14/2010	7/14/2010
Sample Event:	Dry	Dry	Dry	Wet	Dry	Dry	Dry	Wet	Dry	Dry	Dry
EDCs and PPCPs via ASTM-D7065-06M (ug/L)											
Bisphenol A	0.62 UJ	0.46 UJ	0.9 UJ	0.44 U	0.62 UJ	0.69 UJ	**1.8 J**	1.1 UJ	0.77 UJ	0.82 UJ	0.96 UJ
Nonylphenol	3.1 UJ	**6.4 J**	4.5 UJ	**7.6**	3.1 UJ	**6.7 J**	**9.1 J**	5.3 UJ	**5.3 J**	**8.2 J**	4.8 UJ
Nonylphenol Monoethoxylate	6.2 UJ	4.6 UJ	9 UJ	4.4 U	6.2 UJ	**9.3 J**	**5.2 J**	11 UJ	7.7 UJ	8.2 UJ	9.6 UJ
EDCs and PPCPs via EPA Method 1694M (ug/L)											
Acetaminophen	0.0052 UJ	0.0043 UJ	0.0057 UJ	0.0031 UJ	**0.0069 J**	**0.0058**	**0.0056 J**	0.0058 UJ	0.006 UJ	0.0074 UJ	0.0053 UJ
alpha-Estradiol	0.0052 UJ	0.0043 UJ	0.0057 UJ	0.0031 UJ	0.0056 UJ	0.0057 U	0.0044 UJ	0.0058 UJ	0.006 UJ	0.0074 UJ	**0.0067 J**
Bisphenol A	**0.053 J**	**0.14 J**	0.057 UJ	**0.033 J**	**0.056 J**	**0.063 J**	0.044 UJ	**1.1 J**	**0.13 J**	0.074 UJ	**0.14 J**
Caffeine	0.026 UJ	0.022 UJ	0.029 UJ	**0.13 J**	0.028 UJ	**0.11 J**	**0.11 J**	0.029 UJ	0.03 UJ	**0.05 J**	**0.047 J**
Carbamazepine	0.0052 UJ	0.0043 UJ	0.0057 UJ	0.0031 UJ	0.0056 UJ	**0.0066 J**	0.0044 UJ	0.0058 UJ	0.006 UJ	0.0074 UJ	0.0053 UJ
Estradiol	0.01 UJ	0.0086 UJ	0.011 UJ	0.0062 UJ	0.011 UJ	**0.027 J**	0.0089 UJ	0.012 UJ	0.012 UJ	0.015 UJ	0.011 UJ
Estrone	0.0052 UJ	0.0043 UJ	0.0057 UJ	0.0031 UJ	0.0056 UJ	0.0057 U	0.0044 UJ	0.0058 UJ	0.006 UJ	0.0074 UJ	**0.021 J**
Fluoxetine	**0.012 J**	R	R	R	**0.007 J**	R	**0.013 J**	R	**0.023 J**	R	**0.0097 J**
Naproxen	**0.012 J**	**0.0094 J**	0.0057 UJ	**0.0082 J**	0.0056 UJ	**0.013 J**	0.0044 UJ	**0.012 J**	**0.016 J**	0.0074 UJ	**0.016 J**
Oxybenzone	0.01 UJ	0.0086 UJ	0.011 UJ	0.0062 UJ	0.011 UJ	0.011 U	**0.015 J**	0.012 UJ	0.012 UJ	0.015 UJ	0.011 UJ
Pentoxifylline	0.0052 UJ	0.0043 UJ	0.0057 UJ	**0.0035 J**	0.0056 UJ	0.0057 U	0.0044 UJ	0.0058 UJ	0.006 UJ	0.0074 UJ	0.0053 UJ
Progesterone	0.052 UJ	0.043 UJ	0.057 UJ	R	**0.15 J**	**0.12 J**	**0.13 J**	0.058 UJ	0.06 UJ	**0.43 J**	**0.072 J**
Testosterone	0.052 UJ	0.043 UJ	0.057 UJ	0.031 UJ	0.056 UJ	**0.12 J**	**0.058 J**	0.058 UJ	0.06 UJ	**0.075 J**	0.053 UJ
Pathogens											
C. perfringens (CFU/g)	**3300 J**	**850 J**	**1900 J**	**2100 J**	**350 J**	**55 J**	NA	**2000 J**	**2500 J**	**300 J**	**370 J**
Enterococci (MPN/g)	**300 J**	**59**	**180 J**	**850**	**130 J**	**5300 J**	NA	**160 J**	**170 J**	**1800 J**	**360 J**
Fecal Coliform (MPN/g)	**43**	**88**	**52**	**640**	**150**	**12000**	NA	**53**	**33 J**	**3200**	**900**
E.Coli (MPN/g)	**24**	**12**	**4.5**	**1300**	**81**	**7400**	NA	**32**	**34 J**	**1700**	**340**
Other (mg/kg)											
Ammonia	**50.8 J**	33.8 UJ	**109 J**	28.9 U	**84.5 J**	**215 J**	**192 J**	**91.7 J**	**446 J**	**176 J**	**78.7 J**

Table 6
Summary of CSO-Related Canal Sediment Results
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

Notes:

CFU - colony forming units
g - grams
L - liters
mg/kg - milligrams/kilogram or parts per million (ppm)
mg/L - milligrams/liter
MPN - most probably number
neg - negative
PFU - plaque forming units
pos - positive
EDC - Endocrine disruptor compounds
PCPPs - Pharmaceutical and personal care products
SVOCs - semivolatile organic compounds
NA - not analyzed

Bolding indicates a detected concentration

Validation Qualifiers:

J - estimated value
U - indicates not detected at or above the reporting limit shown
UJ - not detected at or above the reporting limit shown and the reporting limit is estimated
R - rejected

Table 8
Statistical Summary of Aquatic Analytical Results
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

		CSO Water Samples - All Events (N=25)						Canal Surface Water Samples - All Events (N=10)					
	Units	Minimum Reporting Detection Limit	Maximum Reporting Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Mean	Minimum Reporting Detection Limit	Maximum Reporting Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Mean
EDCs and PPCPs via ASTM-D7065-06M (ug/L)													
Bisphenol A	ug/L	0.4	0.67	0.56	1.3	5/ 16	0.562	0.4	0.85	0.85	0.85	1/10	0.516
Nonylphenol	ug/L	2	2	2	27	14/ 16	8.36	2	2.2	4	5.4	2/10	3.38
Nonylphenol Diethoxylate	ug/L	8	9	10	10	1/ 16	8.43	8	8.5	0	0	0/10	8.06
Nonylphenol Monoethoxylate	ug/L	4	4.5	5	8.5	2/ 16	4.98	4	4.3	0	0	0/10	4.04
4-tert-Octylphenol	ug/L	0.4	0.45	0	0	0/ 16	0.416	0.4	0.43	0	0	0/10	0.404
Total Cyanide													
Free Cyanide	ug/L	10	10	0	0	0/ 25	0	10	10	0	0	0/10	10
EDCs and PPCPs via EPA Method 1694M (ug/L)													
Acetaminophen	ug/L	0.1	0.1	0.091	22	15/ 16	5.11	0	0	0.021	1.8	10/10	0.724
alpha-Estradiol	ug/L	0.0011	0.1	0	0	0/ 16	0.021	0.001	0.001	0	0	0/10	0.0055
Androstenedione	ug/L	0.011	1	0	0	0/ 16	0.167	0.01	0.01	0	0	0/10	0.103
Atrazine	ug/L	0.0011	0.1	0	0	0/ 16	0.0167	0.0017	0.0021	0	0	0/10	0.0107
Bisphenol A	ug/L	0.043	1	0.46	1.3	13/ 16	0.613	0.01	0.074	0.26	1.2	2/10	0.381
Caffeine	ug/L	0.05	12	0.05	30	8/ 16	8.9	0.31	0.4	0.21	0.21	1/10	1.94
Carbamazepin	ug/L	0.0011	0.1	0.01	0.24	5/ 16	0.0599	0.0051	0.0051	0.0067	0.0085	7/10	0.0145
Diazepam	ug/L	0.0011	0.1	0	0	0/ 16	0.0167	0.001	0.001	0	0	0/10	0.0103
Diclofenac	ug/L	0.0023	0.2	0	0	0/ 16	0.0334	0.002	0.002	0.0026	0.0026	1/10	0.0203
Diethylstilbestrol	ug/L	0.0023	0.2	0	0	0/ 16	0.0287	0.002	0.002	0	0	0/9	0.011
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	ug/L	0.0057	0.5	0	0	0/ 16	0.0836	0.005	0.005	0.0059	0.0079	3/10	0.0503
Estradiol	ug/L	0.0023	0.2	0.0063	0.0063	1/ 16	0.0488	0.002	0.002	0.0021	0.0023	2/9	0.011
Estriol	ug/L	0.0023	0.2	0.02	0.094	4/ 16	0.0436	0.002	0.002	0	0	0/9	0.011
Estrone	ug/L	0.011	1	0.1	0.1	1/ 16	0.143	0.01	0.01	0	0	0/9	0.055
Ethinyl Estradiol	ug/L	0.0023	0.2	0	0	0/ 16	0.0287	0.002	0.002	0	0	0/9	0.011
Fluoxetine	ug/L	0.0023	0.2	0.025	0.025	1/ 15	0.0319	0.002	0.002	0	0	0/9	0.011
Gemfibrozil	ug/L	0.01	0.1	0.01	0.17	11/ 16	0.0485	0.055	0.055	0.0063	0.055	9/10	0.0309
Hydrocodone	ug/L	0.023	2	0	0	0/ 16	0.334	0.02	0.02	0	0	0/10	0.203
Ibuprofen	ug/L	0.023	2	0.2	2.5	4/ 16	0.813	0.2	0.57	0.022	0.05	8/10	0.212
Iopromide	ug/L	0.1	1	0.031	0.25	2/ 16	0.174	0.17	0.17	0.083	0.17	9/10	0.168
Meprobamate	ug/L	0.0057	0.5	0	0	0/ 16	0.0836	0.005	0.005	0	0	0/10	0.05
Methadone	ug/L	0.0057	0.5	0	0	0/ 16	0.0836	0.005	0.21	0.21	0.21	1/10	0.0675
Naproxen	ug/L	--	--	0.014	2.9	16/ 16	0.953	--	--	0.027	0.49	10/10	0.181
DEET (N,N-Diethyl-3-Methyl Benzamide)	ug/L	0.038	3.4	0	0	0/ 16	0.636	0.027	0.24	0.24	0.24	1/10	0.378
Oxybenzone	ug/L	0.0023	0.2	0	0	0/ 16	0.0578	0.0058	0.049	0	0	0/10	0.0716
Pentoxifylline	ug/L	0.0011	0.1	0.021	0.024	2/ 16	0.0195	0.001	0.001	0.0012	0.0012	1/10	0.0103
Progesterone	ug/L	0.011	1	0	0	0/ 16	0.167	0.01	0.01	0	0	0/10	0.103
Salicylic Acid	ug/L	0.45	16	0.24	16	6/ 16	4.62	--	--	0.05	2.9	10/10	0.993
Sulfamethoxazole	ug/L	0.01	0.18	0.0028	0.18	5/ 16	0.0354	0.043	0.043	0.0011	0.043	9/10	0.017
Testosterone	ug/L	0.011	1	0	0	0/ 16	0.167	0.01	0.01	0	0	0/10	0.103
Triclosan	ug/L	0	2.5	0	0	0/ 8	0.457	0.025	0.025	0	0	0/8	0.025
Trimethoprim	ug/L	0.0098	0.5	0.099	0.16	3/ 12	0.101	0.0065	0.019	0	0	0/9	0.0236
Pathogen													
C. perfringens	CFU/100 mL	0	0	1000	1300000	16/ 16	95200	0	0	69	15000	10/10	5320
Coliphage, Male Specific	PFU/100 mL	0	0	150	82400	15/ 15	25800	0	0	7	8069	4/10	2630
Coliphage, Somatic	PFU/100 mL	0	0	72	24440	12/ 15	3940	0	0	1039	7049	2/10	2020
Enterococci	MPN/100 mL	0	0	8800	1400000	16/ 16	485000	0	0	164	120000	10/10	49500
Fecal Coliform	MPN/100 mL	0	0	9600	3700000	25/ 25	983000	0	0	29.1	110000	10/10	46000
Plaque forming virus	PFU/187 mL	0	0	0	0	0/ 16	0	0	0	0	0	0/10	0
Cryptosporidium	Oocysts/L	0	0	0	0	0/ 12	0	0	0	0	0	0/8	0
E.Coli	MPN/100 mL	0	0	9600	4400000	16/ 16	1660000	0	0	310	240000	10/10	95900
Giardia	Cysts/L	0	0	0.09	517.1	15/ 16	125	0	0	0.1	0.1	1/10	0.0125
Viruses	pos/neg	0	pos	0	pos	3/ 16	--	0	0	0	0	0/10	0
Other													
Ammonia	mg/L	0.15	0.15	0.15	23.8	24/ 25	6.85	0.33	0.33	0.37	0.71	8/10	0.547

Notes:
Means were calculated using the full reporting detection limit for non-detect results.
Results were rejected for some samples based on data validation. The number of samples shown exclude the rejected results.
Detected analytes shown

