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TASC Review of Gowanus Canal Remedial Investigation and Feasibility Study Reports

Revised October 10, 2012

The U.S. Environmental Protection Agency (EPA) published a draft Remedial Investigation (RI) Report for the Gowanus Canal Superfund site in Brooklyn, Kings County, New York, in January 2011, with supplemental material published in February 2012. EPA published the draft Feasibility Study (FS) Report for the Gowanus Canal in December 2011. The Gowanus Canal Community Advisory Group (CAG) requested technical assistance in the form of a technical document review of both reports. The CAG specifically requested a summary of the RI and FS reports that is easy to understand, with a particular focus on what the reports say about three topics:

a. Combined sewer overflows (CSOs) and their relation to Superfund regulations.
b. How water movement affects contamination in the Gowanus Canal (hydrogeology).
c. How ecological restoration could be integrated into the cleanup of the canal.

This report is provided by EPA's Technical Assistance Services for Communities (TASC) program. Independent technical and environmental consultants implement the TASC program. The report's contents do not necessarily reflect the policies, actions or positions of EPA. TASC has provided this report to the Gowanus Canal CAG and other community members affected by the Gowanus Canal Superfund site.

This report includes five sections:

I. Site Background
II. Remedial Investigation and Feasibility Study Report Overview
III. Combined Sewer Overflows (CSOs) and Superfund Regulations
IV. How Water Movement Affects Contamination in the Gowanus Canal
V. Ecological Restoration and Site Cleanup

I. Site Background

Introduction

The Gowanus Canal is located in Brooklyn, New York. Completed in 1869, the canal was once a major local transportation route. Manufactured gas plants, mills, tanneries and chemical plants operated along the canal. Today, the Gowanus Canal is one of the nation's most extensively contaminated water bodies. EPA added the canal to the Superfund National Priorities List (NPL) on March 2, 2010. The NPL is EPA's list of the most contaminated hazardous wastes sites in the United States. Figure 1 shows the Gowanus Canal as seen from the Union Street Bridge during a walking tour with CAG members.

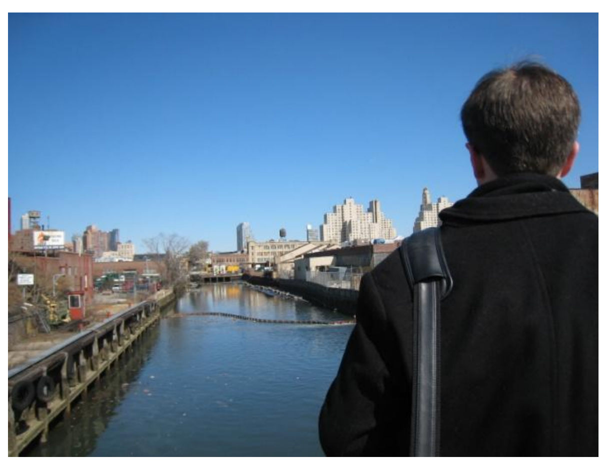

Figure 1: Gowanus Canal from Union Street Bridge

The Superfund Process

Superfund is the common name for the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The program's name refers to the "super fund" of money that was set aside to clean up hazardous waste sites when it was established in 1980.

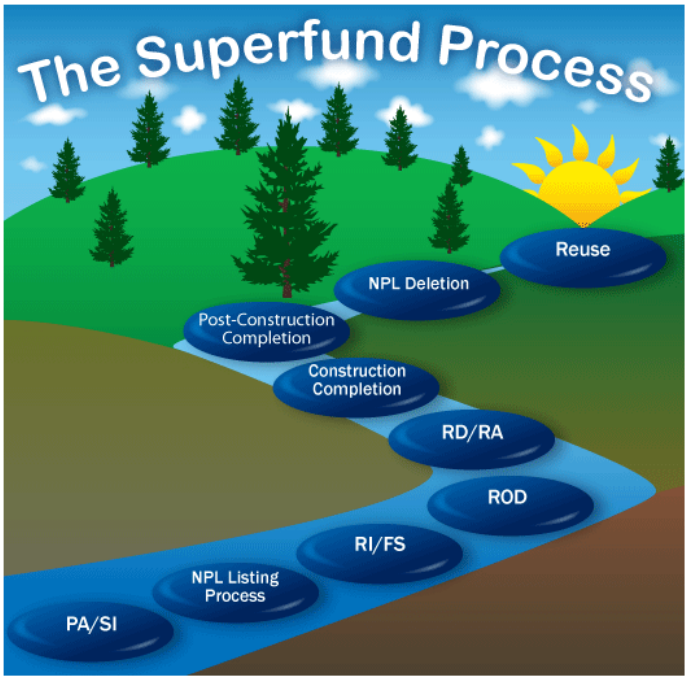

Figure 2: The Superfund process (http://www.epa.gov/superfund/community/process.htm)

Figure 2 shows the Superfund process. It begins with a preliminary assessment and site inspection (PA/SI) and continues on to the NPL listing process. The RI/FS stage determines the nature and extent of contamination at a site and evaluates treatment technologies. EPA then selects a remedy for sites in a decision document called a Record of Decision (ROD). Leading up to the ROD, EPA selects a preferred remedy and presents this remedy in a document called the Proposed Plan. Public comments are solicited on the Proposed Plan before the ROD is completed. After the ROD, detailed cleanup plans are developed and implemented during the remedial design/remedial action (RD/RA) stage, leading to the completion and monitoring of cleanups during the construction completion and post-construction completion stages. Once sites are fully protective of human health and the environment, EPA deletes them from the NPL.

