FIRST FIVE-YEAR REVIEW REPORT FOR GOWANUS CANAL SUPERFUND SITE KINGS COUNTY, NEW YORK

Prepared by

U.S. Environmental Protection Agency
Region 2
New York, New York

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Date

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LIST OF ABBREVIATIONS & ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
BERA	baseline ecological risk assessment
BTEX	benzene, toluene, ethylbenzene and xylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSO	Combined Sewer Overflow
CFR	Code of Federal Regulations
CWA	Clean Water Act
EPA	United States Environmental Protection Agency
FYR	Five-Year Review
ICs	Institutional Controls
MGP	Manufactured Gas Plant
$\mu g/m^3$	Micrograms per Cubic Meter
NAPL	Nonaqueous Phase Liquid
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NYC	New York City
OU	Operable Unit
O&M	Operation and Maintenance
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PRP	Potentially Responsible Party
RAO	Remedial Action Objectives
ROD	Record of Decision
RME	Reasonable Maximum Exposure
RPM	Remedial Project Manager
RTA	Remediation Target Area
SVOC	semivolatile organic compound
TBC	To be considered
VOCs	Volatile Organic Compounds

I. INTRODUCTION

The purpose of a five-year review (FYR) is to evaluate the implementation and performance of a remedy to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports, such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

This is the first FYR for the Gowanus Canal Superfund site. The triggering action for this statutory review is the on-site construction start date of the remedial action. The FYR has been prepared because hazardous substances, pollutants or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure (UU/UE).

The U.S. Environmental Protection Agency (EPA) is preparing this FYR review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Contingency Plan (NCP)(40 CFR Section 300.430(f)(4)(ii)), and considering EPA policy.

The site consists of one operable unit (OU) which will be addressed in this FYR. OU1 addresses the in-canal work, construction of two combined sewer overflow (CSO)[1] retention tanks adjacent to the canal, and portions of the upland Fulton Works Former Manufactured Gas Plant (MGP) site.

The remaining portions of the Fulton Works Former MGP site, Carroll Gardens/Public Place (formerly known as "Citizens Gas Works") MGP site, Metropolitan former MGP site, and a number of New York State Brownfield sites are being addressed under New York State Department of Environmental Conservation (NYSDEC) enforcement authorities in coordination with the New York State Department of Health (NYSDOH) and EPA.

The Gowanus Canal Superfund site FYR was led by Victoria Sacks, EPA Remedial Project Manager (RPM). Participants included Tom Mongelli (RPM), Mark Granger (RPM), Joel Singerman (Section Supervisor), Paul Zarella (hydrogeologist), Dr. Abby Debofsky (ecological risk assessor), Dr. Lora Smith (human health risk assessor), Tara Bhat (human health risk assessor), and Natalie Loney (community involvement coordinator) from EPA and Aaron Fischer (project manager) from NYSDEC. The potentially responsible parties (PRPs) were notified of the initiation of the FYR, which began on September 24, 2024.

Site Background

The Gowanus Canal is a 1.8-mile-long, man-made canal in the Borough of Brooklyn in New York City (NYC), Kings County, New York.

Prior to development, the area around the Gowanus Canal was occupied by Gowanus Creek, its tributaries and lowland marshes. Before the mid-1840s, the creek and its tributaries were dammed and used primarily to power tide mills (Hunter Research *et al.,* 2004). By the mid-1840s, Brooklyn was rapidly growing, and the Gowanus marshes were considered to be a detriment to local development. In 1848, the State of New York authorized the construction of the Gowanus Canal to open the area to barge traffic, flush away sewage, receive stormwater, and fill the adjacent lowlands for development. The canal was constructed

[1] Combined sewers receive both sewage and stormwater flows and discharge to the canal when the sewer system's capacity is exceeded.

by bulkheading and dredging.

North of Hamilton Avenue, the canal is approximately 5,600 feet long and 100 feet wide, with a maximum water depth of approximately 15 feet mean lower low water (MLLW)[2] in the main channel at low tide. There are four short turning basins that branch to the east of the main channel at 4th Street, 6th Street, 7th Street, and 11th Street. A turning basin at 1st Street and an extension of the 4th Street turning basin that had been referred to as the 5th Street turning basin, were filled in between 1953 and 1965, respectively. An extension of the 7th Street turning basin has also been filled.

South of Hamilton Avenue, the canal widens to a maximum of approximately 2,200 feet and ranges in depth from -15 to -35 feet MLLW. The Gowanus Canal has no remaining natural wetlands (various small, unconnected areas of vegetation and intertidal habitat) or natural shoreline. The vast majority of the shoreline of the canal is lined with retaining structures or bulkheads.

To facilitate the assessment and management of the canal, it was divided into three Remediation Target Areas (RTAs) that correspond to the upper reach (RTA 1), middle reach (RTA 2), and lower reach (RTA 3). There are five east–west bridge crossings over the canal, at Union Street, Carroll Street, 3rd Street, 9th Street, and Hamilton Avenue. The Gowanus Expressway and a viaduct for NYC subway trains pass over head. See Appendix A, Figure 1.

The initial canal design recognized the likelihood of stagnant pollution problems and proposed various flushing solutions. In 1911, NYC began operating the Gowanus Canal flushing tunnel to address the canal's serious water quality issues. The flushing tunnel connects the head of the canal with Buttermilk Channel in Upper New York Bay. It was designed to improve circulation and flush pollutants from the canal by pumping water in either direction.

The canal is located in a mixed residential-commercial-industrial area. It borders several residential neighborhoods, including Gowanus, Park Slope, Cobble Hill, Carroll Gardens, and Red Hook, with housing located within one block of the canal. The waterfront properties abutting the canal are primarily commercial and industrial. Rezoning of canal-front parcels to high density residential began in 2009.

A number of businesses use the canal for maritime commerce. The canal is also regularly used by recreational boaters (primarily canoers and kayakers).

Appendix B, attached, summarizes the documents utilized to prepare this FYR. Additional details related to the site's background, physical characteristics, geology/hydrogeology, land/resource use, and history can be found at EPA's webpage for the site, www.epa.gov/superfund/gowanus-canal.

[2] As a tidally-influenced water body, the canal has two high tides and two low tides of unequal height each tidal day. MLLW is the lower low water height of the two low tides.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Gowanus Canal		
EPA ID: NYN000206222		
Region: 2	**State:** NY	**City/County:** Brooklyn/Kings County
SITE STATUS		
NPL Status: Final		
Multiple OUs? No	**Has the site achieved construction completion?** No	
REVIEW STATUS		
Lead agency: EPA		
Author name (Federal or State Project Manager): Victoria Sacks		
Author affiliation: EPA		
Review period: 9/24/2024 - 6/1/2025		
Date of site inspection: 9/26/2024		
Type of review: Statutory		
Review number: 1		
Triggering action date: 8/31/2020		
Due date *(five years after triggering action date)*: 8/31/2025		

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

Manufactured Gas Plant Wastes

Coal tar nonaqueous phase liquid (NAPL)[3] from the three former MGP facilities was discharged directly into the canal during the periods when the MGPs were operating. This NAPL, being heavier than water, settled to the bottom of the canal, and a portion of it might have been transported within the canal as a result of tidal currents and the action of the flushing tunnel. Native sediments along nearly the entire length of the canal above the Gowanus Expressway became contaminated with coal tar. In some areas, this NAPL has moved downward to substantial depths below the canal and laterally into the banks of the canal. Additional coal tar NAPL can be found in the subsurface soils at the former MGP facilities. This is coal tar which escaped from the subsurface structures at the former MGP facilities and seeped into the surrounding soils.

[3] Concentrated liquid contamination, typically oil-like, that forms a separate phase and is not miscible with water.