Table 9
Statistical Summary of Canal Sediment Analytical Results
CSO/Gowanus Canal Sampling Report and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

		Canal Sediment - All Events (N=10)					
	Units	Minimum Reporting Detection Limit	Maximum Reporting Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Mean
EDCs and PPCPs via ASTM-D7065-06M (mg/kg)							
Bisphenol A	mg/kg	0.44	1.1	1.8	1.8	1/10	0.819
Nonylphenol	mg/kg	3.1	5.3	5.3	9.1	5/10	6.01
Nonylphenol Diethoxylate	mg/kg	8.7	22	0	0	0/10	15.2
Nonylphenol Monoethoxylate	mg/kg	4.4	11	9.3	9.3	1/10	7.65
4-tert-Octylphenol	mg/kg	0.44	1.1	0	0	0/10	0.75
Cyanides							
Free Cyanide	mg/kg	0.34	0.72	0	0	0/10	0.548
EDCs and PPCPs via EPA Method 1694M (mg/kg)							
Acetaminophen	mg/kg	0.0031	0.0074	0.0058	0.0069	2/10	0.00514
alpha-Estradiol	mg/kg	0.0031	0.0074	0.0067	0.0067	1/10	0.00514
Androstenedione	mg/kg	0.031	0.074	0	0	0/10	0.0505
Atrazine	mg/kg	0.0031	0.0074	0	0	0/10	0.00505
Bisphenol A	mg/kg	0.057	0.074	0.033	1.1	8/10	0.328
Caffeine	mg/kg	0.022	0.03	0.047	0.13	4/10	0.0611
Carbamazepin	mg/kg	0.0031	0.0074	0.0066	0.0066	1/10	0.00511
Diazepam	mg/kg	0.0031	0.0074	0	0	0/10	0.00505
Diclofenac	mg/kg	0.0062	0.015	0	0	0/10	0.0102
Diethylstilbestrol	mg/kg	0.0062	0.015	0	0	0/10	0.0102
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	mg/kg	0.0031	0.0074	0	0	0/10	0.00505
Estradiol	mg/kg	0.0062	0.015	0.027	0.027	1/10	0.0112
Estriol	mg/kg	0.0031	0.0074	0	0	0/10	0.00505
Estrone	mg/kg	0.0031	0.0074	0.021	0.021	1/10	0.00603
Ethinyl Estradiol	mg/kg	0.0062	0.015	0	0	0/10	0.0102
Fluoxetine	mg/kg	--	--	0.007	0.023	5/5	0.0129
Gemfibrozil	mg/kg	0.0031	0.0074	0	0	0/10	0.00505
Hydrocodone	mg/kg	0.015	0.037	0	0	0/10	0.0251
Ibuprofen	mg/kg	0.015	0.037	0	0	0/10	0.0251
Iopromide	mg/kg	0.031	0.074	0	0	0/10	0.0505
Meprobamate	mg/kg	0.015	0.037	0	0	0/10	0.0251
Methadone	mg/kg	0.015	0.037	0	0	0/10	0.0251
Naproxen	mg/kg	0.0056	0.0074	0.0082	0.016	7/10	0.0104
DEET (N,N-Diethyl-3-Methyl Benzamide)	mg/kg	0.015	0.037	0	0	0/10	0.0251
Oxybenzone	mg/kg	0.0062	0.015	0.015	0.015	1/10	0.0104
Pentoxifylline	mg/kg	0.0043	0.0074	0.0035	0.0035	1/10	0.00515
Progesterone	mg/kg	0.043	0.06	0.072	0.43	4/9	0.0911
Salicylic Acid	mg/kg	0.031	0.074	0	0	0/10	0.0505
Sulfamethoxazole	mg/kg	0.0031	0.0074	0	0	0/10	0.00505
Testosterone	mg/kg	0.031	0.06	0.075	0.12	1/10	0.0545
Trimethoprim	mg/kg	--	--	--	--	0/0	--
Pathogen							
C. perfringens	CFU/g	0	0	55	3300	10/10	1630
Coliphage, Male Specific	PFU/100 mL	0	0	0	0	0/10	--
Coliphage, Somatic	PFU/100 mL	0	0	0	0	0/10	--
Enterococci	MPN/g	0	0	59	5300	10/10	771
Fecal Coliform	MPN/g	0	0	33	12000	10/10	1200
Plaque forming virus	PFU/187 mL	0	0	0	0	0/10	--
Cryptosporidium	Oocysts/L	0	0	0	0	0/9	--
E.Coli	MPN/g	0	0	4.5	7400	10/10	933
Giardia	Cysts/L	0	0	0	0	0/10	--
Viruses	pos/neg	0	0	0	0	0/8	--
Other							
Ammonia	mg/kg	28.9	33.8	50.8	446	8/10	60.3

Notes:

Means were calculated using the full reporting detection limit for non-detect results
Results were rejected for some samples based on data validation. The number of samples shown exclude the rejected results
Detected analytes shown

Table 10
Ecological Risk Characterization Screening Values
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
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		Not detected across all samples:			USEPA AWQC				USEPA OPP Aquatic Life Benchmarks							CCME Environmental Quality Guidelines				
Chemical Compound	K_{oc} (L/kg)	In CSO water?	In Canal surface water?	In Canal sediment?	Freshwater CMC (acute) (µg/L)	Freshwater CCC (chronic) (µg/L)	Saltwater CMC (acute) (µg/L)	Saltwater CCC (chronic) (µg/L)	Fish acute (µg/L)	Fish chronic (µg/L)	Invertebrate acute µg/L)	Invertebrate chronic µg/L)	Nonvascular plants (µg/L)	Vascular plants (µg/L)	Chronic Aquatic Community Benchmark (µg/L)	Water - Freshwater Long Term (µg/L)	Water - Marine Long Term (µg/L)	Sediment - Freshwater Long Term (µg/kg)	Sediment - Marine Long Term (µg/kg)	ODEQ Initiation Level (µg/L)
Other SVOCs																				
Bisphenol A	37,670				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	980*
Total Nonylphenols	.				28	6.6	7	1.7	-	-	-	-	-	-	-	1	0.7	1,400	1,000	-
Total Nonylphenol Diethoxylates	.		X	X	-	-	-	-	-	-	-	-	-	-	-	1	0.7	1,400	1,000	-
Total Nonylphenol Monoethoxylates	.		X		-	-	-	-	-	-	-	-	-	-	-	1	0.7	1,400	1,000	-
4-tert-Octylphenol	.	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Cyanide																				
Free cyanide	.	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PPCPs																				
Acetaminophen	45				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17-alpha-estradiol	15,350	X	X		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Androstenedione	.	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atrazine	.	X	X	X	1,500	Non-numeric	760	17	2,650	65	360	60	1	37	17.5	1.8	-	-	-	-
Bisphenol A	37,670				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	980*
Caffeine	10				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbamazepine	1328				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diazepam	.	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diclofenac	.	X		X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diethylstilbestrol	.	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5,5-Diphenylhydantoin	.	X		X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17-beta-estradiol	15,350				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Estriol	.		X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Estrone	23,720		X		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17-alpha-ethynylestradiol	.	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoxetine	93,460		X		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gemfibrozil	.			X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydrocodone	.	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ibuprofen	.			X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iopromide	.			X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meprobamate	.	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methadone	.	X		X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naproxen	335.2				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DEET(N,N-Diethyl-3-Methyl Benzamide)	.	X		X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oxybenzone	945.8	X	X		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pentoxifylline	10.00				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Progesterone	10,070	X	X		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salicylic Acid	21.69			X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfamethoxazole	.			X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Testosterone	2,185	X	X		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Triclosan	.	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	70
Trimethoprim	718.80		X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other																				
Ammonia	.				pH, temperature, life-stage		pH, salinity, temperature		-	-	-	-	-	-	-	-	-	-	-	-

Table 10
Ecological Risk Characterization Screening Values
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
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		GEI literature-derived threshold								FINAL SCREENING VALUES FOR CSO SLERA											
Chemical Compound	Available information	CSO Water Acute (µg/L)	CSO Water Chronic (µg/L)	Surface Water Acute (µg/L)	Surface Water Chronic (µg/L)	Sediment Acute (µg/kg)	Sediment Chronic (µg/kg)	ECOSAR-modeled threshold: Lowest Chronic Value (µg/L)	Basis	CSO Water Acute (µg/L)	Basis	CSO Water Chronic (µg/L)	Basis	Surface Water Acute (µg/L)	Basis	Surface Water Chronic (µg/L)	Basis	Sediment Acute (µg/kg)	Basis	Sediment Chronic (µg/kg)	Basis
Other SVOCs																					
Bisphenol A	8/8 papers	226.5	22.7	226.5	22.7	-	-	227	F-CS-Al	226.5	4, M	22.7	4, M, A	226.5	4, M	22.7	4, M, A	460,742	P, 4, M	46,074	P, 4, M, A
Total Nonylphenols	Existing thresholds							6**	F-NO-Fi	7	1, M	1.7	1, M	7	1, M	1.7	1, M	10,000	2, M, A	1,000	2, M
Total Nonylphenol Diethoxylates	Existing thresholds							-	-	7	1, M	1.7	1, M								
Total Nonylphenol Monoethoxylates	Existing thresholds							0.339~	M-CS-MS	7	1, M	1.7	1, M					10,000	2, M, A	1,000	2, M
4-tert-Octylphenol								24	F-NO-Fi												
Total Cyanide																					
Free cyanide								151,095	M-CS-Fi												
PPCPs																					
Acetaminophen	2/3 papers	17,591	1,759	17,591	1,759	-	-	253	F-CS-Al	17,591	4, F	1759	4, F, A	17,591	4, F	1759	4, F, A	42,832	P, 4, F	4,283	P, 4, F, A
17-alpha-estradiol	EPA white paper					-	-	207	F-CS-Fi									24,867	P, 4, M	5	P, 4, M
Androstenedione								1,790	M-CS-MS												
Atrazine								1,621	F-CS-Da												
Bisphenol A	8/8 papers	226.5	22.7	226.5	22.7	-	-	227	F-CS-Al	226.5	4, M	22.7	4, M, A	226.5	4, M	22.7	4, M, A	460,742	P, 4, M	46,074	P, 4, M, A
Caffeine	7/17 papers	56,670	40,000	56,670	40,000	-	-	168	F-CS-Da	56,670	4, F	40,000	4, F	56,670	4, F	40,000	4, F	30,602	P, 4, F	21,600	P, 4, F
Carbamazepine	11/16 papers	10,067	0.4	10,067	0.4	1,330	133	36	F-CS-Al	10,067	4, F	0.4	4, F	10,067	4, F	0.4	4, F	1,330	4, F, A	133	4, F
Diazepam								61	F-CS-Fi												
Diclofenac	11/21 papers			14,500	447			433	M-CS-MS					14,500	4, F	447	4, F				
Diethylstilbestrol								15	F-NO-Fi												
5,5-Diphenylhydantoin	1/2 papers			62,570	6,257			143	F-CS-Fi					62,570	4, F	6,257	4, F, A				
17-beta-estradiol	EPA white paper	30	0.006	30	0.006	-	-	207	F-CS-Fi	30	4, M	0.006	4, M	30	4, M	0.006	4, M	24,867	P, 4, M	5	P, 4, M
Estriol	3/6 papers	1,515	0.02					995	F-CS-Da	1,515	4, M	0.02	4, F								
Estrone	5/7 papers	604	0.78			-	-	415	F-CS-Fi	604	4, M	0.78	4, F					774,164	P, 4, M	999	P, 4, F
17-alpha-ethynylestradiol	EPA white paper							177	F-CS-Fi												
Fluoxetine	13/21 papers	234	0.09			15,200	690	20	M-CS-MS	234	4, F	0.09	4, F					15200	4, F	0.69	4, F
Gemfibrozil	5/7 papers	2,028	203	2,028	203			37	M-CS-MS	2,028	4, F	203	4, F, A	2,028	4, F	203	4, F, A				
Hydrocodone								34	M-CS-MS												
Ibuprofen	12/14 papers	2,268	13.3	2,268	13.3			593	M-CS-MS	2,268	4, F	13.3	4, F	2,268	4, F	13.3	4, F				
Iopromide	1/2 papers	-	-	-	-			39,847,754**	F-CS-Al	398,477,540	3, F, A	39,847,754	3, F	398,477,540	3, F, A	39,847,754	3, F				
Meprobamate								17,600**	M-CS-MS												
Methadone	-			-	-			38,309	F-NO-Da					383,090	3, F, A	38,309	3, F				
Naproxen	X/2 papers	665	66.5	665	66.5	-	-	5,377	M-CS-MS	665	4, F	66.5	4, F, A	665	4, F	66.5	4, F, A	12,037	P, 4, F	1,204	P, 4, F, A
DEET(N,N-Diethyl-3-Methyl Benzamide)	2/15 papers			73,127	7,313			91	F-CS-Fi					73,127	4, F	7,313	4, F, A				
Oxybenzone	1/1 papers	2861	286.1			-	-	308	F-CS-Fi									146,120	P, 4, F, A	14,612	P, 4, F
Pentoxifylline	-	-	-	-	-	-	-	176	F-CS-Ma	1760	3, F, A	176	3, F	1760	3, F, A	176	3, F	950	P, 3, F, A	95	P, 3, F
Progesterone	3/6 papers	547	54.7			-	-	126	M-CS-MS									297,230	P, 4, M	29,723	P, 4, M, A
Salicylic Acid	4/4 papers	141,423	1,342	141,423	1,342			3,787	F-NO-Da	141,423	4, F	1,342	4, F	141,423	4, F	1,342	4, F				
Sulfamethoxazole	6/10 papers	989	26.8	989	26.8			117	F-CS-Da	989	4, F	26.8	4, F	989	4, F	26.8	4, F				
Testosterone	6/17 papers	1,950	975			-	-	384	M-CS-MS									230,081	P, 4, M	115,040	P, 4, F
Triclosan								82	F-CS-Fi												
Trimethoprim	9/12 papers	16,000	10,954					75	F-CS-Da	16,000	4, F	10,954	4, F								
Other																					
Ammonia	Existing thresholds							NA	NA	18,000	1, M	2,700	1, M	18,000	1, M	2,700	1, M	-	-	-	-