As described above, EPA listed the Gowanus Canal on the NPL in March 2010 following a request by New York State. The site's draft RI and FS reports were completed in January 2011 and December 2011, respectively. Next steps include the Proposed Plan for the site's cleanup and the formal selection of the site's remedy in a ROD.

II. Remedial Investigation and Feasibility Study (RI/FS) Overview

Remedial Investigation (RI), January 2011

Data collection is the purpose of the RI. The data helps EPA characterize site conditions, determine the nature of the waste (contamination), assess risk to human health and the environment, and do tests to evaluate the potential performance and cost of treatment technologies. EPA publishes RI findings in an RI Report.

The results of the RI Report for the Gowanus Canal show that contamination in canal sediments presents an unacceptable ecological and human health risk. Chemicals of concern in sediments identified in the human health risk assessment include polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and metals.[1] Combined sewer overflows (CSOs) that discharge into the Gowanus

Combined Sewer Overflows (CSOs)

Sewers that collect stormwater runoff, domestic sewage and industrial wastewater in the same pipe. During rain events, when stormwater enters the sewers, the capacity of the system may be exceeded and excess wastewater may be discharged directly into a body of water such as Gowanus Canal.

[1] PAHs are a group of chemicals created when products like coal, oil, gas and garbage are partially burned and the burning process is not completed. PCBs are heat-resistant, manmade chemicals. Some PAHs and PCBs are linked to cancer in humans.

Canal during wet weather are sources of PAHs and metals.

The RI found that non-aqueous phase liquid (NAPL) is present in the upper and lower layers of sediments in some parts of the canal. NAPLs are liquids that, like oil, do not dissolve readily in water. Three nearby former manufactured-gas plants (MGPs) are sources of NAPL contamination in the ground water flowing toward the canal.

More information about the RI is available at:
http://www.epa.gov/region2/superfund/npl/gowanus/ri_docs/Gowanus_RI_FACT_SHEET.pdf.

Information on possible exposure pathways to contaminated sediments and EPA's suggestions on how people can avoid or limit such exposure is available at:
http://www.epa.gov/region2/superfund/npl/gowanus/pdf/gowanus_colorcoding-041212.pdf.

A Spanish language version of the information is also available:
http://www.epa.gov/region2/superfund/npl/gowanus/pdf/gowanus_colorcoding_spanish.pdf.

Feasibility Study (FS), December 2011

The purpose of the FS is to develop and evaluate cleanup options based on the findings of the RI. The FS Report discusses options for two distinct layers of sediments. The upper layer is referred to as "soft" sediment. This layer has accumulated in the canal since its construction. The lower layer consists of native sediments that were present before the canal's construction.

The FS Report discusses applying different types of layers over the sediments remaining in the canal after dredging. From top to bottom, these are called an armor layer, an isolation layer and a treatment layer. The armor layer would consist of one-and-a-half feet of stone to protect lower layers from erosion. The armor layer is covered with sand to support organisms. The isolation layer would consist of a fill layer of a half-foot of gravel and a half-foot of sand. The treatment layer would consist of a layer of clay that attracts oils that reduce the movement of contaminants from below the canal into the canal.

For cleanup, the Gowanus Canal is divided into three remediation target areas (RTAs 1, 2 and 3). The RTAs are shown in Figure 3, which is Figure 2-2 in the FS Report. RTA 2 contains the sediment most extensively contaminated with NAPL.

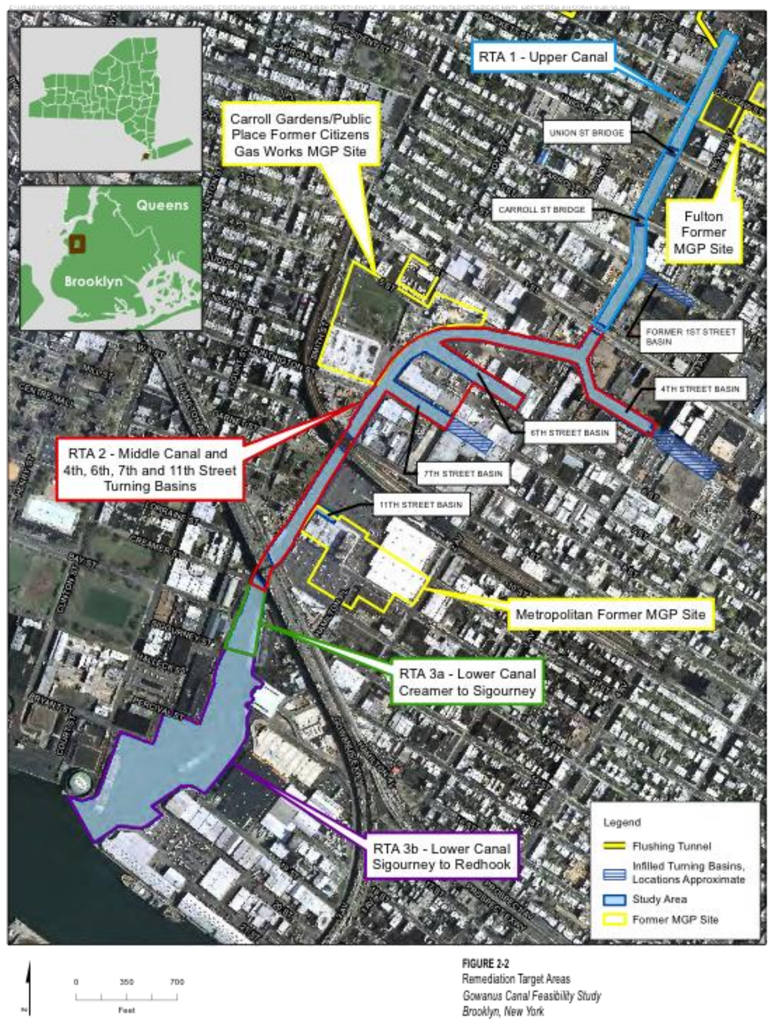

Figure 3: RTAs for the Gowanus Canal Cleanup

Cleanup Alternatives

The FS Report describes seven cleanup alternatives for the site:

Alternative 1	No Action (a required option for every FS)
Alternative 2	Dredge soft sediment to a specified elevation in RTAs 1 and 3 and remove all of the soft sediment in RTA 2. Cap with isolation layer and armor layer.
Alternative 3	Dredge soft sediment to a specified elevation, in RTAs 1 and 3 and remove all of the soft sediment in RTA 2. Cap with oleophilic (oil-absorbing) treatment layer, isolation layer and armor layer.
Alternative 4	Dredge entire soft sediment column in RTAs 1, 2 and 3. Cap with isolation layer and armor layer.
Alternative 5	Dredge entire soft sediment column in RTAs 1, 2 and 3. Cap with oleophilic (oil-absorbing) treatment layer, isolation layer and armor layer.
Alternative 6	Dredge entire soft sediment column in RTAs 1, 2 and 3. Solidify top 3-5 feet of native sediment in targeted areas. Cap with isolation layer and armor layer.
Alternative 7	Dredge entire soft sediment column. Solidify top 3-5 feet of native sediment in targeted areas. Cap with oleophilic (oil-absorbing) treatment layer, isolation layer and armor layer.

Regardless of the cleanup alternative selected by EPA for the Proposed Plan, the cleanup will include these common elements:

- *Predesign investigation*: collection of additional information needed for the design of the remedy.
- *Upland source control*: measures to prevent CSOs and other upland sources from recontaminating the canal.
- *Preconstruction and bulkhead stabilization and repair*: clearing an area, constructing security fencing and setting up job-site trailers and utility services, evaluating bulkheads, and repairing bulkheads to prevent collapse.
- *Dredging*: creation of enclosed cells for dredging by driving temporary sheet piling into the native sediment in two segments of the canal. Debris would be removed using an excavator positioned on a barge. Sediment removal would be performed using mechanical dredges.
- *Sediment dewatering and stabilization*: passive dewatering of removed sediment at an on-site staging area, with transport of sediment by barge for treatment.
- *Cap placement*: a cap would be placed over remaining sediment in the canal to prevent exposure.
- *Dredge cell dewatering and water treatment*: the water in the cell would be tested and, if needed, pumped through the on-site water treatment processes and discharged back to the canal.

Treatment and Disposal Options

All of the cleanup alternatives include dredging. There are several different options for handling dredged sediments in the different RTAs. Treatment and disposal options considered in the FS Report include options A through G as follows. The treatment and disposal options retained for the RTAs are included in parentheses after each option.

- Option A: off-site thermal desorption and beneficial use (RTAs 1, 2 and 3).
- Option B: off-site disposal (landfill and RTAs 1, 2 and 3).
- Option C: off-site cogeneration and beneficial use (RTAs 1, 2 and 3).
- Option D: off-site stabilization and off-site beneficial use (RTAs 1 and 3).
- Option E: on-site stabilization and on-site beneficial use (RTAs 1 and 3).
- Option F: off-site stabilization and placement in an on-site constructed confined disposal facility (CDF) (RTA 3).
- Option G: on-site stabilization and placement in an on-site constructed CDF (RTA 3).

Thermal Desorption

The use of heat to vaporize contaminants in sediment. The vaporized contaminants are then collected or destroyed by heat.

The FS Report does not identify a preferred remedy or a preferred option for handling dredged sediments. The following table describes the evaluation of sediment treatment and disposal options.

Criteria	Option A: Thermal Desorption	Option B: Offsite Landfill	Option C: Co-gen	Option D: Offsite Stabilization, Beneficial Use	Option E: Onsite Stabilization, Beneficial Use	Option F: Offsite Stabilization, CDF	Option G: Onsite Stabilization, CDF
Overall Protection of Human Health and Environment	Meets	Meets	Meets	Meets	Meets	Meets	Meets
Compliance with ARARs	Meets	Meets	Meets	Meets	Meets	Meets	Meets
Long-Term Effectiveness	High	High	High	Low to Moderate	Low to Moderate	Moderate to High	Moderate to High
Reduction of Toxicity, Mobility, or Volume Through Treatment	High	Moderate	High	Moderate	Moderate	Moderate	Moderate
Short-Term Effectiveness	Moderate to High	Moderate to High	Moderate to High	Moderate to High	Moderate to High	Moderate to High	Moderate to High
Implementabi-lity	Moderate	Moderate to High	Moderate	Moderate	Moderate	Moderate	Moderate

Evaluation of Cleanup Alternatives

EPA screened the seven cleanup alternatives with regards to their effectiveness, implementability and cost. EPA selected Alternative 5 and Alternative 7 for further evaluation, with Alternative 1, the No Action baseline alternative, also retained, as required by the National Contingency Plan (NCP).

EPA evaluated each of these three cleanup alternatives using the criteria specified in Section 300.430(e)(9)(iii) of the NCP:

1. Overall protection of human health and the environment
2. Compliance with ARARs
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility or volume through treatment
5. Short-term effectiveness
6. Implementability
7. Cost

EPA will later use two NCP modifying criteria, public and state acceptance, to evaluate the proposed remedy.