Canal sediments are affected by contaminants that are adsorbed to them and by the upwelling and horizontal transport of coal tar NAPL, which contains polycyclic aromatic hydrocarbons (PAHs). In surface sediments (0-to-6-inch depth interval), PAHs, polychlorinated biphenyls (PCBs), barium, cadmium, copper, lead, mercury, nickel, and silver were found to be contributing to unacceptable ecological and human health risks. Concentrations of these contaminants in surface sediment were statistically significantly higher in the canal than at reference locations in Gowanus Bay and Upper New York Bay. The average total PAH concentration in surface sediment from the canal is two orders of magnitude higher than the average concentration in reference area surface sediment. Average total PAH concentrations in subsurface soft (sediment which have accumulated above the native sediment) and native sediment are three orders of magnitude higher than samples from the reference area.

Subsurface sediment sampling data indicated that volatile organic compounds (VOCs), particularly benzene, toluene, ethylbenzene, and xylene (BTEX), and total PAHs, were frequently detected at high concentrations. PCBs and metals were all frequently detected in the soft sediment (*i.e.,* material deposited on top of the native sediments) but were infrequently detected or detected at lower concentrations in the native sediments. In the subsurface soft sediment, VOCs (primarily BTEX), PAHs, PCBs, and metals were all detected at substantially higher concentrations than those found in the surface sediments.

Combined Sewer Overflows

Wet weather CSO water samples (*i.e.*, samples collected from the sewer system during wet weather overflow events) indicated that CSOs containing VOCs, PAHs, PCBs, pesticides and metals are discharged to the canal during wet weather events. The wet weather CSO water samples represent actual discharges to the canal. Samples were collected from the combined sewer regulators, approximately one block from the discharge points, to eliminate potential backflow (tidal intrusion) from the canal. Sample results for residual CSO sediments collected from within sewer pipes indicate that, if mobilized during wet weather events, they will discharge VOCs, PAHs, PCBs, pesticides and metals to the canal.

There are ten active CSOs and three stormwater outfalls discharging to the Gowanus Canal (see Appendix A, Figure 2, for the locations). Four of the CSO outfalls account for 95 percent of the annual discharge. The greatest annual discharge volume is from outfall RH-034, located at the head of the canal (121 million gallons; NYCDEP, 2008a). The CSO discharges result in point source loading of high-organic-content solids and associated hazardous substances to the canal.

Unpermitted Pipe Outfalls

More than 250 unpermitted pipe outfalls were identified and inspected during the remedial investigation (RI); 25 of these pipe outfalls were observed to be actively discharging during dry weather. Effluent from 14 of the 25 active outfalls identified during the RI could not be attributed to tidal drainage (*i.e.*, drainage of seawater that entered the pipe at high tide). Samples from 12 of these 14 outfall discharges contained VOCs, PAHs and metals (two of the discharges were not sampled due to low flow rates). Pesticides and PCBs were not detected. Contaminant loading from the unpermitted outfalls was estimated to be very low because observed pipe discharges were intermittent and at very low flow rates (estimated to be less than 1 liter per minute). According to a NYC Department of Environmental Protection (NYCDEP) 2008 study, these loadings are insignificant by comparison to other sources, such as the CSOs.

Surface Water

VOCs, semivolatile organic compounds (SVOCs), and metals were detected in surface water samples collected from the canal under wet- and dry-weather conditions during the RI. Pesticides and PCBs were not detected in any surface water sample. BTEX compounds were the most common VOCs detected and PAHs were the most common SVOCs detected. Concentrations of contaminants, including benzene and PAHs in the Gowanus Canal surface water samples were significantly higher than their concentrations at the Gowanus Bay and Upper New York Bay reference locations during both dry- and wet-weather conditions.

High levels of bacteria are also present in the canal as a result of periodic discharges from the CSOs. Although not considered for CERCLA remedy selection purposes, risk to child and adult recreational users and workers from CSO-related pathogen exposure is a significant issue, as was outlined in a NYSDOH Gowanus Canal Public Health Assessment.

Human Health and Ecological Health Threat and Exposure Pathways

The Human Health Risk Assessment (HHRA) indicated completed human risk exposure pathways with unacceptable risk levels for surface water/sediment contact and fish consumption. Human exposure to hazardous substances in surface water and surface sediment by recreating adults, adolescents, and children may result in carcinogenic risks above EPA's target risk range. These risks are associated, primarily, with exposure to carcinogenic PAHs in the surface water and the surface sediment. The total noncarcinogenic hazard index for this pathway was within or below EPA's acceptable risk levels.

Human exposure to surface water and surface sediment from canal overflow by residential adults and children may result in carcinogenic risks above EPA's target risk range. The risk for the adult/child resident is associated with PAHs in sediment (with a smaller contribution from surface water).

The total noncarcinogenic hazards and/or carcinogenic risks for angler adults, adolescents and children consuming the catch exceed EPA's target hazard quotient/risk range. The noncarcinogenic hazards and carcinogenic risks are associated with PCBs in fish and crab. The concentrations of PCBs in canal fish and crab samples were higher than the PCB concentrations in the reference area samples collected from Gowanus Bay and Upper New York Bay. The HHRA showed that risk for airborne exposure from the canal was within the acceptable range.

Both a screening level risk assessment and a baseline ecological risk assessment ((BERA) were conducted to assess the risk to ecological receptors at the site. The key results of the BERA indicated that PAHs, PCBs, and metals in the sediment are toxic to benthic organisms. PAHs represent the greatest site-related risk to the benthic community. PCBs and seven metals (barium, cadmium, copper, lead, mercury, nickel, and silver) were also detected at concentrations that are associated with potentially unacceptable risk and are significantly higher than those detected in reference area sediments. The observed toxicity in laboratory tests could have resulted from the effects of one or a combination of these contaminants. The toxicity test results cannot be used to distinguish which contaminants were causing the effects, although the results for simultaneously extracted metals/acid volatile sulfide analyses presented in the BERA indicate that the bioavailability of metals is low; thus, it is likely that PAHs caused a significant portion of the observed toxicity in laboratory tests. However, potential site-related risk to the benthic community from metals cannot be dismissed. PAHs were found to be a potential risk to aquatic herbivores

(represented by the black duck) and mercury was found to be a potential risk to avian omnivores (represented by the heron).

Response Actions

In 2009, the Gowanus Canal was proposed for inclusion on the National Priorities List (NPL) pursuant to the Superfund law at the request of NYSDEC. Following the proposal for inclusion on the NPL, EPA commenced an RI. In March 2010, EPA placed the Gowanus Canal on the NPL.

In April 2010, EPA entered into administrative consent orders with NYC and National Grid to perform work in support of EPA's RI and feasibility study (FS). The RI report was completed in January 2011 and the FS report was completed in December 2011. In connection with the release of these reports, EPA conducted significant public outreach throughout 2011 and 2012. The outreach process included numerous public meetings with formal presentations, as well as informal question and answer sessions. An FS report addendum was completed in December 2012.

A Record of Decision (ROD) was signed on September 27, 2013. The following Remedial Action Objectives (RAOs) were established for the site:

- Reduce the cancer risk to human health from the incidental ingestion of and dermal contact with PAHs in sediment during recreational use of the canal or from exposure to canal overflow to levels that are within or below EPA's excess lifetime cancer risk range of 10^{-6} to 10^{-4}.
- Reduce the contribution of PCBs from the Gowanus Canal to fish and shellfish by reducing the concentrations of PCBs in Gowanus Canal sediment to levels that are within the range of Gowanus Bay and Upper New York Bay reference concentrations.
- Reduce the risks to benthic organisms in the canal from direct contact with PAHs, PCBs and metals in the sediments by reducing sediment toxicity to levels that are comparable to reference conditions in Gowanus Bay and Upper New York Bay;
- Reduce the risk to herbivorous birds from dietary exposure to PAHs.
- Eliminate the migration of NAPL into the canal so as to minimize NAPL serving as a source of contaminants, primarily PAHs, to the canal.