Table 10
Ecological Risk Characterization Screening Values
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Gowanus Canal Superfund Site
Brooklyn, New York

Notes:

	Do not need SV - ND in all samples
	Do not need SV - existing threshold
-	Not available
.	Not applicable
*	Tetrabromobisphenol A (TBBPA)
**	Chemcial may not be soluable enough to measure this predicted result
#	4-Nonylphenol
~	4-Nonylphenol monoethoxylate
M	Marine
F	Freshwater
NO	Neutral Organic SAR (Baseline Toxicity)
CS	Class Specific SAR (Excess Toxicity)
Fi	Chronic Value for Fish
Da	Chronic Value for Daphnid
Al	Chronic Value for Algae
MS	Chronic Value for Mysid Shrimp
A	Assessment factor applied
P	Predicted using ESB approach
1	USEPA AWQC
2	CCME WQ Guideline
3	USEPA ECOSAR
4	GEI literature review

Table 11
Ecological Risk Characterization for Canal Sediments - Dry Event
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

	Canal Dry Event - Sediment (N=8)											
	Units	Number of Samples Available	Number of Detections	Frequency of Detection	Minimum Reporting Detection Limit	Maximum Reporting Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration	Mean	EPC	Hazard Quotient (AV)	Hazard Quotient (ChV)
Other SVOCs												
Bisphenol A	mg/kg	8	1	13%	0.46	0.96	1.8	1.8	0.869	1.8	0.004	0.039
Nonylphenol	mg/kg	8	4	50%	3.1	4.8	5.3	9.1	5.56	9.1	0.910	9.100
Nonylphenol Diethoxylate	mg/kg	8	0	0%	9.2	20	-	--	15	--	NA	NA
Nonylphenol Monoethoxylate	mg/kg	8	1	13%	4.6	9.6	9.3	9.3	7.6	9.3	0.930	9.300
4-tert-Octylphenol	mg/kg	8	0	0%	0.46	0.96	--	--	0.73	--	NA	NA
Cyanides												
Free Cyanide	mg/kg	8	0	0%	0.44	0.72	--	--	0.605	--	NA	NA
PPCPs												
Acetaminophen	mg/kg	8	2	25%	0.0043	0.0074	0.0058	0.0069	0.00582	0.0069	0.0002	0.002
alpha-Estradiol	mg/kg	8	1	13%	0.0043	0.0074	0.0067	0.0067	0.00582	0.0067	0.0003	1.347
Androstenedione	mg/kg	8	0	0%	0.043	0.074	--	--	0.0565	--	NA	NA
Atrazine	mg/kg	8	0	0%	0.0043	0.0074	--	--	0.00565	--	NA	NA
Bisphenol A	mg/kg	8	6	75%	0.057	0.074	0.053	0.14	0.0891	0.14	0.0003	0.003
Caffeine	mg/kg	8	3	38%	0.022	0.03	0.047	0.11	0.0428	0.11	0.004	0.005
Carbamazepin	mg/kg	8	1	13%	0.0043	0.0074	0.0066	0.0066	0.00576	0.0066	0.005	0.050
Diazepam	mg/kg	8	0	0%	0.0043	0.0074	--	--	0.00565	--	NA	NA
Diclofenac	mg/kg	8	0	0%	0.0086	0.015	--	--	0.0112	--	NA	NA
Diethylstilbestrol	mg/kg	8	0	0%	0.0086	0.015	--	--	0.0112	--	NA	NA
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	mg/kg	8	0	0%	0.0043	0.0074	--	--	0.00565	--	NA	NA
Estradiol	mg/kg	8	1	13%	0.0086	0.015	0.027	0.027	0.0132	0.027	0.001	5.429
Estriol	mg/kg	8	0	0%	0.0043	0.0074	--	--	0.00565	--	NA	NA
Estrone	mg/kg	8	1	13%	0.0043	0.0074	0.021	0.021	0.00761	0.021	0.00003	0.021
Ethinyl Estradiol	mg/kg	8	0	0%	0.0086	0.015	--	--	0.0112	--	NA	NA
Fluoxetine*	mg/kg	5	5	100%	--	--	0.007	0.023	0.0129	0.023	0.002	33.333
Gemfibrozil	mg/kg	8	0	0%	0.0043	0.0074	--	--	0.00565	--	NA	NA
Hydrocodone	mg/kg	8	0	0%	0.022	0.037	--	--	0.0282	--	NA	NA
Ibuprofen	mg/kg	8	0	0%	0.022	0.037	--	--	0.0282	--	NA	NA
Iopromide	mg/kg	8	0	0%	0.043	0.074	--	--	0.0565	--	NA	NA
Meprobamate	mg/kg	8	0	0%	0.022	0.037	--	--	0.0282	--	NA	NA
Methadone	mg/kg	8	0	0%	0.022	0.037	--	--	0.0282	--	NA	NA
Naproxen	mg/kg	8	5	63%	0.0056	0.0074	0.0094	0.016	0.0106	0.016	0.001	0.013
DEET (N,N-Diethyl-3-Methyl Benzamide)	mg/kg	8	0	0%	0.022	0.037	--	--	0.0282	--	NA	NA
Oxybenzone	mg/kg	8	1	13%	0.0086	0.015	0.015	0.015	0.0117	0.015	0.000	0.001
Pentoxifylline	mg/kg	8	0	0%	0.0043	0.0074	--	--	0.00565	--	NA	NA
Progesterone	mg/kg	8	4	50%	0.043	0.06	0.072	0.43	0.124	0.43	0.001	0.014
Salicylic Acid	mg/kg	8	0	0%	0.043	0.074	--	--	0.0565	--	NA	NA
Sulfamethoxazole	mg/kg	8	0	0%	0.0043	0.0074	--	--	0.00565	--	NA	NA
Testosterone	mg/kg	8	1	13%	0.043	0.06	0.075	0.12	0.0645	0.12	0.001	0.001
Trimethoprim*	mg/kg	0	0	NA	--	--	--	--	--	--	NA	NA
Other												
Ammonia	mg/kg	8	7	88%	33.8	33.8	50.8	446	0	446	NA	NA

EPC - Exposure Point Concentration
NA - Not Applicable
-- Not Available
Notes:
* Some results were rejected for some samples based on data validation. The number of samples shown exclude the rejected results
Means were calculated using the full reporting detection limit for non-detect results
ChV - Hazard quotient was based on comparison to the selected chronic sediment screening value
AV - Hazard quotient was based on comparison to the selected acute sediment screening value
Highlighting indicates HQs > 1, identifing the potential for ecological risk at detected concentrations

Table 12
Ecological Risk Characterization for Canal Sediments - Wet Event
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

	Canal Wet Event - Sediment (N=2)											
	Units	Number of Samples Available	Number of Detections	Frequency of Detection	Minimum Reporting Detection Limit	Maximum Reporting Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration	Mean	EPC	Hazard Quotient (AV)	Hazard Quotient (ChV)
Other SVOCs												
Bisphenol A	mg/kg	2	0	0%	0.44	1.1	--	--	0.77	--	NA	NA
Nonylphenol	mg/kg	2	1	50%	5.3	5.3	7.6	7.6	6.45	7.6	0.760	7.600
Nonylphenol Diethoxylate	mg/kg	2	0	0%	8.7	22	--	--	15.4	--	NA	NA
Nonylphenol Monoethoxylate	mg/kg	2	0	0%	4.4	11	--	--	7.7	--	NA	NA
4-tert-Octylphenol	mg/kg	2	0	0%	0.44	1.1	--	--	0.77	--	NA	NA
Cyanides												
Free Cyanide	mg/kg	2	0	0%	0.34	0.64	--	--	0.49	--	NA	NA
PPCPs												
Acetaminophen	mg/kg	2	0	0%	0.0031	0.0058	--	--	0.00445	--	NA	NA
alpha-Estradiol	mg/kg	2	0	0%	0.0031	0.0058	--	--	0.00445	--	NA	NA
Androstenedione	mg/kg	2	0	0%	0.031	0.058	--	--	0.0445	--	NA	NA
Atrazine	mg/kg	2	0	0%	0.0031	0.0058	--	--	0.00445	--	NA	NA
Bisphenol A	mg/kg	2	2	100%	--	--	0.033	1.1	0.566	1.1	0.002	0.024
Caffeine	mg/kg	2	1	50%	0.029	0.029	0.13	0.13	0.0795	0.13	0.004	0.006
Carbamazepin	mg/kg	2	0	0%	0.0031	0.0058	--	--	0.00445	--	NA	NA
Diazepam	mg/kg	2	0	0%	0.0031	0.0058	--	--	0.00445	--	NA	NA
Diclofenac	mg/kg	2	0	0%	0.0062	0.012	--	--	0.0091	--	NA	NA
Diethylstilbestrol	mg/kg	2	0	0%	0.0062	0.012	--	--	0.0091	--	NA	NA
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	mg/kg	2	0	0%	0.0031	0.0058	--	--	0.00445	--	NA	NA
Estradiol	mg/kg	2	0	0%	0.0062	0.012	--	--	0.0091	--	NA	NA
Estriol	mg/kg	2	0	0%	0.0031	0.0058	--	--	0.00445	--	NA	NA
Estrone	mg/kg	2	0	0%	0.0031	0.0058	--	--	0.00445	--	NA	NA
Ethinyl Estradiol	mg/kg	2	0	0%	0.0062	0.012	--	--	0.0091	--	NA	NA
Fluoxetine*	mg/kg	0	0	NA	--	--	--	--	--	--	NA	NA
Gemfibrozil	mg/kg	2	0	0%	0.0031	0.0058	--	--	0.00445	--	NA	NA
Hydrocodone	mg/kg	2	0	0%	0.015	0.029	--	--	0.022	--	NA	NA
Ibuprofen	mg/kg	2	0	0%	0.015	0.029	--	--	0.022	--	NA	NA
Iopromide	mg/kg	2	0	0%	0.031	0.058	--	--	0.0445	--	NA	NA
Meprobamate	mg/kg	2	0	0%	0.015	0.029	--	--	0.022	--	NA	NA
Methadone	mg/kg	2	0	0%	0.015	0.029	--	--	0.022	--	NA	NA
Naproxen	mg/kg	2	2	100%	--	--	0.0082	0.012	0.0101	0.012	0.001	0.010
DEET (N,N-Diethyl-3-Methyl Benzamide)	mg/kg	2	0	0%	0.015	0.029	--	--	0.022	--	NA	NA
Oxybenzone	mg/kg	2	0	0%	0.0062	0.012	--	--	0.0091	--	NA	NA
Pentoxifylline	mg/kg	2	1	50%	0.0058	0.0058	0.0035	0.0035	0.00465	0.0035	0.004	0.037
Progesterone*	mg/kg	1	0	0%	0.058	0.058	--	--	0.058	--	NA	NA
Salicylic Acid	mg/kg	2	0	0%	0.031	0.058	--	--	0.0445	--	NA	NA
Sulfamethoxazole	mg/kg	2	0	0%	0.0031	0.0058	--	--	0.00445	--	NA	NA
Testosterone	mg/kg	2	0	0%	0.031	0.058	--	--	0.0445	--	NA	NA
Trimethoprim*	mg/kg	0	0	NA	--	--	--	--	--	--	NA	NA
Other												
Ammonia	mg/kg	2	1	50%	28.9	28.9	91.7	91.7	60.3	91.7	NA	NA

EPC - Exposure Point Concentration
NA - Not Applicable
-- Not Available
Notes:
* Some results were rejected for some samples based on data validation. The number of samples shown exclude the rejected results
Means were calculated using the full reporting detection limit for non-detect results
ChV - Hazard quotient was based on comparison to the selected chronic sediment screening value
AV - Hazard quotient was based on comparison to the selected acute sediment screening value
Highlighting indicates HQs > 1, identifing the potential for ecological risk at detected concentrations

Table 13
Ecological Risk Characterization for Canal Surface Water - Dry Event
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