Below, Figure 4 and Figure 5 illustrate the cap configuration for cleanup alternatives 5 and 7, respectively.

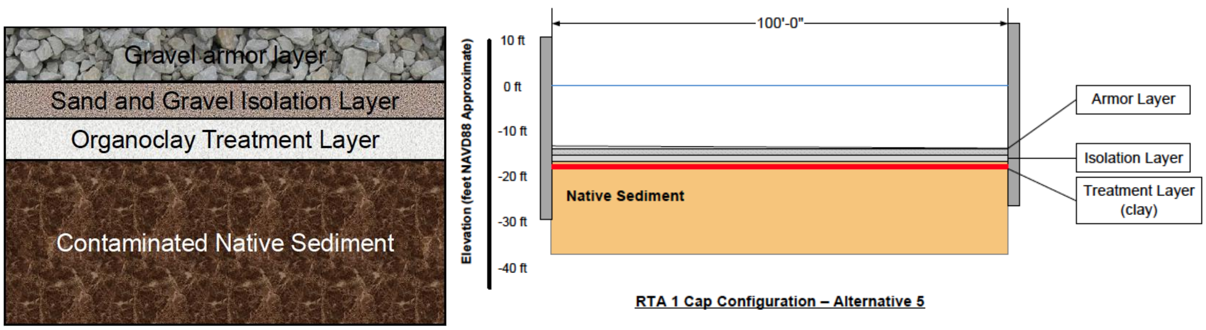

Figure 4: Cap configuration for Alternative 5

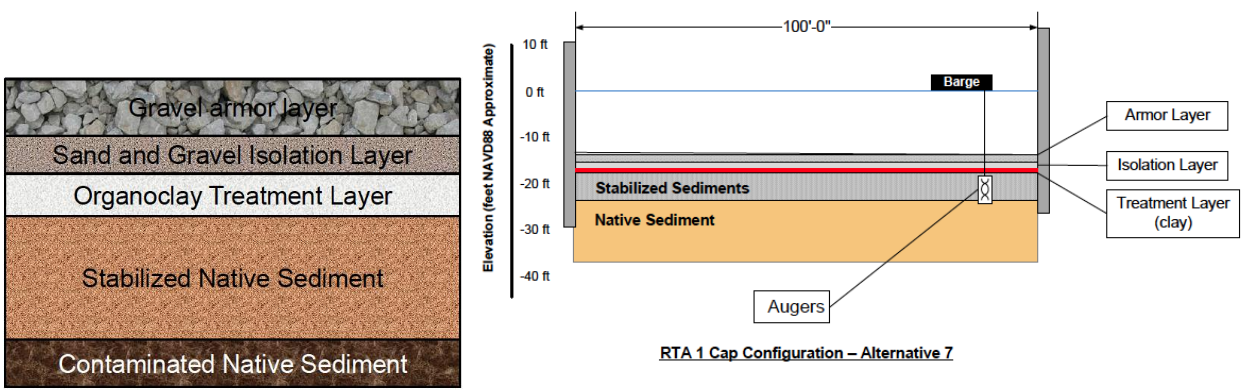

Figure 5: Cap configuration for Alternative 7

Additional Work

The FS Report indicates that more work is needed before designing the remedy for Gowanus Canal. The FS Report identifies the following data collection activities that may be needed:

- Development of a ground water model for the entire project area.
- Additional data collection and analysis to determine NAPL seepage rates.
- Additional evaluation of in situ stabilization (ISS) or other developing technologies that could increase the overall protection and permanence of the remedy. In situ means "in place."
- Additional evaluation and analysis of the sustainability impacts of the selected remedy.

- Other data collection activities and surveys such as a bulkhead stability evaluation, bathymetric surveys (study of underwater depths) and sediment-probing surveys to refine volumes and establish baseline conditions prior to cleanup, and sediment chemistry surveys to establish baseline, or pre-remedy, conditions.
- Additional bench-scale testing to support sediment disposal options.
- Hydrodynamic modeling (a study of the motion of water in the canal) to support cap design.

Retained Alternatives

EPA retained cleanup alternatives 1, 5 and 7 for further evaluation. Reasons for rejecting the other alternatives are as follows:

- Cleanup alternatives that included only partial removal of the soft sediment column were not retained because capping the soft sediment column would be challenging. This is due to the sediments' insufficient load-bearing capacity to support a cap and/or the potential for destabilization of NAPL present in the soft sediments (Alternatives 2 and 3).

- Cleanup alternatives that included the installation of a two-layer cap with isolation and armor layers were not retained because this type of cap is not sufficient to control the long-term flux of NAPL and dissolved-phase contaminants (Alternatives 2, 4 and 6).

Consideration of cleanup alternative 1 is required throughout the FS process per the NCP requirement to provide a baseline condition against which to evaluate the performance of remaining alternatives. Alternatives 5 and 7 include removal of all soft sediments in the canal as well as a three-layer cap (an armor layer, an isolation layer and an oleophilic clay treatment layer). The only significant difference between Alternatives 5 and 7 is Alternative 7's inclusion of ISS in RTAs 1 and 2. Alternative 7 is also retained for RTA 3 if predesign investigations show RTA 3 areas with NAPL that could benefit from ISS application.