The selected remedy includes, among other things:

- Dredging of the entire column of hazardous substance-contaminated sediments which have accumulated above the native sediments in the upper and mid-reaches of the canal.
- In-situ stabilization (ISS)[4] of those native sediments in select areas in the upper and mid-reaches of the canal contaminated with high levels of NAPL.
- Construction of a multilayered cap in the upper and mid-reaches of the canal to isolate and prevent the migration of PAHs and residual NAPL from native sediments.
- Dredging of the entire soft sediment column in the lower reach of the canal.
- Construction of a multilayer cap to isolate and prevent the migration of PAHs from native sediments in the lower reach of the canal.

[4] Mixing of materials, such as Portland cement, into the sediments to bind the contaminants physically/chemically.

- Off-site treatment of the NAPL-impacted sediments dredged from the upper and mid-reaches of the canal with thermal desorption,[5] followed by beneficial reuse off-site (*e.g.,* landfill daily cover) if possible.
- Off-site stabilization of the less contaminated sediments dredged from the lower reach of the canal and the sediments in the other reaches not impacted by NAPL, followed by beneficial reuse off-site.
- Excavation and restoration of approximately 475 feet of the filled-in former 1st Street turning basin.
- Excavation and restoration of the portion of the 5th Street turning basin beginning underneath the 3rd Avenue bridge and extending approximately 25 feet to the east and the installation of a barrier or interception system at the eastern boundary of the excavation.
- Implementation of institutional controls (ICs) incorporating the existing fish consumption advisories (modified, as needed), as well as other controls to protect the integrity of the cap and in-situ stabilized material and limit construction within the canal, including bulkhead maintenance and navigation dredging within the canal.
- Periodic maintenance of the cap and long-term monitoring to ensure that the remedy continues to function effectively.
- Construction of 8-million gallon and 4-million gallon in-line retention tanks to retain CSOs through outfalls RH-034 and OH-007, respectively.
- Control of discharges from upland contaminated areas adjacent to the canal, including the three former MGP facilities, that have already been referred to NYSDEC for action.
- Control or eliminate unpermitted pipe outfalls.

Status of Implementation

In-Canal

EPA issued a Unilateral Administrative Order (UAO) in 2014 to National Grid and more than 30 other PRPs collectively called the "PRP Group." The UAO required the PRP Group to design the in-canal remedy.

To prepare for the cleanup work, National Grid performed a marine debris removal test in 2016, conducted test dredging from 2017 to 2018, and performed test capping in the 4th Street turning basin in 2018 to provide information necessary to complete the full-scale dredging and capping design for the upper canal from Butler Street to 3rd Street.

National Grid finished constructing a cutoff wall (to prevent coal tar migration to the canal) at the former Fulton MGP in fall 2020.

NYC[6] completed the design of the 1st Street turning basin excavation and restoration in 2019. The work will be performed by the PRP Group.

EPA issued a UAO to National Grid, NYC, Consolidated Edison, Hess Corp., Honeywell, and the Brooklyn Improvement Co. to perform the RTA 1 dredging, capping, and ISS construction in January 2020. The RTA 1 design was completed in July 2020.

[5] Utilization of heat to increase the volatility of organic contaminants so that they can be removed and destroyed.
[6] NYC is the PRP for the filled-in 1st Street turning basin.

Dredging in the main channel of the Gowanus Canal north of the 3rd Street bridge (RTA 1) began in November 2020. An excavator mounted on a platform barge removed approximately 35,000 cubic yards of contaminated sediment from the bottom of the canal. Dredging was conducted in three major phases: Phase I, dredging of soft sediments to provide access throughout RTA1 for bulkhead work and further dredging; Phase II, high production dredging prior to ISS; and Phase III, dredging conducted after ISS to the final surface throughout RTA1 including beneath the bridges. Hydrographic surveys were conducted to demonstrate that dredging activities were implemented to the elevations and extents required by the design. The dredged material was loaded onto small barges and transported down the canal to a staging area at Smith and Huntington Streets. At the staging area, water was removed from the sediment, treated, and pumped back into the canal. The dewatered sediment was then transferred onto a larger barge and transported to an off-site facility. The sediment was processed so that it can be used beneficially as landfill cover. Portions of the sediment that contained high levels of tar contamination were thermally treated, followed by processing to allow for beneficial use. The initial phase of dredging was completed late spring 2021.

In October 2021, contractors began solidifying portions of the original bottom (or native soil) of the northern stretch of the canal using ISS. This process involved adding a concrete mix into the native soil using drilling equipment mounted on barges. Most of the contaminated soft sediment was removed during the Phase I dredging, but a layer of soft sediment was left in place as a protective layer to prevent tar from moving up into the canal during the ISS operation. Construction quality assurance (CQA) samples were taken from discrete locations varying both horizontally across the ISS areas and vertically within the ISS columns. Sample molds were created to determine the physical stability of the ISS monolith. CQA samples were collected at select ISS columns immediately following installation at a rate of one per 100 cubic yards of material treated or once every day of ISS production, with a minimum of one sample per day during full scale implementation of the ISS work. In addition, a CQA sample was collected every 50 linear horizontal feet of material treated by ISS along the perimeter of the bulkhead alignment shown on the Construction Drawings, with a minimum of one sample per day. A complex CQA data decision process flow diagram for unconfined compressive strength was followed to determine the ISS was installed as designed. ISS was completed in August 2022 and then the remaining layer of soft sediment was removed.

ISS and Phase III dredging was followed by the placement of a cap. The RTA 1 cap consists of several layers. The first (deepest) layer is an "active" layer made of a type of clay that will remove contamination that could move up into the canal from the lower layers of contaminated native sediment. The second layer is another active layer made of granular activated carbon that also acts as a sponge and removes chemicals dissolved in the water moving upward from the native sediment. An "isolation" layer of sand was placed on top of the active layers to keep these layers in place. Finally, an "armor" layer of heavy mats of concrete was placed on top to prevent erosion of the underlying layers by boat traffic and canal currents. Total thickness of the active cap ranged from 12 to 44 inches. Clean sand was placed on top of the "armor" layer to fill in the space between stones. Cap material requirements were verified using a series of checks and measurements. Cap thickness and final elevations were verified using a series of methods including, but not limited to coring, catch pans, probing, and hydrographic surveys. The clean sand created the bottom of the canal and will help restore the canal bottom as a habitat. The solidified portions of the native sediment in combination with the protective layer and cap will prevent contamination from the native sediment and contaminants dissolved in the groundwater from moving into the water of the canal.

Work in RTA 1 was completed in July 2024, other than Turning Basin 1 and the area immediately adjacent to the Carroll Street bridge.

The detailed engineering and design work for RTA 2, the middle section of the Gowanus Canal, commenced in September 2020 and was performed concurrent with the upper portion construction. The design for the middle segment of the canal is nearing completion.

Initial construction work, which began in June 2024, includes access dredging to facilitate the mobilization and use of equipment needed to conduct work in this portion of the canal, followed by debris removal and bulkhead construction. The full-scale dredging and capping required by an amended UAO, which was issued in June 2024, will follow the completion of ongoing bulkhead work.

The design of the lower segment of the canal will commence during the construction in the middle section. Construction at the lower segment of the canal is expected to be implemented after the completion of the middle section.

CSO Retention Tanks

EPA issued a UAO in 2014 to NYC that required it to design the CSO retention tanks and to coordinate with the PRP Group. The UAO also required NYC to identify preferred sites for the two CSO tanks. NYC decided to build the smaller CSO tank at the location of a New York City Department of Transportation salt shed. NYC's preferred location for the larger CSO tank was on privately-owned land located on the Fulton former MGP site across the street from the Thomas Greene Park and immediately adjacent to the canal. The proposed location for this CSO tank generated extensive discussion between NYC, NYSDEC, and EPA. EPA accepted NYC's preferred location with several conditions. These conditions were memorialized in an Administrative Order on Consent (AOC) with EPA which required NYC to acquire the canal-side property by a certain date and conduct dual CSO tank remedial designs for both the Thomas Greene Park and canal-side tank locations pending the property acquisition. Following acquisition, NYC was required to build the tank perimeter wall and then conduct a removal action to excavate contaminated soils from within the tank. In addition, the AOC required NYC to waive its ability to challenge the CSO remedy selected in EPA's 2013 ROD. NYC and EPA signed the AOC in 2016 after a public comment period.