	Canal Dry Event - Surface Water (N=8)											
	Units	Number of Samples Available	Number of Detections	Frequency of Detection	Minimum Reporting Detection Limit	Maximum Reporting Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration	Mean	EPC	Hazard Quotient (AV)	Hazard Quotient (ChV)
Other SVOCs												
Bisphenol A	µg/L	8	0	0%	0.4	0.43	--	--	0.408	--	NA	NA
Nonylphenol	µg/L	8	0	0%	2	2.2	--	--	2.05	--	NA	NA
Nonylphenol Diethoxylate	µg/L	8	0	0%	8	8.5	--	--	8.12	--	NA	NA
Nonylphenol Monoethoxylate	µg/L	8	0	0%	4	4.3	--	--	4.07	--	NA	NA
4-tert-Octylphenol	µg/L	8	0	0%	0.4	0.43	--	--	0.408	--	NA	NA
Cyanides												
Free Cyanide	µg/L	8	0	0%	10	10	--	--	10	--	NA	NA
PPCPs												
Acetaminophen	µg/L	8	8	100%	0	0	0.021	0.066	0.0474	0.066	0.000004	0.00004
alpha-Estradiol	µg/L	8	0	0%	0.001	0.001	--	--	0.001	--	NA	NA
Androstenedione	µg/L	8	0	0%	0.01	0.01	--	--	0.01	--	NA	NA
Atrazine	µg/L	8	0	0%	0.0017	0.0021	--	--	0.00192	--	NA	NA
Bisphenol A	µg/L	8	0	0%	0.01	0.074	--	--	0.0329	--	NA	NA
Caffeine	µg/L	8	1	13%	0.31	0.4	0.21	0.21	0.322	0.21	0.000004	0.00001
Carbamazepin	µg/L	8	7	88%	0.0051	0.0051	0.0067	0.0085	0.00708	0.0085	0.000001	0.021
Diazepam	µg/L	8	0	0%	0.001	0.001	--	--	0.001	--	NA	NA
Diclofenac	µg/L	8	1	13%	0.002	0.002	0.0026	0.0026	0.00208	0.0026	0.0000002	0.00001
Diethylstilbestrol	µg/L	8	0	0%	0.002	0.002	--	--	0.002	--	NA	NA
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	µg/L	8	3	38%	0.005	0.005	0.0059	0.0079	0.00568	0.0079	0.0000001	0.000001
Estradiol	µg/L	8	2	25%	0.002	0.002	0.0021	0.0023	0.00205	0.0023	0.0001	0.383
Estriol	µg/L	8	0	0%	0.002	0.002	--	--	0.002	--	NA	NA
Estrone	µg/L	8	0	0%	0.01	0.01	--	--	0.01	--	NA	NA
Ethinyl Estradiol	µg/L	8	0	0%	0.002	0.002	--	--	0.002	--	NA	NA
Fluoxetine	µg/L	8	0	0%	0.002	0.002	--	--	0.002	--	NA	NA
Gemfibrozil	µg/L	8	8	100%	0	0	0.0063	0.035	0.0197	0.035	0.00002	0.0002
Hydrocodone	µg/L	8	0	0%	0.02	0.02	--	--	0.02	--	NA	NA
Ibuprofen	µg/L	8	8	100%	0	0	0.022	0.05	0.0399	0.05	0.00002	0.004
Iopromide	µg/L	8	8	100%	0	0	0.083	0.14	0.106	0.14	0.0000000004	0.000000004
Meprobamate	µg/L	8	0	0%	0.005	0.005	--	--	0.005	--	NA	NA
Methadone	µg/L	8	0	0%	0.005	0.005	--	--	0.005	--	NA	NA
Naproxen	µg/L	8	8	100%	0	0	0.027	0.059	0.047	0.059	0.0001	0.001
DEET (N,N-Diethyl-3-Methyl Benzamide)	µg/L	8	0	0%	0.027	0.048	--	--	0.0366	--	NA	NA
Oxybenzone	µg/L	8	0	0%	0.0058	0.049	--	--	0.0296	--	NA	NA
Pentoxifylline	µg/L	8	1	13%	0.001	0.001	0.0012	0.0012	0.00102	0.0012	0.000001	0.00001
Progesterone	µg/L	8	0	0%	0.01	0.01	--	--	0.01	--	NA	NA
Salicylic Acid	µg/L	8	8	100%	0	0	0.05	0.12	0.0815	0.12	0.000001	0.0001
Sulfamethoxazole	µg/L	8	8	100%	0	0	0.0011	0.016	0.00759	0.016	0.00002	0.001
Testosterone	µg/L	8	0	0%	0.01	0.01	--	--	0.01	--	NA	NA
Triclosan	µg/L	8	0	0%	0.025	0.025	--	--	0.025	--	NA	NA
Trimethoprim	µg/L	8	0	0%	0.0065	0.019	--	--	0.0113	--	NA	NA
Other												
Ammonia	mg/L	8	6	75%	0.33	0.33	0.37	0.44	0.384	0.44	0.024	0.163

EPC - Exposure Point Concentration

NA - Not Applicable

-- Not Available

Notes:

* Some results were rejected for some samples based on data validation. The number of samples shown exclude the rejected results

Means were calculated using the full reporting detection limit for non-detect results

ChV - Hazard quotient was based on comparison to the selected chronic surface water screening value

AV - Hazard quotient was based on comparison to the selected acute surface water screening value

Highlighting indicates HQs > 1, identifing the potential for ecological risk at detected concentrations

Table 14
Ecological Risk Characterization for Canal Surface Water - Wet Event
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

	Canal Wet Event - Surface Water (N=2)											
	Units	Number of Samples Available	Number of Detections	Number of Non-detects	Frequency of Detection	Minimum Reporting Detection Limit	Maximum Reporting Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration	Mean	EPC	Hazard Quotient (AV)	Hazard Quotient (ChV)
Other SVOCs													
Bisphenol A	µg/L	2	1	1	50%	0.85	0.85	0.85	0.85	0.625	0.85	0.004	0.038
Nonylphenol	µg/L	2	2	0	100%	--	--	4	5.4	4.7	5.4	0.771	3.176
Nonylphenol Diethoxylate	µg/L	2	0	2	0%	0	0	--	--	8	--	NA	NA
Nonylphenol Monoethoxylate	µg/L	2	0	2	0%	0	0	--	--	4	--	NA	NA
4-tert-Octylphenol	µg/L	2	0	2	0%	0	0	--	--	0.4	--	NA	NA
Cyanides													
Free Cyanide	µg/L	2	0	2	0%	0	0	--	--	10	--	NA	NA
PPCPs													
Acetaminophen	µg/L	2	2	0	100%	--	--	1	1.8	1.4	1.8	0.0001	0.001
alpha-Estradiol	µg/L	2	0	2	0%	0	0	--	--	0.01	--	NA	NA
Androstenedione	µg/L	2	0	2	0%	0	0	--	--	0.195	--	NA	NA
Atrazine	µg/L	2	0	2	0%	0	0	--	--	0.0195	--	NA	NA
Bisphenol A	µg/L	2	2	0	100%	--	--	0.26	1.2	0.73	1.2	0.005	0.053
Caffeine	µg/L	2	0	2	0%	0	0	--	--	3.55	--	NA	NA
Carbamazepin	µg/L	2	0	2	0%	0	0	--	--	0.022	--	NA	NA
Diazepam	µg/L	2	0	2	0%	0	0	--	--	0.0195	--	NA	NA
Diclofenac	µg/L	2	0	2	0%	0	0	--	--	0.0385	--	NA	NA
Diethylstilbestrol*	µg/L	1	0	1	0%	0	0	--	--	0.02	--	NA	NA
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	µg/L	2	0	2	0%	0	0	--	--	0.095	--	NA	NA
Estradiol*	µg/L	1	0	1	0%	0	0	--	--	0.02	--	NA	NA
Estriol*	µg/L	1	0	1	0%	0	0	--	--	0.02	--	NA	NA
Estrone*	µg/L	1	0	1	0%	0	0	--	--	0.1	--	NA	NA
Ethinyl Estradiol*	µg/L	1	0	1	0%	0	0	--	--	0.02	--	NA	NA
Fluoxetine*	µg/L	1	0	1	0%	0	0	--	--	0.02	--	NA	NA
Gemfibrozil	µg/L	2	1	1	50%	0.055	0.055	0.055	0.055	0.042	0.055	0.00003	0.0003
Hydrocodone	µg/L	2	0	2	0%	0	0	--	--	0.385	--	NA	NA
Ibuprofen	µg/L	2	0	2	0%	0	0	--	--	0.385	--	NA	NA
Iopromide	µg/L	2	1	1	50%	0.17	0.17	0.17	0.17	0.23	0.17	0.0000000004	0.000000004
Meprobamate	µg/L	2	0	2	0%	0	0	--	--	0.095	--	NA	NA
Methadone	µg/L	2	1	1	50%	0.21	0.21	0.21	0.21	0.13	0.21	0.000001	0.00001
Naproxen	µg/L	2	2	0	100%	--	--	0.14	0.49	0.315	0.49	0.001	0.007
DEET (N,N-Diethyl-3-Methyl Benzamide)	µg/L	2	1	1	50%	0.24	0.24	0.24	0.24	0.72	0.24	0.000003	0.00003
Oxybenzone	µg/L	2	0	2	0%	0	0	--	--	0.114	--	NA	NA
Pentoxifylline	µg/L	2	0	2	0%	0	0	--	--	0.0195	--	NA	NA
Progesterone	µg/L	2	0	2	0%	0	0	--	--	0.195	--	NA	NA
Salicylic Acid	µg/L	2	2	0	100%	--	--	0.91	2.9	1.9	2.9	0.00002	0.002
Sulfamethoxazole	µg/L	2	1	1	50%	0.043	0.043	0.043	0.043	0.0265	0.043	0.00004	0.002
Testosterone	µg/L	2	0	2	0%	0	0	--	--	0.195	--	NA	NA
Triclosan*	µg/L	0	0	0	NA	--	--	--	--	--	--	NA	NA
Trimethoprim*	µg/L	1	0	1	0%	0	0	--	--	0.036	--	NA	NA
Other													
Ammonia	mg/L	2	2	0	100%	--	--	0.71	0.71	0.71	0.71	0.039	0.015

EPC - Exposure Point Concentration
NA - Not Applicable
-- Not Available
Notes:
* Some results were rejected for some samples based on data validation. The number of samples shown exclude the rejected results
Means were calculated using the full reporting detection limit for non-detect results
ChV - Hazard quotient was based on comparison to the selected chronic surface water screening value
AV - Hazard quotient was based on comparison to the selected acute surface water screening value
Highlighting indicates HQs > 1, identifing the potential for ecological risk at detected concentrations

Table 15
Ecological Risk Characterization for CSO Water - Wet Event 1
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

	Canal Wet Event 1 - CSO Water (N=5; July 13)											
	Units	Number of Samples Available	Number of Detections	Frequency of Detection	Minimum Reporting Detection Limit	Maximum Reporting Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration	Mean	EPC	Hazard Quotient (AV)	Hazard Quotient (ChV)
Other SVOCs												
Bisphenol A	µg/L	5	3	60%	0.4	0.4	0.88	1.3	0.796	1.3	0.006	0.057
Nonylphenol	µg/L	5	4	80%	2	2	4.2	27	11.3	27	3.857	15.882
Nonylphenol Diethoxylate	µg/L	5	1	20%	8	8	10	10	8.4	10	1.429	5.882
Nonylphenol Monoethoxylate	µg/L	5	1	20%	4	4	5	5	4.2	5	0.714	2.941
4-tert-Octylphenol	µg/L	5	0	0%	0.4	0.4	--	--	0.4	--	NA	NA
Total Cyanide												
Free Cyanide	µg/L	5	0	0%	10	10	--	--	10	--	NA	NA
PPCPs												
Acetaminophen	µg/L	5	5	100%	--	--	0.091	4	1.26	4	0.0002	0.002
alpha-Estradiol	µg/L	5	0	0%	0.0011	0.1	--	--	0.023	--	NA	NA
Androstenedione	µg/L	5	0	0%	0.011	1	--	--	0.302	--	NA	NA
Atrazine	µg/L	5	0	0%	0.0011	0.1	--	--	0.0302	--	NA	NA
Bisphenol A	µg/L	5	2	40%	0.043	1	0.6	0.064	0.477	0.064	0.0003	0.003
Caffeine	µg/L	5	0	0%	0.32	12	--	--	6.4	--	NA	NA
Carbamazepin	µg/L	5	0	0%	0.0011	0.1	--	--	0.0302	--	NA	NA
Diazepam	µg/L	5	0	0%	0.0011	0.1	--	--	0.0302	--	NA	NA
Diclofenac	µg/L	5	0	0%	0.0023	0.2	--	--	0.0603	--	NA	NA
Diethylstilbestrol	µg/L	5	0	0%	0.0023	0.2	--	--	0.046	--	NA	NA
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	µg/L	5	0	0%	0.0057	0.5	--	--	0.151	--	NA	NA
Estradiol	µg/L	5	1	20%	0.0023	0.2	0.0063	0.0063	0.0465	0.0063	0.0002	1.050
Estriol	µg/L	5	1	20%	0.0023	0.2	0.022	0.022	0.0464	0.022	0.00001	1.100
Estrone	µg/L	5	1	20%	0.011	1	0.1	0.1	0.23	0.1	0.0002	0.128
Ethinyl Estradiol	µg/L	5	0	0%	0.0023	0.2	--	--	0.046	--	NA	NA
Fluoxetine	µg/L	5	0	0%	0.0023	0.2	--	--	0.0531	--	NA	NA
Gemfibrozil	µg/L	5	2	40%	0.02	0.1	0.015	0.063	0.0436	0.063	0.00003	0.0003
Hydrocodone	µg/L	5	0	0%	0.023	2	--	--	0.603	--	NA	NA
Ibuprofen	µg/L	5	1	20%	0.023	2	1	1	0.763	1	0.0004	0.075
Iopromide	µg/L	5	1	20%	0.1	1	0.031	0.031	0.306	0.031	0.0000000001	0.000000001
Meprobamate	µg/L	5	0	0%	0.0057	0.5	--	--	0.151	--	NA	NA
Methadone	µg/L	5	0	0%	0.0057	0.5	--	--	0.151	--	NA	NA
Naproxen	µg/L	5	5	100%	--	--	0.014	2.6	1.05	2.6	0.004	0.039
DEET (N,N-Diethyl-3-Methyl Benzamide)	µg/L	5	0	0%	0.038	0.5	--	--	0.237	--	NA	NA
Oxybenzone	µg/L	5	0	0%	0.0023	0.2	--	--	0.0963	--	NA	NA
Pentoxifylline	µg/L	5	0	0%	0.0011	0.1	--	--	0.0302	--	NA	NA
Progesterone	µg/L	5	0	0%	0.011	1	--	--	0.302	--	NA	NA
Salicylic Acid	µg/L	5	4	80%	4.5	4.5	0.24	6.1	3.63	6.1	0.00004	0.005
Sulfamethoxazole	µg/L	5	1	20%	0.01	0.1	0.0028	0.0028	0.0306	0.0028	0.000003	0.0001
Testosterone	µg/L	5	0	0%	0.011	1	--	--	0.302	--	NA	NA
Triclosan	µg/L	5	0	0%	0.028	2.5	--	--	0.664	--	NA	NA
Trimethoprim*	µg/L	4	0	0%	0.0098	0.5	--	--	0.142	--	NA	NA
Other												
Ammonia	mg/L	5	5	100%	--	--	2	14.8	5.86	14.8	0.822	5.481