The evaluation of cleanup alternatives for RTA 1 indicates that Alternatives 5 and 7 are similar in anticipated effectiveness. However, Alternative 5 is more implementable and should cost less. Also, the long-term effectiveness of Alternative 7 could be better than Alternative 5 if pilot testing shows that ISS is effective and implementable. Disposal options for dredged sediments for RTA 1 include Options A through E. Disposal options A and C score similarly and highest considering all criteria. There is one exception: disposal option B is scored as more implementable. Option E is the lowest-cost disposal option.

The evaluation of cleanup alternatives for RTA 2 is similar to the RTA 1 evaluation. The RTA 2 evaluation indicates that Alternatives 5 and 7 are similar in anticipated effectiveness. However, Alternative 5 is more implementable and should cost less. Also, the long-term effectiveness of Alternative 7 could be better than Alternative 5 if pilot testing shows that ISS is effective and implementable. Disposal options for dredged sediments for RTA 2 include Options A through C. Disposal options A and C score similarly and highest considering all criteria. There is one exception: disposal option B is scored as more implementable. Option A is the lowest-cost disposal option.

The evaluation of cleanup alternatives for RTA 3 is similar to the RTA 1 and RTA 2 evaluations. The RTA 3 evaluation indicates that Alternatives 5 and 7 are similar in anticipated effectiveness. However, Alternative 5 is more implementable. Costs for Alternatives 5 and 7 are estimated to be the same. The long-term effectiveness of Alternative 7 could be better than Alternative 5 if pilot testing shows that ISS is effective and implementable. Disposal options for dredged sediments for RTA 3 include Options A through G. Disposal options A and C score similarly and highest considering all criteria. There is one exception: disposal option B is scored as more implementable. Option G is the lowest-cost disposal option.

III. Combined Sewer Overflows (CSOs) and Superfund Regulations

Since its construction, the Gowanus Canal has served as a drainage system for sewage and stormwater when combined sewer systems that collect sanitary wastewater and stormwater runoff overflow during wet weather, discharging untreated wastewater directly into the canal. Because CSOs are one source of the hazardous chemicals building up in canal sediments, the site's RI and FS addressed the hazardous chemicals entering the canal from CSOs. The Superfund program does not regulate stormwater or sewage discharges or biological hazards from sewage.

The site's RI Report states that CSO and stormwater discharges are the canal's only sources of freshwater. Two combined sewer systems, the Red Hook and Owls Head water pollution control plants, operate 12 permitted CSOs. Ten of these permitted CSOs are active. Figure 1-6 of the RI Report (attached as Figure 5) shows the locations of the CSOs and other outfalls. The greatest annual discharge volumes from the CSOs are from outfalls RH-034, at the head of the canal, RH-035, at the intersection of Bond and 4th Streets, and OH-007, at the north end of 2nd Avenue. These CSOs discharge 121, 111 and 69 million gallons annually, respectively. A floatables boom installed in the canal at Sackett Street detains floating debris that enters the canal from the RH-034 outfall, shown in Figure 4 below.

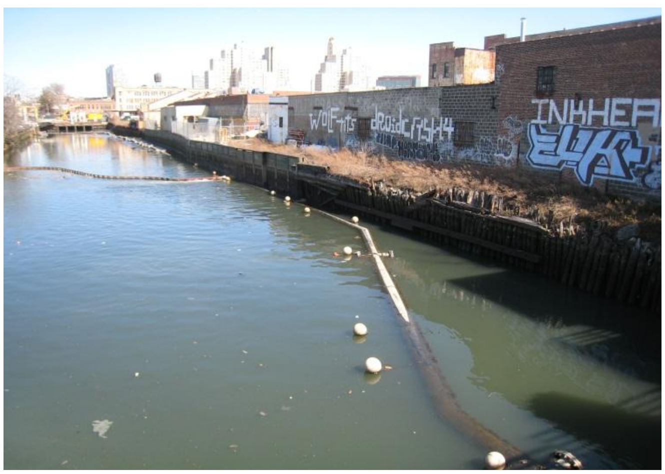

Figure 6: Boom in Gowanus Canal to catch floatable material

Tables 4-12, 4-13 and 4-14 in the RI Report present CSO sediment and wastewater sampling results. Seven canal sediment samples were taken. Sampling identified five different PAHs at concentrations above the applicable human health residential soil screening level in four to seven of the samples. Sampling identified eight different metals at concentrations above the applicable human health residential soil screening level in one to seven of the samples. One of seven samples contained a PCB at a concentration higher than the applicable human health residential soil screening level.

Sediments from the CSOs have contributed to the site's contamination. Site wastewater sampling results summarized in the FS Report are similar: PAHs, a PCB and several metals in the wastewater from CSOs exceed human health residential soil screening levels. In addition, a few volatile organic compounds (VOCs) in the CSOs' wastewater also exceed human health residential soil screening levels.

The FS Report states that discharges from the CSOs as well as from contaminated sites and unpermitted pipes along the canal must be controlled at the same time or before cleanup of the canal to prevent recontamination. New York City's Department of Environmental Protection (NYCDEP) has begun to address CSOs according to the Draft MGP and CSO Cleanup Coordination Schedule (see text box on next page). NYCDEP plans to:

1. *Continue programmatic controls.* Programs currently in place to reduce CSO effects include floatables reduction plans, targeted sewer cleaning, implementation of 14 best management practices, sustainable stormwater management initiatives, and the City-Wide Comprehensive CSO Floatables Plan.

2. *Modernize the Gowanus Canal flushing tunnel.* September 2014 is the anticipated completion date. The Gowanus Canal tunnel flushing system was originally constructed in the early 1900s. Reactivation of the facility in the late 1990s resulted in dramatic water quality improvements in the canal.