In 2021, EPA issued another UAO that requires NYC to implement the CSO controls contained in the ROD to significantly reduce overall contaminated solid discharges to the canal. This UAO also notes that the CSO cleanup implementation had been delayed due to substantial noncompliance by the City. NYC has returned to compliance with EPA's administrative orders. EPA is seeking to resolve NYC's potential penalty liability for its prior noncompliance.

The RH-034 retention tank building demolition and site preparation design was completed in 2020. The demolition of the existing structures, disconnection of utilities, etc. was performed between 2021 and 2023. The construction of the tank's perimeter wall began in October 2023 and was completed in July 2024.

A community air monitoring plan (CAMP), which included eight Summa cannister monitoring stations around the perimeter of the RH-034 retention tank site that continuously measured total VOCs and particulate matter concentrations during working hours, was established prior to the start of this work. The CAMP provided on-site construction staff with real time notifications via text and email if PM_{10} (particulate matter with a diameter of 10 micrometers or less, which are inhalable and can induce adverse health effects) or VOCs were detected above set limits that are protective of human health.

Beginning in February 2024, during construction of the RH-034 retention tank's perimeter wall, NYCDEP began collecting weekly air samples at the intersection of Sackett and Nevins Streets in response to residents' odor complaints. NYCDEP continued this effort at additional locations in the neighborhood in June and July 2024. Upon collection, air samples were sent for TO-15 analysis. This analysis included reporting for several dozen compounds, though naphthalene was the primary contaminant of concern due to its low odor threshold and association with the coal tar contamination present at the RH-034 tank site. The naphthalene results from these weekly canister tests ranged from non-detect to a maximum observed concentration of 7.3 micrograms per cubic meter ($\mu g/m^3$). To make additional assessments of human health impacts, EPA directed NYCDEP to expand the SUMMA canister sampling program to include 13 locations, including four background locations, in the neighborhood surrounding the RH-034 tank site. A total of four full rounds of sampling at all these locations were conducted between July 2 and July 23, 2024. The maximum naphthalene concentration observed during this effort was 28 $\mu g/m^3$ at a background location near the corner of Union Street and Hoyt Street on July 17, 2024. This result exceeded the daily acute naphthalene screening level of 20 $\mu g/m^3$. Two other samples from the July 17th event were found to have naphthalene concentrations of 14 $\mu g/m^3$. Naphthalene was also observed at a concentration of 8.1 $\mu g/m^3$ in a sample collected from Douglas Street on July 2nd. However, all four of these results are considered estimated, due to canister pressure deviations noted by the laboratory during analysis. As such, there is reason toconclude these results were not accurate representations of naphthalene air concentrations. All other concentrations of naphthalene were below health-based levels of concern. These health-based levels were developed to be protective of the most sensitive members of the community, including children, pregnant women, the elderly and immunocompromised.

While the results showed no harmful levels of contamination, odors were reported by community members. NYCDEP took steps to lessen the odors and worked to improve those measures as work progressed. This included increasing the use of odor-suppressing foam on soil excavation areas, using odor-suppressing foam or tarps on soil stockpiles during times of inactive construction, and constructing a tent with a ventilation system and carbon treatment over equipment believed to be the primary source of the odors. NYCDEP, EPA, and NYSDEC investigated odor complaints reported by impacted residents.

Excavation of soils for the future RH-034 tank began in December 2024. During this work, EPA required NYCDEP to expand air monitoring, enhance odor mitigation measures, and increase community notifications. Along with the expanded air monitoring, EPA's mobile laboratory bus, the Trace Atmospheric Gas Analyzer was on-site at the beginning of the excavation work for two weeks and returned monthly for two weeks through April 2025 while work was ongoing. The excavation work was completed in March 2025. All data collected to date have been below the daily and running average (3 $\mu g/m^3$ based on the chronic reference concentration) screening levels for naphthalene. No other volatile contaminants have exceeded their respective screening levels.

Following the completion of the OH-007 retention tank demolition and site preparation design in 2022, the work commenced in 2023. The construction of the perimeter wall began in October 2024 and is expected to be completed by September 2025.

Uplands Cleanups

In 2017, EPA determined that certain response activities needed to be taken at the Fulton Works Former MGP site in order to coordinate with the construction of the RH-034 CSO tank, and that EPA would be the lead for those activities. EPA issued the "Fulton Wall Design UAO" to National Grid, requiring the

design of a bulkhead barrier wall (the "Fulton Wall") on the eastern bank of the canal from the head end of the canal to the Union Street bridge.

EPA then entered into an AOC with National Grid in 2018, which required it to construct the Fulton Wall after the design was completed under the Fulton Wall Design UAO, and address MGP-related contamination at the Thomas Greene Park property. The AOC, which included the potential demolition of the pool at the Park, required National Grid to develop plans for and provide a temporary swimming pool, and develop plans to permanently replace the pool and impacted areas of the Thomas Greene Park property after addressing the MGP-related contamination. The 2018 AOC also required National Grid to cooperate and coordinate with NYC's design and construction of the RH-034 retention tank. EPA approved the Fulton Wall design in 2019. The Fulton Wall construction was completed in 2021. EPA is evaluating paths forward to address MGP-related contamination at the Thomas Greene Park property.

Several dozen properties along and around the canal are being redeveloped. Many of these properties are being addressed under the NYS Brownfields Cleanup Program ("BCP"). EPA has coordinated with NYSDEC regarding many of these cleanups. EPA and NYSDEC agreed that NYSDEC's BCP remedies must, at minimum, address uplands contamination which may pose a risk of migrating into and re-contaminating the canal. These requirements are set forth in the "Uplands Cleanup Matrix," an agreement between EPA and NYS, which specifies the cleanup depths and accepted cleanup methods.

Institutional Controls

Table 1, below, summarizes the implemented ICs.

Table 1: Summary of Planned and/or Implemented ICs

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Sediments (limit damage to the cap)	Yes	Yes	Sediments	Regulated navigation area or equivalent encompassing RTAs 1, 2, and 3 to prohibit activities that would disturb the cap such as anchoring, spudding, and boating activities that may come in contact with the cap	Regulated navigation area (e.g. signs posted at entrance of canal and permanent NML (notice to mariners list) planned by start of RTA3 construction)
Fish consumption	Yes	Yes	N/A	To prohibit the consumption of PCB-contaminated fish and shellfish while tissue levels remain high	NYSDOH fish advisories in place for upper New York Bay for PCB-contaminates fish and shellfish

Limitation to construction within the canal	Yes	Yes	Sediments	Limit the damage to the cap from bulkhead maintenance and construction	EPA approval required during remedy construction and planned EPA approval required during canal O&M.

Systems Operations/Operation & Maintenance

Although operation and maintenance (O&M) will be required, because the remedies are still underway, O&M plans have not yet been developed.

Remedy Resilience

Potential impacts to the Site area from severe weather have been assessed, and the performance of the remedy is currently not at risk due to the expected effects of weather-related events in the region and near the Site. Please see Appendix C, attached, for the full remedy resilience evaluation.

III. PROGRESS SINCE THE LAST REVIEW

This is the first FYR.

IV. FIVE-YEAR REVIEW PROCESS

Community Notification, Involvement & Site Interviews

On August 7, 2024, EPA Region 2 posted a notice on its website indicating that it would be reviewing site cleanups and remedies at Superfund sites in New York, New Jersey, and Puerto Rico, including the Gowanus Canal Superfund site. The announcement can be found at the following web address: https://www.epa.gov/superfund/R2-fiveyearreviews.

In addition to this notification, Ms. Loney posted a public notice on the EPA's webpage on April 30, 2025 at www.epa.gov/superfund/gowanus-canal and provided the notice to the community advisory group (CAG). This notice indicated that a FYR would be conducted at the Gowanus Canal Superfund site to ensure that the cleanup at the site continues to be protective of people's health and the environment. Once the FYR is completed, the results will be made available on EPA's website. EPA will share the final FYR with the CAG and present the conclusions of the review. Efforts will be made to reach out to local public officials to inform them of the results.