EPC - Exposure Point Concentration
NA - Not Applicable
-- Not Available
Notes:
* Some results were rejected for some samples based on data validation. The number of samples shown exclude the rejected results
Means were calculated using the full reporting detection limit for non-detect results
ChV - Hazard quotient was based on comparison to the selected chronic CSO water screening value
AV - Hazard quotient was based on comparison to the selected acute CSO water screening value
Highlighting indicates HQs > 1, identifing the potential for ecological risk at detected concentrations

Table 16
Ecological Risk Characterization for CSO Water - Wet Event 2
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

	Canal Wet Event 2 - CSO Water (N=2; September 28)											
	Units	Number of Samples Available	Number of Detections	Frequency of Detection	Minimum Reporting Detection Limit	Maximum Reporting Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration	Mean	EPC	Hazard Quotient (AV)	Hazard Quotient (ChV)
Other SVOCs												
Bisphenol A	µg/L	2	0	0%	0.4	0.45	--	--	0.425	--	NA	NA
Nonylphenol	µg/L	2	2	100%	--	--	4.7	9	6.85	9	1.286	5.294
Nonylphenol Diethoxylate	µg/L	2	0	0%	8	8.9	--	--	8.45	--	NA	NA
Nonylphenol Monoethoxylate	µg/L	2	1	50%	4.5	4.5	8.5	8.5	6.5	8.5	1.214	5.000
4-tert-Octylphenol	µg/L	2	0	0%	0.4	0.45	--	--	0.425	--	NA	NA
Total Cyanide												
Free Cyanide	µg/L	2	0	0%	10	10	--	--	10	--	NA	NA
PPCPs												
Acetaminophen	µg/L	2	2	100%	--	--	2.1	18	10	18	0.001	0.010
alpha-Estradiol	µg/L	2	0	0%	0.02	0.02	--	--	0.02	--	NA	NA
Androstenedione	µg/L	2	0	0%	0.1	0.1	--	--	0.1	--	NA	NA
Atrazine	µg/L	2	0	0%	0.01	0.01	--	--	0.01	--	NA	NA
Bisphenol A	µg/L	2	2	100%	--	--	0.66	0.71	0.685	0.71	0.003	0.031
Caffeine	µg/L	2	1	50%	0.05	0.05	22	22	11	22	0.0004	0.001
Carbamazepin	µg/L	2	2	100%	--	--	0.027	0.2	0.114	0.2	0.00002	0.500
Diazepam	µg/L	2	0	0%	0.01	0.01	--	--	0.01	--	NA	NA
Diclofenac	µg/L	2	0	0%	0.02	0.02	--	--	0.02	--	NA	NA
Diethylstilbestrol	µg/L	2	0	0%	0.02	0.02	--	--	0.02	--	NA	NA
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	µg/L	2	0	0%	0.05	0.05	--	--	0.05	--	NA	NA
Estradiol	µg/L	2	0	0%	0.05	0.05	--	--	0.05	--	NA	NA
Estriol	µg/L	2	1	50%	0.02	0.02	0.092	0.092	0.056	0.092	0.0001	4.600
Estrone	µg/L	2	0	0%	0.1	0.1	--	--	0.1	--	NA	NA
Ethinyl Estradiol	µg/L	2	0	0%	0.02	0.02	--	--	0.02	--	NA	NA
Fluoxetine	µg/L	2	1	50%	0.02	0.02	0.025	0.025	0.0225	0.025	0.0001	0.278
Gemfibrozil	µg/L	2	2	100%	--	--	0.023	0.098	0.0605	0.098	0.00005	0.0005
Hydrocodone	µg/L	2	0	0%	0.2	0.2	--	--	0.2	--	NA	NA
Ibuprofen	µg/L	2	1	50%	0.25	0.25	1.9	1.9	1.08	1.9	0.001	0.143
Iopromide	µg/L	2	0	0%	0.1	0.1	--	--	0.1	--	NA	NA
Meprobamate	µg/L	2	0	0%	0.05	0.05	--	--	0.05	--	NA	NA
Methadone	µg/L	2	0	0%	0.05	0.05	--	--	0.05	--	NA	NA
Naproxen	µg/L	2	2	100%	--	--	0.21	2.3	1.26	2.3	0.003	0.035
DEET (N,N-Diethyl-3-Methyl Benzamide)	µg/L	2	0	0%	0.05	2.2	--	--	1.12	--	NA	NA
Oxybenzone	µg/L	2	0	0%	0.038	0.06	--	--	0.049	--	NA	NA
Pentoxifylline	µg/L	2	1	50%	0.01	0.01	0.024	0.024	0.017	0.024	0.00001	0.0001
Progesterone	µg/L	2	0	0%	0.1	0.1	--	--	0.1	--	NA	NA
Salicylic Acid	µg/L	2	1	50%	1.4	1.4	14	14	7.7	14	0.0001	0.010
Sulfamethoxazole	µg/L	2	2	100%	--	--	0.021	0.056	0.0385	0.056	0.0001	0.002
Testosterone	µg/L	2	0	0%	0.1	0.1	--	--	0.1	--	NA	NA
Triclosan	µg/L	0	0	NA	0	0	--	--	--	--	NA	NA
Trimethoprim	µg/L	2	1	50%	0.05	0.05	0.12	0.12	0.085	0.12	0.00001	0.00001
Other												
Ammonia	mg/L	2	2	100%	--	--	7.5	9.1	8.3	9.1	0.506	3.370

EPC - Exposure Point Concentration
NA - Not Applicable
-- Not Available
Notes:
* Some results were rejected for some samples based on data validation. The number of samples shown exclude the rejected results
Means were calculated using the full reporting detection limit for non-detect results
ChV - Hazard quotient was based on comparison to the selected chronic CSO water screening value
AV - Hazard quotient was based on comparison to the selected acute CSO water screening value
Highlighting indicates HQs > 1, identifing the potential for ecological risk at detected concentrations

Table 17
Ecological Risk Characterization for CSO Water - Wet Event 3
CSO/Gowanus Canal Sampling Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

Canal Wet Event 3 - CSO Water (N=9; September 30 - October 1)												
	Units	Number of Samples Available	Number of Detections	Frequency of Detection	Minimum Reporting Detection Limit	Maximum Reporting Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration	Mean	EPC	Hazard Quotient (AV)	Hazard Quotient (ChV)
Other SVOCs												
Bisphenol A	µg/L	9	2	22%	0.4	0.67	0.56	0.67	0.464	0.67	0.003	0.030
Nonylphenol	µg/L	9	8	89%	2	2	2	24	6.98	24	3.429	14.118
Nonylphenol Diethoxylate	µg/L	9	0	0%	8	9	--	--	8.44	--	NA	NA
Nonylphenol Monoethoxylate	µg/L	9	0	0%	4	4.5	--	--	4.24	--	NA	NA
4-tert-Octylphenol	µg/L	9	0	0%	0.4	0.45	--	--	0.424	--	NA	NA
Total Cyanide												
Free Cyanide	µg/L	9	0	0%	10	10	--	--	10	--	NA	NA
PPCPs												
Acetaminophen	µg/L	9	8	89%	0.1	0.1	0.1	22	4.02	22	0.001	0.013
alpha-Estradiol	µg/L	9	0	0%	0.02	0.02	--	--	0.02	--	NA	NA
Androstenedione	µg/L	9	0	0%	0.1	0.1	--	--	0.1	--	NA	NA
Atrazine	µg/L	9	0	0%	0.01	0.01	--	--	0.01	--	NA	NA
Bisphenol A	µg/L	9	9	100%	--	--	0.46	1.3	0.678	1.3	0.006	0.057
Caffeine	µg/L	9	7	78%	0.05	0.05	0.05	30	9.27	30	0.001	0.001
Carbamazepin	µg/L	9	3	33%	0.01	0.01	0.01	0.24	0.0361	0.24	0.00002	0.600
Diazepam	µg/L	9	0	0%	0.01	0.01	--	--	0.01	--	NA	NA
Diclofenac	µg/L	9	0	0%	0.02	0.02	--	--	0.02	--	NA	NA
Diethylstilbestrol	µg/L	9	0	0%	0.02	0.02	--	--	0.02	--	NA	NA
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	µg/L	9	0	0%	0.05	0.05	--	--	0.05	--	NA	NA
Estradiol	µg/L	9	0	0%	0.05	0.05	--	--	0.05	--	NA	NA
Estriol	µg/L	9	2	22%	0.02	0.02	0.02	0.094	0.0284	0.094	0.0001	4.700
Estrone	µg/L	9	0	0%	0.1	0.1	--	--	0.1	--	NA	NA
Ethinyl Estradiol	µg/L	9	0	0%	0.02	0.02	--	--	0.02	--	NA	NA
Fluoxetine	µg/L	8	0	0%	0.02	0.022	--	--	0.0202	--	NA	NA
Gemfibrozil	µg/L	9	7	78%	0.01	0.01	0.01	0.17	0.0414	0.17	0.0001	0.001
Hydrocodone	µg/L	9	0	0%	0.2	0.2	--	--	0.2	--	NA	NA
Ibuprofen	µg/L	9	2	22%	0.2	0.2	0.2	2.5	0.6	2.5	0.001	0.188
Iopromide	µg/L	9	1	11%	0.1	0.1	0.1	0.25	0.117	0.25	0.000000001	0.00000001
Meprobamate	µg/L	9	0	0%	0.05	0.05	--	--	0.05	--	NA	NA
Methadone	µg/L	9	0	0%	0.05	0.05	--	--	0.05	--	NA	NA
Naproxen	µg/L	9	9	100%	--	--	0.025	2.9	0.553	2.9	0.004	0.044
DEET (N,N-Diethyl-3-Methyl Benzamide)	µg/L	9	0	0%	0.05	3.4	--	--	0.546	--	NA	NA
Oxybenzone	µg/L	9	0	0%	0.02	0.093	--	--	0.0281	--	NA	NA
Pentoxifylline	µg/L	9	1	11%	0.01	0.01	0.021	0.021	0.0112	0.021	0.00001	0.0001
Progesterone	µg/L	9	0	0%	0.1	0.1	--	--	0.1	--	NA	NA
Salicylic Acid	µg/L	9	1	11%	0.45	16	16	16	2.52	16	0.0001	0.012
Sulfamethoxazole	µg/L	9	2	22%	0.01	0.18	0.085	0.18	0.0372	0.18	0.0002	0.007
Testosterone	µg/L	9	0	0%	0.1	0.1	--	--	0.1	--	NA	NA
Triclosan*	µg/L	3	0	0%	0.25	0.25	--	--	0.25	--	NA	NA
Trimethoprim*	µg/L	6	2	33%	0.05	0.16	0.099	0.16	0.0765	0.16	0.00001	0.00001
Other												
Ammonia	mg/L	9	8	89%	0.15	0.15	0.15	4.3	0.966	4.3	0.239	1.593

EPC - Exposure Point Concentration
NA - Not Applicable
-- Not Available
Notes:
* Some results were rejected for some samples based on data validation. The number of samples shown exclude the rejected results
Means were calculated using the full reporting detection limit for non-detect results
ChV - Hazard quotient was based on comparison to the selected chronic CSO water screening value
AV - Hazard quotient was based on comparison to the selected acute CSO water screening value
Highlighting indicates HQs > 1, identifing the potential for ecological risk at detected concentrations

Table 18
Ecological Risk Characterization -Elevated Chronic Value and Acute Value Hazard Quotients
CSO/Gowanus Canal Sampling Report and Risk Assessment
Gowanus Canal Superfund Site
Brooklyn, New York

	CSO Water						Canal Surface Water	Canal Sediment	
	ChV HQ			AV HQ			ChV HQ	ChV HQ	ChV HQ
	Event 1 (n=4)	Event 2 (n=2)	Event 3 (n=9)	Event 1 (n=4)	Event 2 (n=2)	Event 3 (n=9)	Wet Event (n=2)	Dry Event (n=8)	Wet Event (n=2)
Nonylphenol	15.882	5.294	14.118	3.857	1.286	3.429	3.176	9.1	7.6
Nonylphenol Diethoxylate	5.882	-	-	1.429	-	-	-	-	-
Nonylphenol Monoethoxylate	2.941	5	-	-	1.214	-	-	9.3	-
Estradiol	1.05	-	-	-	-	-	-	5.429	-
alpha-Estradiol	-	-	-	-	-	-	-	1.347	-
Estriol	1.1	4.6	4.7	-	-	-	-		-
Fluoxetine	-	-	-	-	-	-	-	33.333	-
Ammonia	5.481	3.37	1.593	-	-	-	-	-	-

Pharmaceutical and personal care products (PPCPs) with chronic value (ChV) and acute value (AV) hazard quotients (HQs) greater than one, by media and sampling event.