3. *Reconstruct the Gowanus Wastewater Pump Station.* September 2014 is the pump station's anticipated construction completion date.

4. *Clean/inspect the OH-007 floatables/solids trap monthly*. Activity to continue until an understanding of how quickly material accumulates in the trap is established.

5. *Conduct periodic water body floatables skimming.* Activity will start after completion of the pump station, expected by September 2014.

6. *Dredge 750 feet of the canal from its head downstream and apply a 2-foot-thick sand cap.* The final water depth will be -3 feet mean lower low water (MLLW). [MLLW is the average of the lower low-water height of each tidal day observed over a specific 19-year period.]

The FS Report indicates that CSO measures in addition to those planned by NYCDEP will be required to prevent recontamination of the canal. The FS Report further indicates that controlling CSO and other contaminant sources will be a first step in the cleanup plan.

> "In order for any of the remedial alternatives to be effective, upland sources of contamination – such as discharges from the CSOs, from the former manufactured gas plant (MGP) sites and other contaminated sites along the canal, and from the unpermitted pipes along the canal – must be controlled in parallel with or prior to the implementation of the selected sediment remedy. These upland source controls need to be coordinated and implemented in concert with the selected sediment remedy to prevent recontamination of the canal following remedy implementation. All of these alternatives in this FS rely upon the successful implementation of these controls; therefore, they are included as the first component of all alternatives. The source control measures that will be developed are included by reference in this FS." (FS Report p. 4-14)

EPA and the City of New York are currently negotiating CSO management decisions and responsibilities.

Draft MGP and CSO Cleanup Coordination Schedule

NYC CSO Upgrades

ROD will include Superfund-related overflow and solids controls
12/2012

↓

Flushing Tunnel/
Pump Station Work
2013

↓

Design of Superfund-related overflow/solids controls
2013-2015

↓

Dredge Area 1 Superfund-related outfall controls
must be in place by
December 2015

↓

Dredge Area 2 Superfund-related outfall controls
must be in place by
February 2016

↓

Dredge Area 3 Superfund-related outfall controls
Must be in place by
December 2018

Source:
http://www.epa.gov/region2/superfund/npl/gowanus/pdf/EPADECDEPGowanusTimeline11-2011.pdf

Figure 7: CSO and stormwater outfall locations

IV. How Water Movement Affects Contamination in the Gowanus Canal

Hydrogeology is the study of how water moves under the ground and how ground water and surface water are connected. Hydrogeology helps us understand how water movement affects contaminated sediment in the Gowanus Canal. The canal is a dead-end channel that opens to Gowanus Bay and Upper New York Bay. The canal dead-ends at Butler Street. The canal experiences two high tides and two low tides of unequal height each tidal day, with water levels varying by five to six feet due to the tides. The only freshwater flowing into the canal are wet-weather CSO and stormwater discharges. The canal has low current speeds and limited tidal exchange with Gowanus Bay. Stormwater drains into Gowanus Canal from a surrounding area that is about 1,758 acres in size. The waterfront area along the canal is occupied primarily by commercial and industrial land uses. These properties may affect the quality of the water runoff into the canal during wet weather.

In 1911, the City of New York built the Gowanus Canal Flushing Tunnel to improve water circulation and flush contaminants from the canal. The tunnel starts at Degraw Street on Buttermilk Channel and ends on the west side of the canal at Douglas Street. The tunnel fell into disrepair in the mid-1960s, was reactivated in 1999 and shut down for modernization in 2010. Even with the flushing tunnel, contaminated sediments accumulate in the canal rather than being flushed out into the bay. Currents generated by the flushing tunnel carry canal sediments. However, current speeds become slower farther down the canal and the sediments fall to the bottom of the canal.

The water in the Gowanus Canal generally flows at a rate less than one-half (0.5) of a foot per second. This current flow rate is too slow to resuspend sediment deposited on the bottom of the canal. Figure 8 shows how the water flow rate (velocity) affects what happens to different sizes of sediment particles. At low-flow rates (see the bottom part of the diagram), sediment is not eroded and only very small particles stay suspended in the water. At high-flow rates (see the top part of the diagram), sediment at the bottom of the canal is eroded (resuspended in the water).

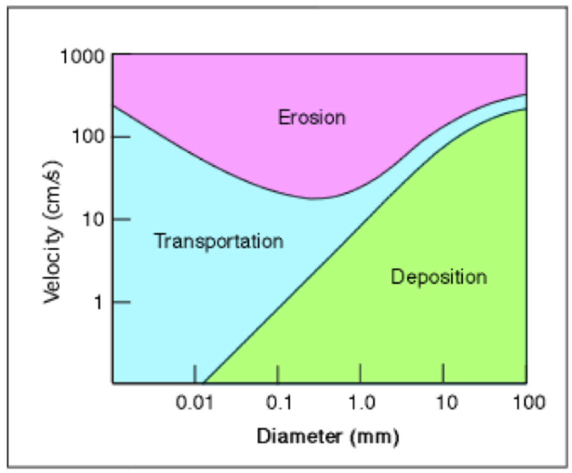

Figure 8: Canal velocity versus sediment transportation (http://www.columbia.edu/~vjd1/streams_basic.htm)

The RI Report states that the amount of sediment transported out of (or into) the canal in typical weather conditions or during storm events has not been measured or estimated. However, there is a steep drop in total PAH concentrations in surface sediments from the middle reach of the canal to its lower reach. There is an additional drop from the canal's lower reach to Gowanus Bay and Upper New York Bay. This pattern of PAH concentrations in the top layer of sediment in the canal indicates that much of the contaminated sediment likely stays relatively close to its source.