No interviews were conducted for this FYR.

Data Review

The remedy is currently being implemented. Because of the nature of the remedy (construction of CSO retention tanks, dredging the entire column of hazardous substance-contaminated sediments which have accumulated above the native sediments, ISS, and capping), the only data that is being collected is related to atmospheric releases during the work (discussed under Status of Implementation above). Therefore, there is no relevant data related to remedy performance or progress toward meeting RAOs at this time.

Site Inspection

A FYR inspection of the site was conducted on September 26, 2024. In attendance were Ms. Sacks and Mr. Granger. The purpose of the inspection was to assess the progress of the ongoing work. All work was being performed as designed with no deficiencies noted.

V. TECHNICAL ASSESSMENT

QUESTION A: Is the remedy functioning as intended by the decision documents?

The ROD called for sediment dredging, bulkhead installation, ISS, and multi-layer cap installation. CSO retention tanks were also called for to mitigate impacts to the in-canal remedy. The ROD required that upland properties, including but not limited to MGP facilities, be addressed to mitigate those as sources of recontamination to the in-canal remedy.

In-canal remedial components relative to RTA 1 were completed in 2024. In-canal remedial components relative to RTA 2 were initiated commensurate with substantial completion of the RTA 1 components. RTA 3 remedial components will be initiated commensurate with substantial completion of the RTA 2 components. The CSO retention tanks are expected to be completed in 2029. Progress related to upland-property remedial components is ongoing.

It is expected that the remedy will function as intended by the decision documents upon completion of the in-canal, CSO-control, and upland remedial components. The development of ICs is ongoing (see Table 1, above). Fish advisories are currently in place.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Human Health

The 2011 HHRA followed current Risk Assessment Guidance for Superfund. Although some toxicity values may have changed since the time of the decision document, the risk assessment process that was used is consistent with current practice and the need to implement the remedial action remains valid. Exposure pathways evaluated in the HHRA included: direct contact with sediment and surface water, inhalation of volatile emissions from the canal into ambient air near the canal, and ingestion of fish and shellfish.

Human health COCs present in the Gowanus Canal include PAHs (individually and as NAPL) and PCBs. Lead was evaluated as a potential COC in sediments and determined to not be a concern; however, the target blood lead level associated with screening levels utilized in the calculations was 10 ug/dL. Although

current EPA guidance specifies that lower blood lead levels are associated with adverse health effects, with the dredging of contaminated sediments, ISS and capping, some of which is partially complete, the exposure pathway from sediment is or will be incomplete.

In the northern section of the canal, contaminated sediments were dredged and treated/disposed off-site, native soils were solidified using ISS and then capped. As a result, the direct contact exposure to contaminated sediments was eliminated in RTA 1. Further, removal of the source sediments will serve to lower surface water concentrations over time. Reductions in sediment and surface water contaminants, specifically PCBs, will then lower concentrations in fish and shellfish. It is expected that the planned remediation of sediments in RTAs 2 and 3 will further enhance human health protections and minimize the direct contact exposure, as well as the fish/shellfish consumption exposure. A fish advisory is currently in place through the NYSDOH for Upper New York Bay for PCB-contaminated fish and shellfish which should aid in minimizing the consumption pathway. Further, an IC limits construction within the canal, including bulkhead maintenance and navigation dredging within the canal, thus restricting direct contact with sediment.

The RAOs identified in the decision documents remain valid for the site and through remediation to date, have been achieved or are expected to be achieved.

Ecological

While the ecological risk screening values used to support the ROD might not necessarily reflect the current values for aquatic receptors, the exposure assumptions remain appropriate. As construction is ongoing, ecological receptors continue to be exposed to contaminated sediment, particularly in RTAs 2 and 3. Achievement of RAOs and reduction in risk should occur as the remedy is implemented and will be evaluated in the next FYR.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

As described under Section II (Status of Implementation), ambient air concentrations and the presence of odors was monitored extensively during soil remediation and retention tank construction as detailed in the approved community air monitoring plan. Excavation at RH-034 is now complete, and it is not anticipated that odors will be detected or air concentrations will exceed screening values in the future.

No additional information has come to light that would question the protectiveness of the remedy.

VI. ISSUES/RECOMMENDATIONS

Table 2, below, notes that there are no recommendations or follow-up actions for this FYR.

Table 2: Issues and Recommendations

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
OU1

There are no recommendations or follow-up actions resulting from this FYR.

VII. PROTECTIVENESS STATEMENT

Table 3, below, presents the OU and Sitewide protectiveness statements.

Table 3: Protectiveness Statements

Protectiveness Statement(s)	
Operable Unit: 01	*Protectiveness Determination:* Will be Protective
Protectiveness Statement: The remedy is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.	

VIII. NEXT REVIEW

The next FYR report for the Gowanus Canal Superfund site is required five years from the completion date of this review.