Note:

- Not applicable

Table 19
Summary of Screening Level Ecological Risk Assement
CSO/Gowanus Canal Sampling Report and Risk Assessment
Gowanus Canal Superfund Site
Brooklyn, New York

Assessment Endpoint		Measurement Endpoint Components		Risk Characterization Results*	
		Measure of Exposure	Measure of Effect	Acute SV HQ>1	Chronic SV HQ>1
1	Survival of pelagic fish populations in the canal	Maximum PPCP concentrations in Canal surface water and CSO water	Exceedance of surface water and CSO water acute SVs	Canal surface water · No Exceedances CSO water · Nonylphenol (1.286 – 3.857) · Nonylphenol Diethoxylate (1.429) · Nonylphenol Monoethoxylate (1.214)	Not applicable
2	Survival of benthic fish populations in the canal	Maximum PPCP concentrations in canal surface water, CSO water, and canal sediment	Exceedance of surface water, CSO water, and sediment acute SVs	Canal surface water · No Exceedances CSO water · Nonylphenol (1.286 – 3.857) · Nonylphenol Diethoxylate (1.429) · Nonylphenol Monoethoxylate (1.214) Canal sediment · No Exceedances	Not applicable
3	Survival, growth, and reproduction of plants, zooplankton, and epibenthic invertebrates in the canal	Maximum PPCP concentrations in Canal surface water and CSO water	Exceedance of surface water and CSO water acute and chronic SVs	Canal surface water · No Exceedances CSO water · Nonylphenol (1.286 – 3.857) · Nonylphenol Diethoxylate (1.429) · Nonylphenol Monoethoxylate (1.214)	Canal surface water · Nonylphenol (3.176) CSO water · Nonylphenol (5.294 – 15.882) · Nonylphenol Diethoxylate (5.882) · Nonylphenol Monoethoxylate (2.941 – 5.000) · Estradiol (1.050) · Estriol (1.100 – 4.700) · Ammonia (1.593 – 5.481)
4	Survival, growth, and reproduction of benthic invertebrates in the canal	Maximum PPCP concentrations in canal surface water , CSO water, and canal sediment	Exceedance of surface water, CSO water, and sediment acute and chronic SVs	Canal surface water · No Exceedances CSO water · Nonylphenol (1.286 – 3.857) · Nonylphenol Diethoxylate (1.429) · Nonylphenol Monoethoxylate (1.214) Canal sediment · No Exceedances	Canal surface water · Nonylphenol (3.176) CSO water · Nonylphenol (5.294 – 15.882) · Nonylphenol Diethoxylate (5.882) · Nonylphenol Monoethoxylate (2.941 – 5.000) · Estradiol (1.050) · Estriol (1.100 – 4.700) · Ammonia (1.593 – 5.481) Canal Sediment · Nonylphenol (7.600 – 9.100) · Nonylphenol Monoethoxylate (9.300) · alpha-Estradiol (1.347) · Estradiol (5.429) · Fluoxetine (33.333)

Note:

*Range of hazard quotients (HQs) calculated across multiple events, where applicable, is included in parentheses following PPCP.

Table 20
Human Health Risk Assessment - Chemicals of Potential Concern and Exposure Point Concentrations
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

COPC	PPCP Use	Maximum Detected Sediment Concentration (mg/kg)	Maximum Detected Surface Water Concentration (ug/L)	Maximum Detected CSO Water Concentration (ug/L)
Semivolatile EDCs and PPCPs				
Bisphenol A	Alkyphenol	1.8	1.2	1.3
Nonylphenol	Alkyphenol	9.1	5.4	27
Nonylphenol Diethoxylate	Alkyphenol	-	-	10
Nonylphenol Monoethoxylate	Alkyphenol	9.3	-	8.5
EDCs and PPCPs				
Acetaminophen	Analgesic	0.0069	1.8	18
alpha-Estradiol	Estrogen	0.0067	-	-
Caffeine	Stimulant	0.13	0.21	22
Carbamazepin	Anti-seizure	0.0066	0.0085	0.24
Diclofenac	Anti-arthritic	-	0.0026	-
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	Anti-convulsant	-	0.0079	-
Estradiol (beta)	Estrogen	0.027	0.0023	0.0063
Estriol	Estrogen	-	-	0.094
Estrone	Estrogen	0.021	-	0.1
Fluoxetine	Anti-depressant	0.023	-	0.025
Gemfibrozil	Lipid Regulator	-	0.055	0.098
Ibuprofen	Anti-inflammatory	-	0.05	2.5
Iopromide	Contrast Enhancer	-	0.17	0.031
Methadone	Opiate	-	0.21	-
Naproxen	Anti-inflammatory	0.016	0.49	2.9
DEET (N,N-Diethyl-3-Methyl Benzamide)	Insect Repellent	-	0.24	-
Oxybenzone	Sun Screen	0.015	-	-
Pentoxifylline	Improve Blood Flow	0.0035	0.0012	0.024
Progesterone	Estrogen	0.43	-	-
Salicylic Acid	Skin Care	-	2.9	16
Sulfamethoxazole	Antibiotic	-	0.043	0.18
Testosterone	Androgen	0.12	-	
Trimethoprim	Anti-bacterial	-	-	0.16
Other				
Ammonia	-	446	710	23,800
Pathogen				
Units:		**CFU/g**	**CFU / 100 mL**	**CFU / 100 mL**
C. perfringens		3,300	15,000	1,300,000
Coliphage, Male Specific		-	8,069	82,400
Coliphage, Somatic		-	7,049	24,440
Enterococci		5,300	120,000	1,400,000
Fecal Coliform		12,000	110,000	3,700,000
E.Coli		7,400	240,000	4,400,000
Giardia (Cysts / L)		-	0.1	517.1

Notes:
1. "-" COPC was non-detect in medium of concern.
2. CFU - colony forming units.

Table 21
Human Health Risk Assessment - Exposure Assumptions
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

Exposure Route	Average Daily Dose (ADD) Equations	Exposure Parameters		Units	Adult Recreational Visitor		Child Recreational Visitor		Outdoor Worker	
					Value	Source	Value	Source	Value	Source
Water Ingestion (mg/kg-day)	(EPC x IR x EF x ED x CF) / (BW x AT)	EPC	Exposure Point Concentration	ug/L or mg/kg	Maximum	EPC Table	Maximum	EPC Table		
		BW	Body Weight	kg	70	EPA 2010	15	EPA 2010		
		ED	Exposure Duration	years	30	EPA 2010	6	EPA 2010		
		AT	Averaging Time	days	10,950	EPA 2010	2,190	EPA 2010		
		IR	Water Ingestion Rate	L/day	0.13	EPA 2011	0.13	EPA 2011		
		EF	Exposure Frequency	days/year	26	EPA 2011	26	EPA 2011		
		CF	Conversion Factor	mg/ug	1.00E-03		1.00E-03			
Sediment Ingestion (mg/kg-day)	(EPC x IR x EF x ED x CF) / (BW x AT)	IR	Sediment Ingestion Rate	mg/day	50	EPA 2011	100	EPA 2011	100	EPA 2011
		EF	Exposure Frequency	days/year	26	EPA 2011	26	EPA 2011	250	EPA 2010
		CF	Conversion Factor	kg/mg	1.00E-06		1.00E-06		1.00E-06	
Sediment Dermal Contact (mg/kg-day)	(EPC x SA x AF x ABSd x EF x ED x CF) / (BW x AT)	SA	Exposed Surface Area	cm2/day	5,700	EPA 2010	2,800	EPA 2010	3,300	EPA 2010
		AF	Sediment to Skin Adhrence Factor	mg/cm2	1	EPA 2004	1	EPA 2004	1	EPA 2004
		ABSd	Dermal Absorption Factor	unitless	0.1	EPA 2004	0.1	EPA 2004	0.1	EPA 2004
		EF	Exposure Frequency	days/year	26	EPA 2011	26	EPA 2011	250	EPA 2011
		CF	Conversion Factor	kg/mg	1.00E-06		1.00E-06		1.00E-06	
Fish Ingestion (mg/kg-day)	(EPC x IR x EF x ED x BCF x CF) / (BW x AT)	IR	Fish Ingestion Rate	kg/day	0.026	EPA 2011	0.009	EPA 2011		
		EF	Exposure Frequency	events/year	365	EPA 2011	365	EPA 2011		
		BCF	Bio-concentration Factor	L/kg	see	BCF Table	see	BCF Table		
		CF	Conversion Factor	mg/ug	0.001					

Table 22
Toxicity Values and Bio-Concentration Factors
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

COPC	BCF (L/kg) (1)	Acceptable Daily Intake (ADI) (mg/kg-day)	ADI Source	ADI Notes
Semi Volatile EDCs and PPCPs				
Bisphenol A	72	0.05	USEPA, IRIS	RfD Value
Nonylphenol	124	0.005	Danish EPA, 2000	Tolerable Daily Intake
Nonylphenol Diethoxylate	-	0.013	Danish EPA, 2000	Danish EPA, 2000
Nonylphenol Monoethoxylate	52	0.013	Danish EPA, 2000	Danish EPA, 2000
EDCs and PPCPs				
Acetaminophen	3.16	0.05	USEPA, 2009	
alpha-Estradiol	205	5.00E-05	USEPA, 2009	
Caffeine	3.16	0.001	USFDA, 2011	MRTD / SF = 10,000
Carbamazepin	19.2	3.40E-04	Snyder et al., 2008	Derived from cancer endpoint using MTD
Diclofenac	3.16	5.00E-04	Australian Guidelines, 2008	
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	3.16	1.90E-04	Snyder et al., 2008	Derived from cancer endpoint using tumor data and one hit model
Estradiol (beta)	205	5.00E-05	Australian Guidelines, 2008	
Estriol	19.2	1.40E-06	Australian Guidelines, 2008	
Estrone	54	8.60E-07	Australian Guidelines, 2008	
Fluoxetine	154	2.00E-04	IL EPA, 2008	
Gemfibrozil	3.16	1.30E-03	Synder et al., 2008	Derived from cancer endpoint using tumor data and one hit model
Ibuprofen	3.16	1.14E-02	Australian Guidelines, 2008	
Iopromide	3.16	2.14E-02	Australian Guidelines, 2008	
Methadone	182	5.00E-05	USFDA, 2011	MRTD / SF = 10,000
Naproxen	3.16	4.40E-03	IL EPA, 2008	
DEET (N,N-Diethyl-3-Methyl Benzamide)	12.7	1.00E-01	IL EPA, 2008	
Oxybenzone	38.2	NA		
Pentoxifylline	3.16	0.002	USFDA, 2011	MRTD / SF = 10,000
Progesterone	166	3.00E-02	Australian Guidelines, 2008	
Salicylic Acid	3.16	0.3	USFDA, 2011	MRTD / SF = 10,000
Sulfamethoxazole	3.16	1.00E-02	Australian Guidelines, 2008	
Testosterone	72	2.00E-03	Australian Guidelines, 2008	
Trimethoprim	3.16	2.00E-03	IL EPA, 2008	
Other				
Ammonia	3.16	0.9	USEPA, 2009	

Notes:

(1) Bio-Concentation Factors (BCF) calculated using US EPA (2010) BCFBAF™ for Microsoft® Windows, v3.01. United States Environmental Protection Agency, Washington, DC, USA.