Not all types of contaminants stick to sediment and remain in the canal for long periods of time. Contaminants that dissolve easily in water, vaporize easily into the air, or are used as food by microorganisms are not likely to build up to levels of concern in canal sediments. However, some contaminants, such as PAHs and PCBs, are persistent in the environment. Because of low current velocities and limited tidal exchange with Gowanus Bay, canal sediments containing persistent contaminants have accumulated in the canal rather than being flushed out to Gowanus Bay and Upper New York Bay.

When contaminants accumulate in the sediments of a body of water, such as the Gowanus Canal, or when the concentrations of contaminants in the surface water become too high, contamination may move from surface water into ground water. Likewise, contaminated ground water may move into surface water. A network of 91 ground water monitoring wells was installed on site and the wells were sampled to determine how ground water and water in the canal interact. EPA found that ground water generally flows toward the canal at both high and low tides. However, the water flow reverses locally in some areas and with daily regularity. Based on information to date, the flow of ground water into the canal does not appear to be enough volume to influence the overall water chemistry of the water in the canal. However, the high salt content of canal water does appear to change the chemistry of ground water near the canal, making it more saline (salty or brackish).

The blue arrows in Figure 9 show that ground water generally flows toward the canal. Ground water also flows in an upward direction toward the canal in some places. The smaller blue arrows show that water interchanges between the canal and ground water. The RI Report states that contaminated ground water was found underneath some properties along the canal. It is likely that dissolved contaminants are moving from ground water into the canal at certain locations because of the general direction of ground water flow toward the canal.

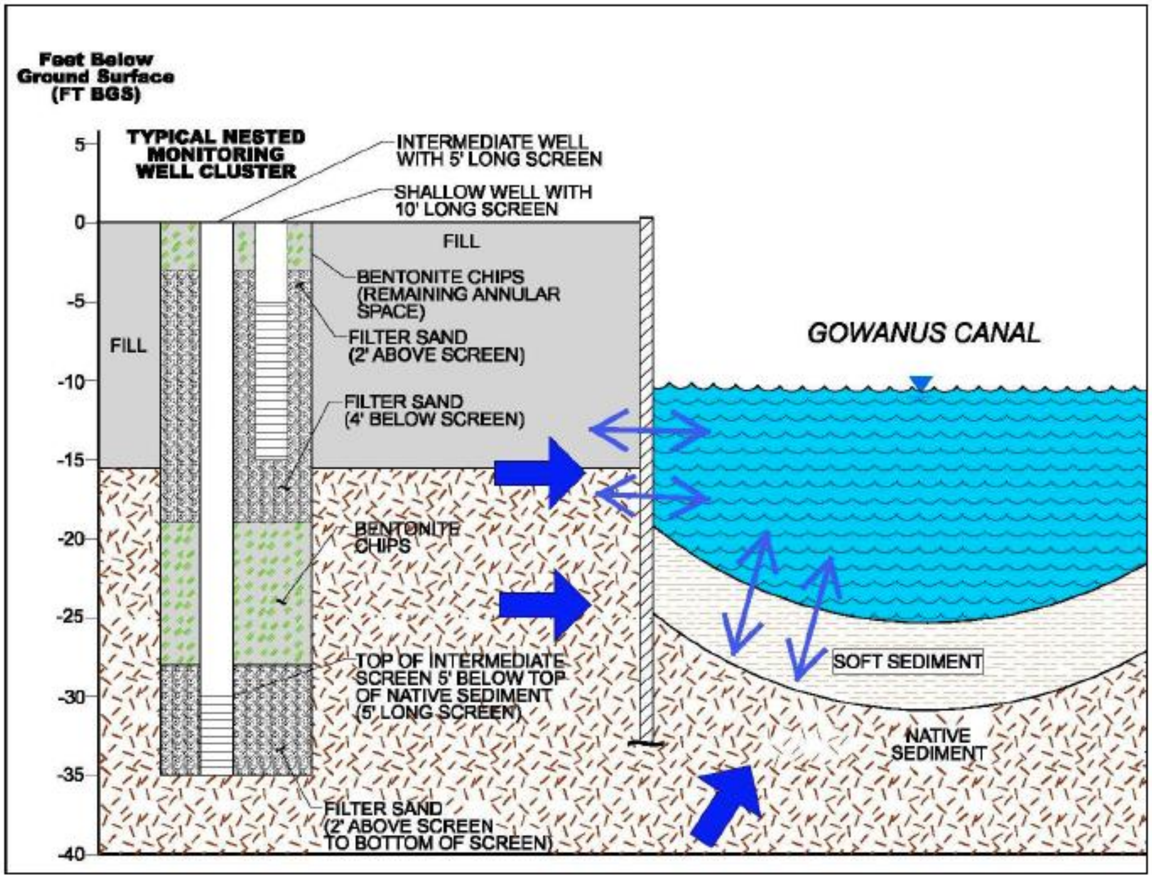

Figure 9: EPA diagram of a typical monitoring well for the Gowanus Canal (http://www.epa.gov/Region2/superfund/npl/gowanus/pdf/cag_presentation_may2011.pdf)

Ground water moves from areas of higher elevation or higher pressure to areas of lower elevation or lower pressure (hydraulic pressure). In the same way that pressure can cause water to flow upward from a garden hose, pressure can cause ground water to flow upward through the spaces between underground soil and rocks. Pressure on ground water is caused by the weight of overlying water and earth materials. Under the force of gravity, ground water generally flows from high areas to low areas. However, pressure can cause ground water to flow upward.