APPENDIX A--FIGURES

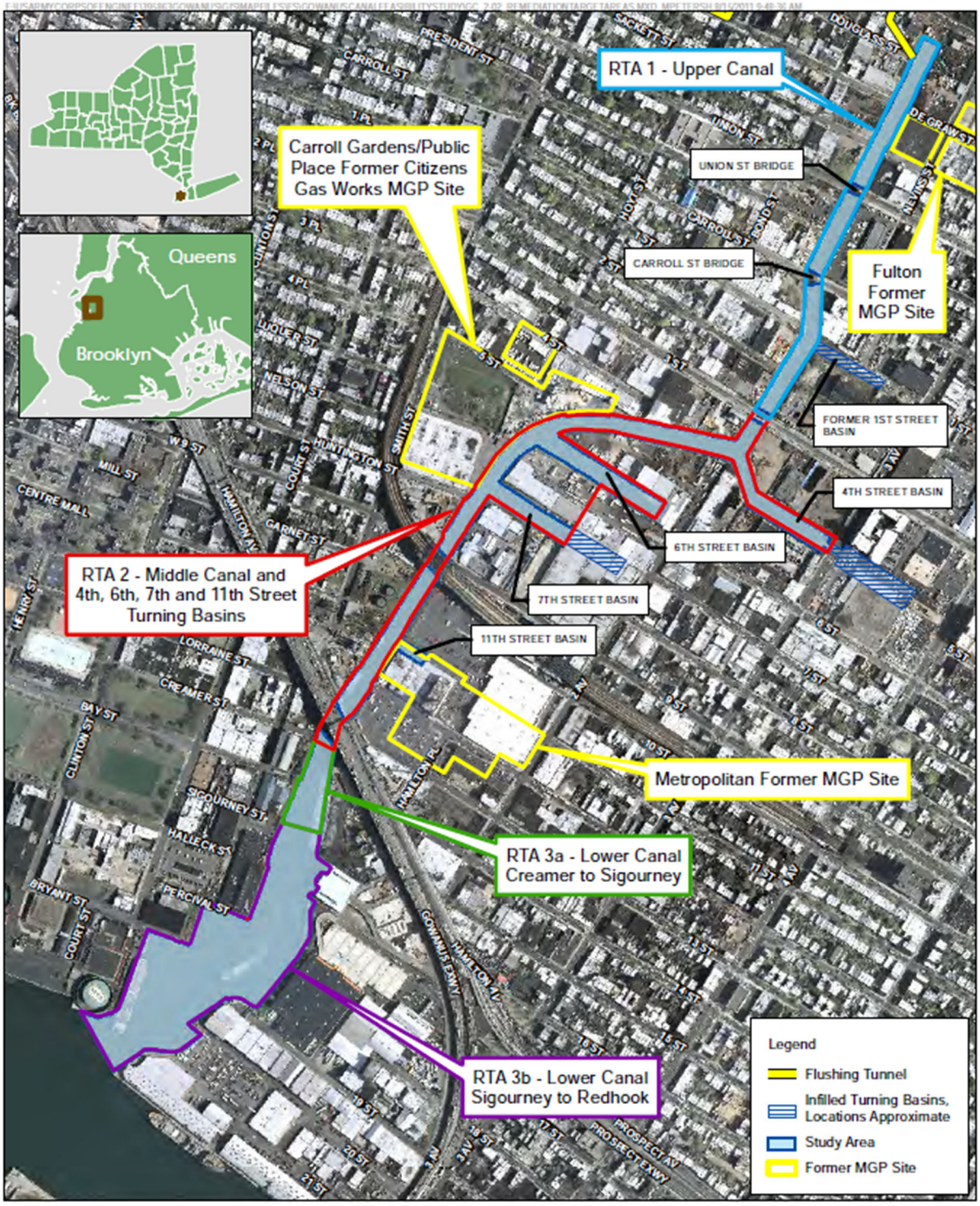


Figure 1: Gowanus Canal Layout

Figure 2: Gowanus Canal Combined Sewer Overflow Layout

APPENDIX B – REFERENCE LIST

- B&B Engineers & Geologists of New York, P.C. (B&B 2020), July 2020 (B&B, 2020). “RTA1 100% Remedial Design Report”.
- EPA, September 2013 (EPA, 2013). “Record of Decision – Gowanus Canal Superfund Site, Brooklyn, Kings County, New York.”
- New York City Department of Environmental Protection, 2015 (NYCDEP, 2015a). “Combined Sewer Overflow Long Term Control Plan for Gowanus Canal” Prepared by AECOM USA, Inc for NYCDEP. June 2015.

APPENDIX C – REMEDY RESILIENCE EVALUATION

Three tools were utilized to assess the Gowanus Canal site. Screenshots from each of the tools assessed are included in this Appendix.

The first tool used to assess the site was the CMRA Tool. The tool examined five hazards for the county the site falls within. According to this tool, the National Risk Index Rating for extreme heat is "Very High." There is a projected increase of days per year with maximum temperatures >100°F, as shown in Figure C-1. The risk for flooding is "Relatively High" in this area. The area is particularly prone to flooding due in part to the geography of the neighborhood, which used to be a tidal marsh. The remedy for the canal is soft sediment removal, the ISS of 5 feet of native sediment in select areas in RTA 1 and RTA 2, an active cap, and scour protection. The scour protection in the canal is robust, consisting of a sand isolation layer underlaying a layer of open-celled articulated concrete blocks. This layer provides stability and protection of the cap. It is expected that the armored cap will withstand the effects of flooding. The other hazards evaluated by this tool – drought, wildfire, and coastal inundation– each have a National Risk Index Rating of "Very Low." Figures C-2 and C-3 show an increase in average annual total precipitation and an increase in days per year with precipitation. Figure C-4 shows an increase in annual days with precipitation over one inch. As shown in Figure C-5, the percent of the county impacted by global sea level rise is 0.01%.

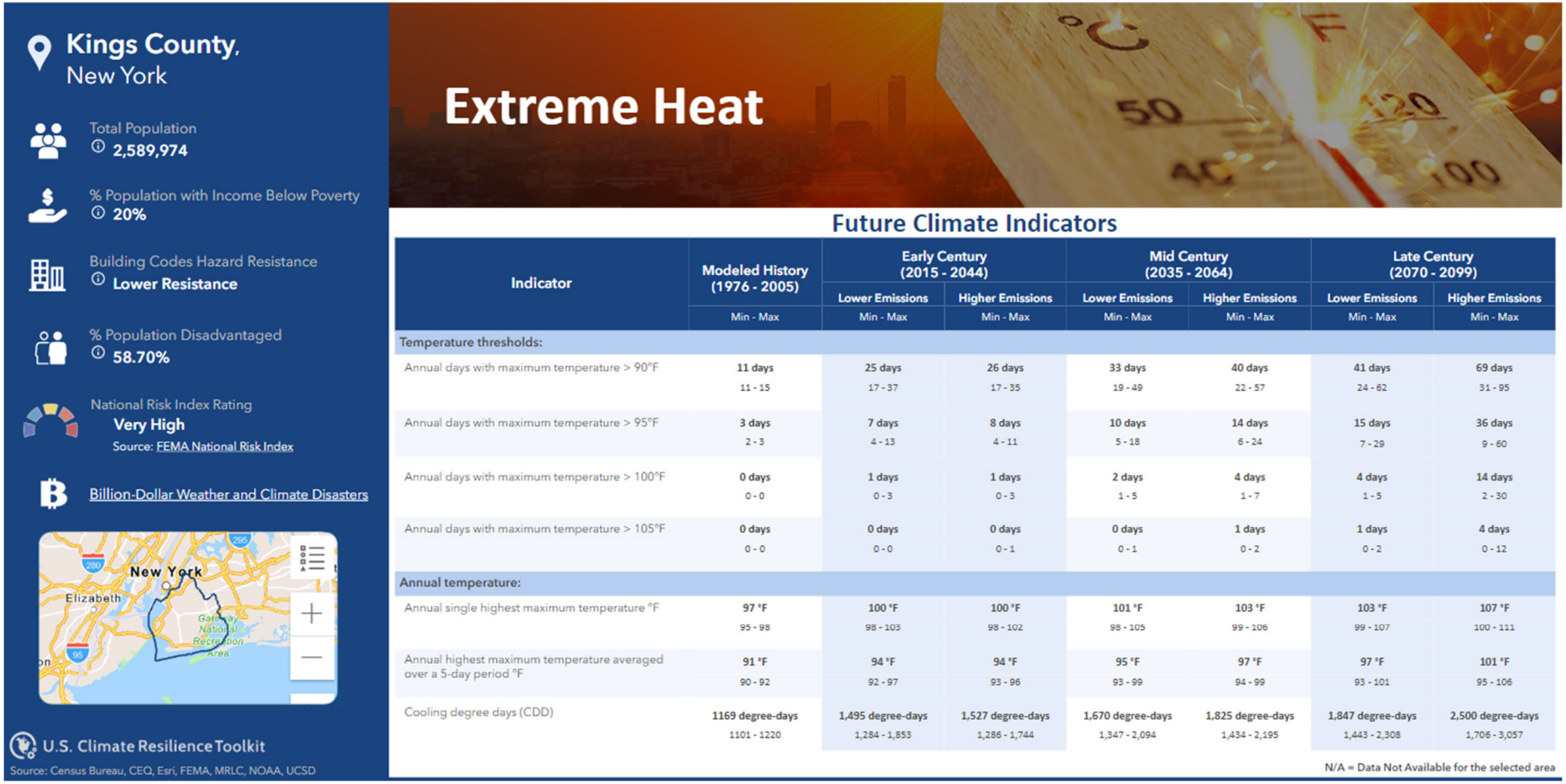
The second tool utilized is called *NOAA Sea Level Rise Viewer*. The Gowanus Canal is surrounded by three zip codes, 11231, 11217, and 11215 (see Figure C-5). These neighborhoods in Brooklyn, New York are vulnerable to sea level rise. Figure C-6 displays the vulnerable area with a 10-foot sea level rise which shows the areas surrounding the Gowanus Canal Superfund site affected. Figure C-7 shows high-tide flooding frequency. Flooding may be experienced in portions of the site as time passes. As sea level rises, the water level in the canal will increase. The canal, however, has hardened sides and the remedy includes a hardened bottom protecting the environmental cap. Given the lack of source material remaining in the canal, flooding is not expected to impact the containment remedy at the site. Flooding of properties adjacent to the canal has historically occurred periodically. Modelling shows that flooding events are likely to increase to some degree at upland properties. As the figure shows, a large portion of the major risk to the 11231 neighborhood is from the sea-facing portion of the neighborhood in Red Hook.

The final tool utilized is called the *USGS U.S. Landslide Inventory*. As shown by Figure C-8, there have been no landslides recorded in the vicinity of the site and overall landslide vulnerability is considered to be relatively low.

Based on this information, potential site impacts from severe weather have been assessed. The canal remedy is comprised of a dredging, ISS, and capping remedy, which includes an armor cap. The performance of the in-canal remedy is currently not at risk due to the expected effects of severe weather in the region and near the site.