General Notes:
COPC = Contaminants of potential concern
EDCs and PPCPs = Endocrine disrupting compounds and pharmaceutical and personal care products
NA = Not Available
MRTD = Maximum Recommended Therapeutic Dose (mg/kg-day)
MTD = Maximum Tolerated Dose
LDTD = Lowest Daily Therapeutic Dose

Table 23
Human Health Risk Assessment - Child Recreational Visitor Sediment Risk Estimates
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

COPC	Maximum Detected Concentration (mg/kg)	Child ADD from Ingestion of Sediment (mg/kg/day)	Child ADD from Dermal Absorption of Sediment (mg/kg/day)	Child Sediment Ingestion HI	Child Sediment Dermal Absorption HI	Child Sediment Total HI
Semivolatile EDCs and PPCPs						
Bisphenol A	1.8	8.55E-07	2.39E-06	1.71E-05	4.79E-05	6.E-05
Nonylphenol	9.1	4.32E-06	1.21E-05	8.64E-04	2.42E-03	3.E-03
Nonylphenol Monoethoxylate	9.3	4.42E-06	1.24E-05	3.40E-04	9.51E-04	1.E-03
EDCs and PPCPs						
Acetaminophen	0.0069	3.28E-09	9.17E-09	6.55E-08	1.83E-07	2.E-07
alpha-Estradiol	0.0067	3.18E-09	8.91E-09	6.36E-05	1.78E-04	2.E-04
Caffeine	0.13	6.17E-08	1.73E-07	6.17E-05	1.73E-04	2.E-04
Carbamazepin	0.0066	3.13E-09	8.78E-09	9.22E-06	2.58E-05	4.E-05
Estradiol (beta)	0.027	1.28E-08	3.59E-08	2.56E-04	7.18E-04	1.E-03
Estrone	0.021	9.97E-09	2.79E-08	1.16E-02	3.25E-02	4.E-02
Fluoxetine	0.023	1.09E-08	3.06E-08	5.46E-05	1.53E-04	2.E-04
Naproxen	0.016	7.60E-09	2.13E-08	1.73E-06	4.84E-06	7.E-06
Oxybenzone	0.015	7.12E-09	1.99E-08	NA	NA	NA
Pentoxifylline	0.0035	1.66E-09	4.65E-09	8.31E-07	2.33E-06	3.E-06
Progesterone	0.43	2.04E-07	5.72E-07	6.81E-06	1.91E-05	3.E-05
Testosterone	0.12	5.70E-08	1.60E-07	2.85E-05	7.98E-05	1.E-04
Other						
Ammonia	446	2.12E-04	5.93E-04	2.35E-04	6.59E-04	9.E-04

Notes:
NA - Not Available
COPC = Contaminants of potential concern
EDCs and PPCPs = Endocrine disrupting compounds and pharmaceutical and personal care products
THI = Total Hazard Index

Table 24
Human Health Risk Assessment - Child Recreational Visitor Surface Water Risk Estimates
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

COPC	Maximum Detected Concentration (ug/L)	Child ADD from Ingestion of Surface Water (mg/kg/day)	Child ADD from Ingestion of Fish (mg/kg/day)	Child Surface Water Ingestion HI	Child Fish Ingestion from Surface Water HI	Child Surface Water Total HI
Semivolatile EDCs and PPCPs						
Nonylphenol	5.4	3.33E-06	4.02E-04	7.E-04	8.E-02	8.E-02
EDCs and PPCPs						
Acetaminophen	1.8	1.11E-06	3.41E-06	2.E-05	7.E-05	9.E-05
Bisphenol A	1.2	7.41E-07	5.18E-05	1.E-05	1.E-03	1.E-03
Caffeine	0.21	1.30E-07	3.98E-07	1.E-04	4.E-04	5.E-04
Carbamazepin	0.0085	5.25E-09	9.79E-08	2.E-05	3.E-04	3.E-04
Diclofenac	0.0026	1.61E-09	4.93E-09	3.E-06	1.E-05	1.E-05
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	0.0079	4.88E-09	1.50E-08	3.E-05	8.E-05	1.E-04
Estradiol (beta)	0.0023	1.42E-09	2.83E-07	3.E-05	6.E-03	6.E-03
Gemfibrozil	0.055	3.40E-08	1.04E-07	3.E-05	8.E-05	1.E-04
Ibuprofen	0.05	3.09E-08	9.48E-08	3.E-06	8.E-06	1.E-05
Iopromide	0.17	1.05E-07	3.22E-07	5.E-06	2.E-05	2.E-05
Methadone	0.21	1.30E-07	2.29E-05	3.E-03	5.E-01	5.E-01
Naproxen	0.49	3.03E-07	9.29E-07	7.E-05	2.E-04	3.E-04
DEET (N,N-Diethyl-3-Methyl Benzamide)	0.24	1.48E-07	1.83E-06	1.E-06	2.E-05	2.E-05
Pentoxifylline	0.0012	7.41E-10	2.28E-09	4.E-07	1.E-06	2.E-06
Salicylic Acid	2.9	1.79E-06	5.50E-06	6.E-06	2.E-05	2.E-05
Sulfamethoxazole	0.043	2.65E-08	8.15E-08	3.E-06	8.E-06	1.E-05
Other						
Ammonia	710	4.38E-04	1.35E-03	5.E-04	1.E-03	2.E-03

Notes:
COPC = Contaminants of potential concern
EDCs and PPCPs = Endocrine disrupting compounds and pharmaceutical and personal care products
HI - Hazard Index

Table 25
Human Health Risk Assessment - Child Recreational Visitor CSO Water Risk Estimates
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

COPC	Maximum Detected Concentration (ug/L)	Child ADD from Ingestion of CSO Water (mg/kg/day)	Child ADD from Ingestion of Fish (mg/kg/day)	Child CSO Water Ingestion HI	Child Fish Ingestion from CSO Water HI	Child CSO Water Total HI
Semivolatile EDCs and PPCPs						
Bisphenol A	1.3	8.03E-07	5.62E-05	2.E-05	1.12E-03	1.E-03
Nonylphenol	27	1.67E-05	2.01E-03	3.E-03	4.02E-01	4.E-01
Nonylphenol Diethoxylate	10	6.17E-06	3.12E-04	5.E-04	2.40E-02	2.E-02
Nonylphenol Monoethoxylate	8.5	5.25E-06	2.65E-04	4.E-04	2.04E-02	2.E-02
EDCs and PPCPs						
Acetaminophen	18	1.11E-05	3.41E-05	2.E-04	6.83E-04	9.E-04
Caffeine	22	1.36E-05	4.17E-05	1.E-02	4.17E-02	6.E-02
Carbamazepin	0.24	1.48E-07	2.76E-06	4.E-04	8.13E-03	9.E-03
Estradiol (beta)	0.0063	3.89E-09	7.75E-07	8.E-05	1.55E-02	2.E-02
Estriol	0.094	5.80E-08	1.08E-06	4.E-02	7.73E-01	8.E-01
Estrone	0.1	6.17E-08	3.24E-06	7.E-02	3.77E+00	4.E+00
Fluoxetine	0.025	1.54E-08	2.31E-06	8.E-05	1.16E-02	1.E-02
Gemfibrozil	0.098	6.05E-08	1.86E-07	5.E-05	1.43E-04	2.E-04
Ibuprofen	2.5	1.54E-06	4.74E-06	1.E-04	4.16E-04	6.E-04
Iopromide	0.031	1.91E-08	5.88E-08	9.E-07	2.75E-06	4.E-06
Naproxen	2.9	1.79E-06	5.50E-06	4.E-04	1.25E-03	2.E-03
Pentoxifylline	0.024	1.48E-08	4.55E-08	7.E-06	2.28E-05	3.E-05
Salicylic Acid	16	9.88E-06	3.03E-05	3.E-05	1.01E-04	1.E-04
Sulfamethoxazole	0.18	1.11E-07	3.41E-07	1.E-05	3.41E-05	5.E-05
Trimethoprim	0.16	9.88E-08	3.03E-07	5.E-05	1.52E-04	2.E-04
Other						
Ammonia	23,800	1.47E-02	4.51E-02	2.E-02	5.01E-02	7.E-02

Notes:
COPC = Contaminants of potential concern
EDCs and PPCPs = Endocrine disrupting compounds and pharmaceutical and personal care products
THI = Total Hazard Index

Table 26
Human Health Risk Assessment - Adult Recreational Visitor Sediment Risk Estimates
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

COPC	Maximum Detected Concentration (mg/kg)	Adult ADD from Ingestion of Sediment (mg/kg/day)	Adult ADD from Dermal Absorption of Sediment (mg/kg/day)	Adult Sediment Ingestion HI	Adult Sediment Dermal Absorption HI	Adult Sediment Total HI
Semivolatile EDCs and PPCPs						
Bisphenol A	1.8	9.16E-08	1.04E-06	1.83E-06	2.09E-05	2.E-05
Nonylphenol	9.1	4.63E-07	5.28E-06	9.26E-05	1.06E-03	1.E-03
Nonylphenol Monoethoxylate	9.3	4.73E-07	5.39E-06	3.64E-05	4.15E-04	5.E-04
EDCs and PPCPs						
Acetaminophen	0.0069	3.51E-10	4.00E-09	7.02E-09	8.00E-08	9.E-08
alpha-Estradiol	0.0067	3.41E-10	3.89E-09	6.82E-06	7.77E-05	8.E-05
Caffeine	0.13	6.61E-09	7.54E-08	6.61E-06	7.54E-05	8.E-05
Carbamazepin	0.0066	3.36E-10	3.83E-09	9.88E-07	1.13E-05	1.E-05
Estradiol (beta)	0.027	1.37E-09	1.57E-08	2.75E-05	3.13E-04	3.E-04
Estrone	0.021	1.07E-09	1.22E-08	1.24E-03	1.42E-02	2.E-02
Fluoxetine	0.023	1.17E-09	1.33E-08	5.85E-06	6.67E-05	7.E-05
Naproxen	0.016	8.14E-10	9.28E-09	1.85E-07	2.11E-06	2.E-06
Oxybenzone	0.015	7.63E-10	8.70E-09			
Pentoxifylline	0.0035	1.78E-10	2.03E-09	8.90E-08	1.02E-06	1.E-06
Progesterone	0.43	2.19E-08	2.49E-07	7.29E-07	8.31E-06	9.E-06
Testosterone	0.12	6.11E-09	6.96E-08	3.05E-06	3.48E-05	4.E-05
Other						
Ammonia	446	2.27E-05	2.59E-04	2.52E-05	2.87E-04	3.E-04

Notes:
COPC = Contaminants of potential concern
EDCs and PPCPs = Endocrine disrupting compounds and pharmaceutical and personal care products
HI = Hazard Index

Table 27
Human Health Risk Assessment - Adult Recreational Visitor Surface Water Risk Estimates
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

COPC	Maximum Detected Concentration (ug/L)	Adult ADD from Ingestion of Surface Water (mg/kg/day)	Adult ADD from Ingestion of Fish (mg/kg/day)	Adult Surface Water Ingestion HI	Adult Fish Ingestion HI	Adult Surface Water Total HI
Semivolatile EDCs and PPCPs						
Nonylphenol	5.4	7.14E-07	2.49E-04	1.E-04	5.E-02	5.E-02
EDCs and PPCPs						
Acetaminophen	1.8	2.38E-07	2.11E-06	5.E-06	4.E-05	5.E-05
Bisphenol A	1.2	1.59E-07	3.21E-05	3.E-06	6.E-04	6.E-04
Caffeine	0.21	2.78E-08	2.46E-07	3.E-05	2.E-04	3.E-04
Carbamazepin	0.0085	1.12E-09	6.06E-08	3.E-06	2.E-04	2.E-04
Diclofenac	0.0026	3.44E-10	3.05E-09	7.E-07	6.E-06	7.E-06
Phenytoin (5,5-Diphenylhydantoin / Dilantin)	0.0079	1.05E-09	9.27E-09	6.E-06	5.E-05	5.E-05
Estradiol (beta)	0.0023	3.04E-10	1.75E-07	6.E-06	4.E-03	4.E-03
Gemfibrozil	0.055	7.28E-09	6.46E-08	6.E-06	5.E-05	6.E-05
Ibuprofen	0.05	6.61E-09	5.87E-08	6.E-07	5.E-06	6.E-06
Iopromide	0.17	2.25E-08	2.00E-07	1.E-06	9.E-06	1.E-05
Methadone	0.21	2.78E-08	1.42E-05	6.E-04	3.E-01	3.E-01
Naproxen	0.49	6.48E-08	5.75E-07	1.E-05	1.E-04	1.E-04
DEET (N,N-Diethyl-3-Methyl Benzamide)	0.24	3.17E-08	1.13E-06	3.E-07	1.E-05	1.E-05
Pentoxifylline	0.0012	1.59E-10	1.41E-09	8.E-08	7.E-07	8.E-07
Salicylic Acid	2.9	3.84E-07	3.40E-06	1.E-06	1.E-05	1.E-05
Sulfamethoxazole	0.043	5.69E-09	5.05E-08	6.E-07	5.E-06	6.E-06
Other						
Ammonia	710	9.39E-05	8.33E-04	1.E-04	9.E-04	1.E-03

Notes:
COPC = Contaminants of potential concern
EDCs and PPCPs = Endocrine disrupting compounds and pharmaceutical and personal care products
HI = Hazard Index

Table 28
Human Health Risk Assessment - Adult Recreational Visitor CSO Water Risk Estimates
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