Across dozens of upland properties requiring cleanup to be protective of the Canal remedy, the upland cleanups all address historical subsurface sources of contamination. As in the Canal, the subsurface contamination requiring cleanup is comprised predominantly of non-soluble coal tar. Severe weather is not expected to affect the subsurface coal tar or the cleanups related to the upland properties.

Figure C-1



Future Climate Indicators

Indicator	Modeled History (1976 - 2005)	Early Century (2015 - 2044)		Mid Century (2035 - 2064)		Late Century (2070 - 2099)	
		Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions
	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max
Temperature thresholds:							
Annual days with maximum temperature > 90°F	11 days 11 - 15	25 days 17 - 37	26 days 17 - 35	33 days 19 - 49	40 days 22 - 57	41 days 24 - 62	69 days 31 - 95
Annual days with maximum temperature > 95°F	3 days 2 - 3	7 days 4 - 13	8 days 4 - 11	10 days 5 - 18	14 days 6 - 24	15 days 7 - 29	36 days 9 - 60
Annual days with maximum temperature > 100°F	0 days 0 - 0	1 days 0 - 3	1 days 0 - 3	2 days 1 - 5	4 days 1 - 7	4 days 1 - 5	14 days 2 - 30
Annual days with maximum temperature > 105°F	0 days 0 - 0	0 days 0 - 0	0 days 0 - 1	0 days 0 - 1	1 days 0 - 2	1 days 0 - 2	4 days 0 - 12
Annual temperature:							
Annual single highest maximum temperature °F	97 °F 95 - 98	100 °F 98 - 103	100 °F 98 - 102	101 °F 98 - 105	103 °F 99 - 106	103 °F 99 - 107	107 °F 100 - 111
Annual highest maximum temperature averaged over a 5-day period °F	91 °F 90 - 92	94 °F 92 - 97	94 °F 93 - 96	95 °F 93 - 99	97 °F 94 - 99	97 °F 93 - 101	101 °F 95 - 106
Cooling degree days (CDD)	1169 degree-days 1101 - 1220	1,495 degree-days 1,284 - 1,853	1,527 degree-days 1,286 - 1,744	1,670 degree-days 1,347 - 2,094	1,825 degree-days 1,434 - 2,195	1,847 degree-days 1,443 - 2,308	2,500 degree-days 1,706 - 3,057

N/A = Data Not Available for the selected area

Figure C-2

Kings County, New York

Total Population
2,589,974

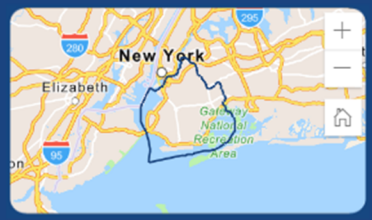
% Population with Income Below Poverty
20%

Building Codes Hazard Resistance
Lower Resistance

% Population Disadvantaged
58.70%

National Risk Index Rating
Very Low
Source: FEMA National Risk Index

Billion-Dollar Weather and Climate Disasters



U.S. Climate Resilience Toolkit

Source: Census Bureau, CEQ, Esri, FEMA, MRLC, NOAA, UCSD

Future Climate Indicators

Indicator	Modeled History (1976 - 2005)	Early Century (2015 - 2044)		Mid Century (2035 - 2064)		Late Century (2070 - 2099)	
		Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions
	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max
Precipitation:							
Average annual total precipitation	46" 44 - 48	48" 44 - 55	48" 42 - 54	48" 44 - 56	49" 44 - 54	49" 44 - 54	51" 44 - 58
Days per year with precipitation (wet days)	156 days 152 - 161	155 days 148 - 162	155 days 146 - 164	154 days 145 - 164	153 days 143 - 169	154 days 144 - 166	151 days 131 - 172
Days per year with no precipitation (dry days)	209 days 204 - 213	210 days 203 - 217	210 days 201 - 219	211 days 201 - 220	212 days 196 - 223	211 days 199 - 221	214 days 193 - 234
Maximum number of consecutive dry days	13 days 12 - 14	14 days 12 - 15	13 days 12 - 16	14 days 12 - 17	14 days 12 - 16	14 days 12 - 16	14 days 12 - 17
Temperature thresholds:							
Annual days with maximum temperature > 90 °F	11 days 11 - 15	25 days 17 - 37	26 days 17 - 35	33 days 19 - 49	40 days 22 - 57	41 days 24 - 62	69 days 31 - 95
Annual days with maximum temperature > 100 °F	0 days 0 - 0	1 days 0 - 3	1 days 0 - 3	2 days 1 - 5	4 days 1 - 7	4 days 1 - 5	14 days 2 - 30

N/A = Data Not Available for the selected area

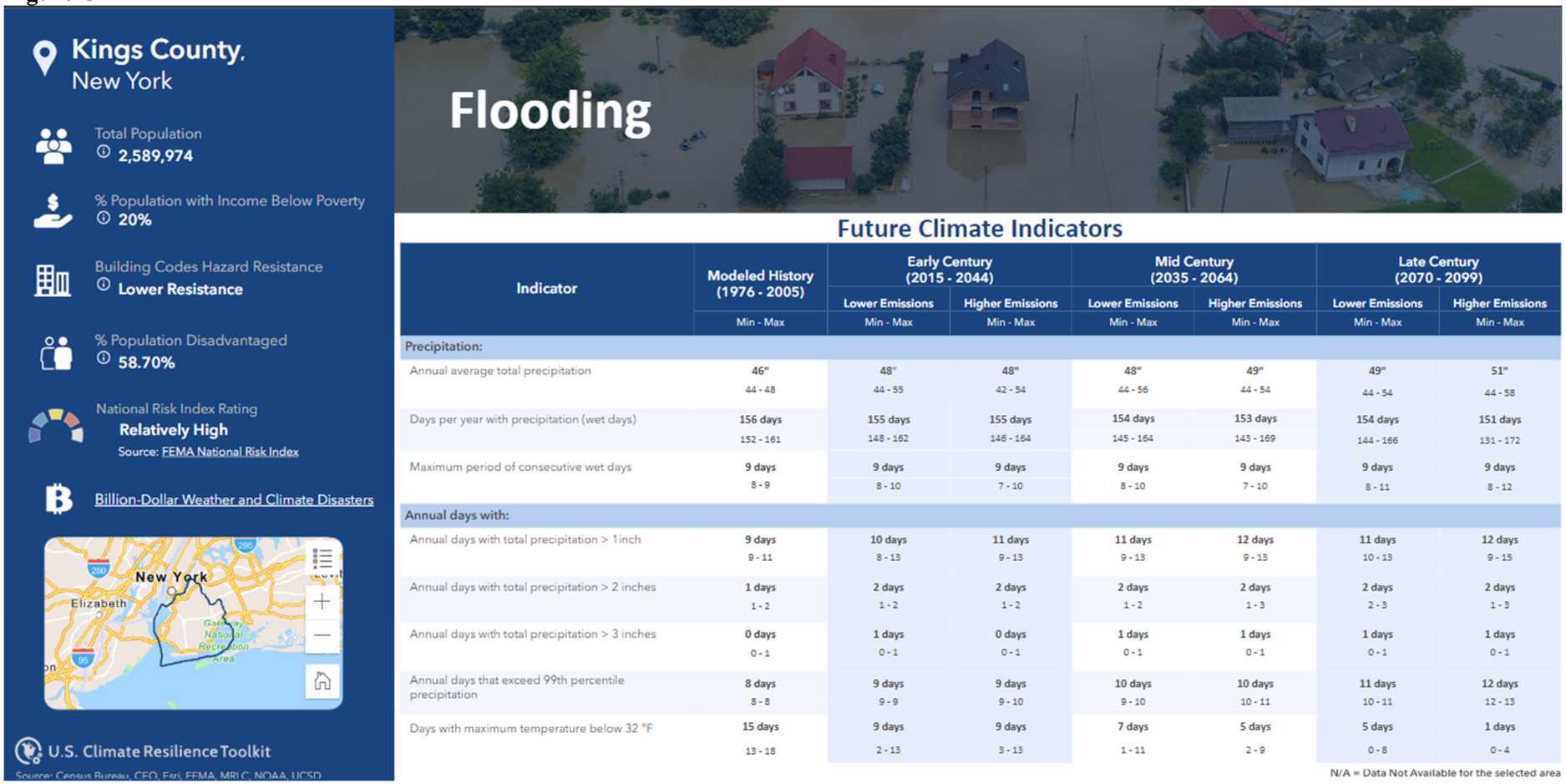
Figure C-3

Future Climate Indicators

Indicator	Modeled History (1976 - 2005)	Early Century (2015 - 2044)		Mid Century (2035 - 2064)		Late Century (2070 - 2099)	
		Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions
	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max
Precipitation:							
Days per year with no precipitation (dry days)	209 days 204 - 213	210 days 203 - 217	210 days 201 - 219	211 days 201 - 220	212 days 196 - 223	211 days 199 - 221	214 days 193 - 234
Maximum number of consecutive dry days	13 days 12 - 14	14 days 12 - 15	13 days 12 - 16	14 days 12 - 17	14 days 12 - 16	14 days 12 - 16	14 days 12 - 17
Days per year with precipitation (wet days)	156 days 152 - 161	155 days 148 - 162	155 days 146 - 164	154 days 145 - 164	153 days 143 - 169	154 days 144 - 166	151 days 131 - 172
Temperature thresholds:							
Annual days with maximum temperature > 90°F	11 days 11 - 15	25 days 17 - 37	26 days 17 - 35	33 days 19 - 49	40 days 22 - 57	41 days 24 - 62	69 days 31 - 95
Annual days with maximum temperature > 100°F	0 days 0 - 0	1 days 0 - 3	1 days 0 - 3	2 days 1 - 5	4 days 1 - 7	4 days 1 - 5	14 days 2 - 30

N/A = Data Not Available for the selected area

Figure C-4



Future Climate Indicators

Indicator	Modeled History (1976 - 2005)	Early Century (2015 - 2044)		Mid Century (2035 - 2064)		Late Century (2070 - 2099)	
		Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions
	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max
Precipitation:							
Annual average total precipitation	46" 44 - 48	48" 44 - 55	48" 42 - 54	48" 44 - 56	49" 44 - 54	49" 44 - 54	51" 44 - 58
Days per year with precipitation (wet days)	156 days 152 - 161	155 days 148 - 162	155 days 146 - 164	154 days 145 - 164	153 days 143 - 169	154 days 144 - 166	151 days 131 - 172
Maximum period of consecutive wet days	9 days 8 - 9	9 days 8 - 10	9 days 7 - 10	9 days 8 - 10	9 days 7 - 10	9 days 8 - 11	9 days 8 - 12
Annual days with:							
Annual days with total precipitation > 1inch	9 days 9 - 11	10 days 8 - 13	11 days 9 - 13	11 days 9 - 13	12 days 9 - 13	11 days 10 - 13	12 days 9 - 15
Annual days with total precipitation > 2 inches	1 days 1 - 2	2 days 1 - 2	2 days 1 - 2	2 days 1 - 2	2 days 1 - 3	2 days 2 - 3	2 days 1 - 3
Annual days with total precipitation > 3 inches	0 days 0 - 1	1 days 0 - 1	0 days 0 - 1	1 days 0 - 1	1 days 0 - 1	1 days 0 - 1	1 days 0 - 1
Annual days that exceed 99th percentile precipitation	8 days 8 - 8	9 days 9 - 9	9 days 9 - 10	10 days 9 - 10	10 days 10 - 11	11 days 10 - 11	12 days 12 - 13
Days with maximum temperature below 32 °F	15 days 13 - 18	9 days 2 - 13	9 days 3 - 13	7 days 1 - 11	5 days 2 - 9	5 days 0 - 8	1 days 0 - 4

N/A = Data Not Available for the selected area

Figure C-5--Zip Codes Surrounding Gowanus Canal Site

Figure C-6. Vulnerable Areas With 10-Foot Sea Level Rise

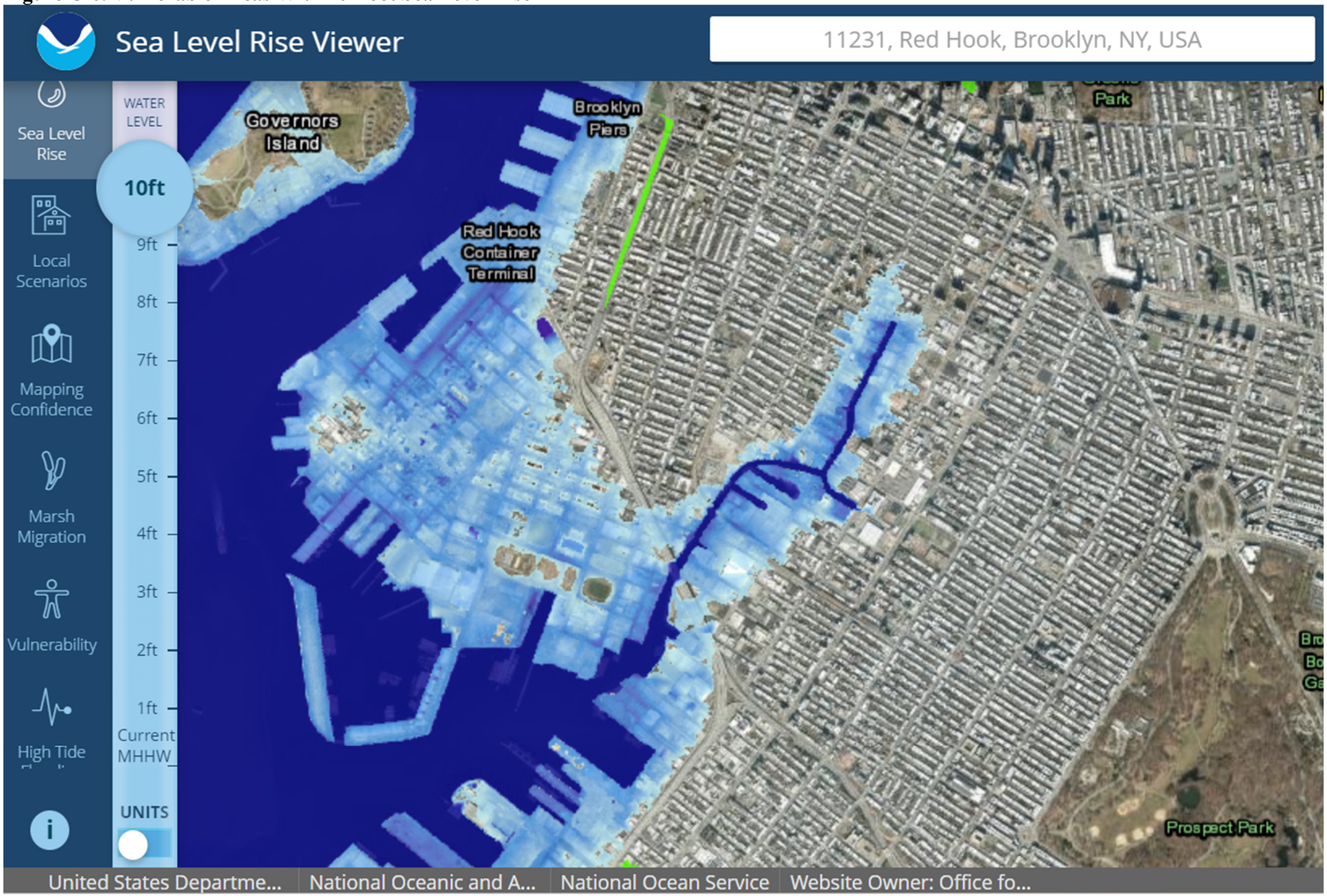


Figure C-7--High Tide Flooding Frequency

Figure C-8—Landslide Vulnerability