COPC	Maximum Detected Concentration (ug/L)	Adult ADD from Ingestion of CSO Water (mg/kg/day)	Adult ADD from Ingestion of Fish (mg/kg/day)	Adult CSO Water Ingestion HI	Adult Fish Ingestion HI	Adult CSO Water Total HI
Semivolatile EDCs and PPCPs						
Bisphenol A	1.3	1.72E-07	3.48E-05	3.E-06	6.95E-04	7.E-04
Nonylphenol	27	3.57E-06	1.24E-03	7.E-04	2.49E-01	2.E-01
Nonylphenol Diethoxylate	10	1.32E-06	1.93E-04	1.E-04	1.49E-02	1.E-02
Nonylphenol Monoethoxylate	8.5	1.12E-06	1.64E-04	9.E-05	1.26E-02	1.E-02
EDCs and PPCPs						
Acetaminophen	18	2.38E-06	2.11E-05	5.E-05	4.23E-04	5.E-04
Caffeine	22	2.91E-06	2.58E-05	3.E-03	2.58E-02	3.E-02
Carbamazepin	0.24	3.17E-08	1.71E-06	9.E-05	5.03E-03	5.E-03
Estradiol (beta)	0.0063	8.33E-10	4.80E-07	2.E-05	9.59E-03	1.E-02
Estriol	0.094	1.24E-08	6.70E-07	9.E-03	4.79E-01	5.E-01
Estrone	0.1	1.32E-08	2.01E-06	2.E-02	2.33E+00	2.E+00
Fluoxetine	0.025	3.31E-09	1.43E-06	2.E-05	7.15E-03	7.E-03
Gemfibrozil	0.098	1.30E-08	1.15E-07	1.E-05	8.85E-05	1.E-04
Ibuprofen	2.5	3.31E-07	2.93E-06	3.E-05	2.57E-04	3.E-04
Iopromide	0.031	4.10E-09	3.64E-08	2.E-07	1.70E-06	2.E-06
Naproxen	2.9	3.84E-07	3.40E-06	9.E-05	7.74E-04	9.E-04
Pentoxifylline	0.024	3.17E-09	2.82E-08	2.E-06	1.41E-05	2.E-05
Salicylic Acid	16	2.12E-06	1.88E-05	7.E-06	6.26E-05	7.E-05
Sulfamethoxazole	0.18	2.38E-08	2.11E-07	2.E-06	2.11E-05	2.E-05
Trimethoprim	0.16	2.12E-08	1.88E-07	1.E-05	9.39E-05	1.E-04
Other						
Ammonia	23800	3.15E-03	2.79E-02	3.E-03	3.10E-02	3.E-02

Notes:
COPC = Contaminants of potential concern
EDCs and PPCPs = Endocrine disrupting compounds and pharmaceutical and personal care products
HI = Hazard Index

Table 29
Outdoor Worker Sediment Risk Estimates
CSO / Gowanus Canal Pathogen Sampling Report
Gowanus Canal Superfund Site
Brooklyn, New York

COPC	Maximum Detected Concentration (mg/kg)	Worker ADD from Ingestion of Sediment (mg/kg/day)	Worker ADD from Dermal Absorption of Sediment (mg/kg/day)	Worker Sediment Ingestion HI	Worker Sediment Dermal Absorption HI	Worker Sediment Total HI
Other SVOCs						
Bisphenol A	1.8	1.76E-06	5.81E-06	3.52E-05	1.16E-04	2.E-04
Nonylphenol	9.1	8.90E-06	2.94E-05	1.78E-03	5.88E-03	8.E-03
Nonylphenol Monoethoxylate	9.3	9.10E-06	3.00E-05	7.00E-04	2.31E-03	3.E-03
Pharmaceutical						
Acetaminophen	0.0069	6.75E-09	2.23E-08	1.35E-07	4.46E-07	6.E-07
alpha-Estradiol	0.0067	6.56E-09	2.16E-08	1.31E-04	4.33E-04	6.E-04
Caffeine	0.13	1.27E-07	4.20E-07	1.27E-04	4.20E-04	5.E-04
Carbamazepin	0.0066	6.46E-09	2.13E-08	1.90E-05	6.27E-05	8.E-05
Estradiol (beta)	0.027	2.64E-08	8.72E-08	5.28E-04	1.74E-03	2.E-03
Estrone	0.021	2.05E-08	6.78E-08	2.39E-02	7.88E-02	1.E-01
Fluoxetine	0.023	2.25E-08	7.43E-08	1.13E-04	3.71E-04	5.E-04
Naproxen	0.016	1.57E-08	5.17E-08	3.56E-06	1.17E-05	2.E-05
Oxybenzone	0.015	1.47E-08	4.84E-08			
Pentoxifylline	0.0035	3.42E-09	1.13E-08	1.71E-06	5.65E-06	7.E-06
Progesterone	0.43	4.21E-07	1.39E-06	1.40E-05	4.63E-05	6.E-05
Testosterone	0.12	1.17E-07	3.87E-07	5.87E-05	1.94E-04	3.E-04
Other						
Ammonia	446	4.36E-04	1.44E-03	4.85E-04	1.60E-03	2.E-03

Table 30
Human Health Risk Assessment - Pathogen Risk Characterization
CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report
Gowanus Canal Superfund Site
Brooklyn, New York

Surface Water

COPC	Units	Geometric Mean Surface Water Concentration (1)	Maximum Detected Surface Water Concentration	Geometric Mean Pathogen Screening Criteria for Bathing (3)	Single Sample Maximum (SSM) Pathogen Screening Criteria for Bathing (3)	Hazard Index for Surface Water Geometric Mean	Hazard Index for Surface Water Maximum
Pathogen							
Enterococci	CFU / 100 mL	430	1,300	35	276	12	5
Fecal Coliform (4)	CFU / 100 mL	213	2,600	200	-	1	-

CSO Water

COPC	Units	Geometric Mean CSO Water Concentration (2)	Maximum Detected CSO Water Concentration	Geometric Mean Pathogen Screening Criteria for Bathing (3)	Single Sample Maximum (SSM) Pathogen Screening Criteria for Bathing (3)	Hazard Index for CSO Water Geometric Mean	Hazard Index for CSO Water Maximum
Pathogen							
Enterococci	CFU / 100 mL	63,562	1,400,000	35	276	1,816	5,072
Fecal Coliform	CFU / 100 mL	66,271	3,700,000	200	-	331	-

Sediment

COPC	Units	Geometric Mean Sediment Concentration (5)	Maximum Sediment Concentration (5)	Geometric Mean Pathogen Screening Criteria for Bathing (3)	Single Sample Maximum (SSM) Pathogen Screening Criteria for Bathing (3)	Hazard Index for Sediment Geometric Mean	Hazard Index for Sediment Maximum
Pathogen							
Enterococci	CFU / 100 mL	35,300	530,000	35	276	1,008	1,920
Fecal Coliform	CFU / 100 mL	27,600	1,200,000	200	-	138	-

General Notes:
"-" Criteria not available.
CFU - colony forming unit.

Notes:
1. Geometric mean surface water concentration calculated based on 8 dry weather surface water samples collected in July, 2010.
2. Geometric mean CSO water concentration calculated based on all CSO water samples collected between June and October, 2010.
3. USEPA Ambient Water Quality Criteria (AWQC) for Marine Recreational Water Use; SSM value based on "lightly used full body contact recreation".
4. The median Fecal coliform concentration for dry surface water samples (274 CFU / 100 mL) exceeds the AWQC of 14 CFU / 100 mL for shellfish harvesting (HI = 20).
5. The pathogen sediment concentration was calculated by converting (CFU / g) to (CFU / 100 g) which was assumed to equal (CFU / 100 mL).

Figures

N

COLUMBIA ST. INTERCEPTOR

FLUSHING TUNNEL

BOND-LORRAINE ST. SEWER

BOERUM HILL

GOWANUS PUMP STATION

CARROLL GARDENS

RH-034

RH-033

RH-038

RH-615

RH-037

RH-036

OH-005

RED HOOK

GOWANUS

RH-035

OH-007

RH-032

OH-008

PARK SLOPE

RH-031

OH-602

RH-614

OH-006

OH-601

OH-024

LEGEND

- STORM OUTFALLS
- CSO OUTFALLS
- PUMPING STATIONS
- WATERBODY/STUDY AREA
- SEPARATE SEWER AREA
- OWL'S HEAD WPCP AREA
- RED HOOK WPCP AREA
- WATERSHED AREA
- DIRECT DRAINAGE AREA

SOURCE:
1. BING AERIAL PHOTOGRAPH © 2008 MICROSOFT CORP.

0 700 1,400 2,800

SCALE, FEET

CSO/GOWANUS CANAL SAMPLING
AND SCREENING-LEVEL RISK ASSESSMENT REPORT
GOWANUS CANAL SUPERFUND SITE
BROOKLYN, NEW YORK

nationalgrid

GEI Consultants

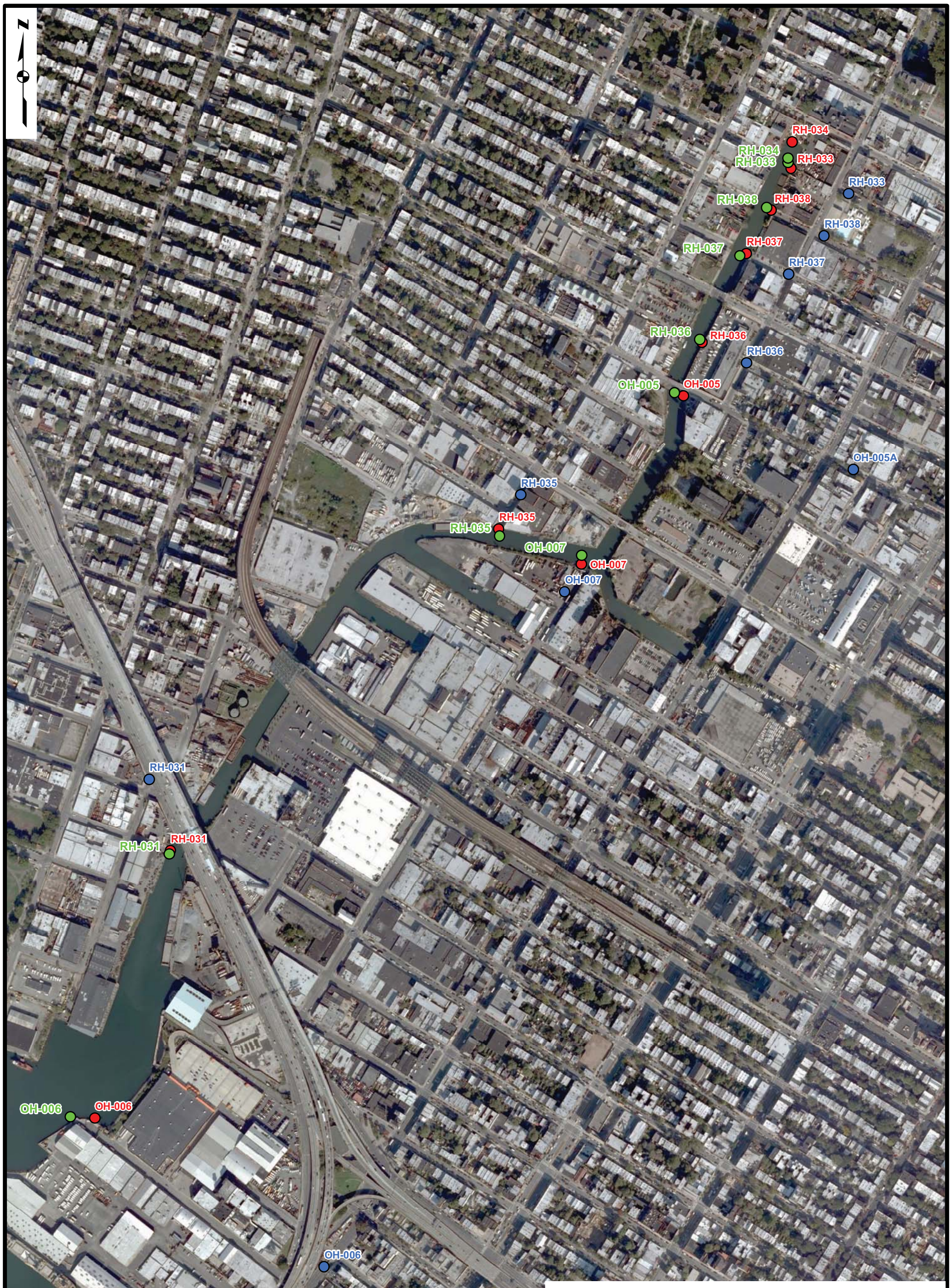
GOWANUS CANAL WATERBODY/WATERSHED STUDY AREA

Proj. 093010-5-1505

April 2011

Figure 1

J:/Projects/National_Grid/Gowanus/2010_CSO_Sample_Locations.mxd



LEGEND

- CSO OUTFALL
- CSO MANHOLE SAMPLE LOCATION
- SEDIMENT AND SURFACE WATER SAMPLE LOCATION

SOURCE:
1. BING AERIAL PHOTOGRAPH © 2008 MICROSOFT CORP.

0 250 500 1,000
SCALE, FEET

CSO/GOWANUS CANAL SAMPLING
AND SCREENING-LEVEL RISK ASSESSMENT REPORT
GOWANUS CANAL SUPERFUND SITE
BROOKLYN, NEW YORK

nationalgrid

GEI Consultants

Proj. 093010-5-1505

CSO SAMPLE LOCATIONS

April 2011 Figure 2

J:/Projects/National_Grid/Gowanus/2010_CSO_Sample_Locations.mxd