V. Ecological Restoration and Site Cleanup

The Gowanus neighborhood was originally a tidal inlet of navigable creeks in marshland (see Figure 10). The canal was transformed into a mile-and-a-half-long commercial waterway connected to Upper New York Bay in the mid 1800s. Some community members have indicated they would like to see ecological restoration incorporated into the cleanup of the Gowanus Canal. Specific ideas include shoreline softening, riparian buffers (vegetated areas along a waterway to protect the waterway from runoff), habitat restoration and increased public access.

Figure 10: 1851 Sunset at Gowanus Bay by Henry Gritten (Source: Brooklyn Historical Society)

Ecological restoration is the practice of renewing and restoring degraded, damaged or destroyed ecosystems and habitats in the environment by active human intervention and action. Such actions could improve water quality in Gowanus Canal by absorbing and reducing stormwater runoff and providing natural areas for particles to settle before reaching the canal. Such actions could also provide a more natural environment along the canal for people to enjoy.

Ecological Restoration and the Site's FS Report

The site's FS Report describes the fill that will be added back into the canal after the dredging occurs. Cleanup alternatives 5 and 7 (the alternatives retained for further evaluation) both incorporate a fill layer called an armor layer as the "top" layer. An armor layer protects the finer materials beneath it from erosion; the armor layer protects the finer layers until it is removed. The armor layer is 1.5 feet thick and consists of large stones with approximately one half-foot of sand placed on top to fill in spaces between the stones to facilitate benthic recolonization.

The benthic zone is the lowest level in a body of water; it includes the sediment surface and some sediment sub-surface layers. Examples of organisms that will recolonize the benthic zone include worms, microorganisms, mussels and crabs. The FS Report does not discuss ecological restoration as part of any of the cleanup alternatives, although the site's preliminary remediation goals (cleanup levels for contaminants) were based on the protection of the benthic community.

Ecological Restoration Considerations

Restoration activities could focus on the canal's ecology as well as the ecology of areas alongside the canal. The restoration of habitats that can support ecosystems will encourage more complex ecosystems with greater numbers of organisms to form. If community members are interested in ecological restoration, they could ask that EPA consider more extensive ecological restoration approaches as part of the site's cleanup. Once EPA releases the draft Proposed Plan for the site's cleanup, the Agency will solicit comments from the public. If community members would like additional ecological restoration measures included as part of the Proposed Plan, they should communicate such requests to EPA.

Canal Restoration

The dredging that will be conducted to clean up the sediments in the canal will remove organisms currently living in the sediments. Community members could recommend that EPA consider several ecological restoration options for the canal as part of the cleanup, including:

- Reintroduction of native populations of organisms and plants to "seed" the population in the canal.
- Construction of soft shorelines, where possible. Soft shorelines are constructed using "non-structural" stabilization techniques that rely on vegetative plantings and sand fill, or "hybrid" techniques that

combine vegetative planting with low rock sills instead of using stabilization structures such as bulkheads.

- Identification of areas for wetlands, marshes or oyster beds.

Restoration Alongside the Canal

Parks and green spaces next to the canal can absorb and filter stormwater to help prevent continued contamination. In an effort separate from the Superfund cleanup conducted by EPA, some community members are already working on plans to provide green spaces along the canal. One such example is the Gowanus Canal Conservancy's effort to improve water quality and promote public access to the Canal by developing and maintaining a contiguous and publicly accessible green space along the Canal and extending into targeted portions the watershed. As part of this effort, the Conservancy is working with state and local agencies to facilitate the funding, design, and construction of street-end rain gardens, bioswales, green roofs, and other form of green infrastructure to create green spaces that would be "aesthetically beautiful while working to reduce the problem of contaminated water flowing into the Gowanus Canal." The design, shown in Figure 11, includes measures for reducing the input of stormwater into the combined sewer system that discharges to Gowanus Canal. Other community groups or private property owners with land along the canal may be engaged in similar planning.

Construction of some portions of the Gowanus Canal Conservancy's vision for a park along the canal, is currently underway, funded by $1 million in commitments from the city and other sources. The design incorporates parks, public space, recreation, wetlands and education areas. These areas are also intended to serve as "green infrastructure," reducing stormwater runoff by absorbing water flows. More information about the planned park is available at: http://www.spongepark.org.

In terms of next steps, community members may want to learn more about the city's commitment to facilitating the creation of a publicly accessible park and related efforts to include green infrastructure along the canal. There may be opportunities for citizen involvement as these efforts progress. Although the Superfund cleanup does not include ecological restoration activities along the canal, there may be opportunities to adjust timing or cleanup plans to dovetail with ecological restoration planning by the city or others. Community members could ask EPA to consider any ecological restoration plans they are aware of and ways that the Superfund cleanup could support the establishment of green infrastructure along the canal. Community groups or private property owners who have plans for green infrastructure may find it beneficial to contact EPA to discuss and coordinate their plans with Superfund cleanup activities.

Figure 11: Design plan for the publicly accessible green space along the Gowanus Canal (http://www.spongepark.org)

Glossary of Terms

Combined sewer overflows (CSOs)	Sewers that collect stormwater runoff, domestic sewage and industrial wastewater in the same pipe. During rain events, when stormwater enters the sewers, the capacity of the system may be exceeded and excess wastewater may be discharged directly into a body of water such as Gowanus Canal.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	Law that created a tax on the chemical and petroleum industries and provided broad federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment.
Ecological restoration	The practice of renewing and restoring degraded, damaged or destroyed ecosystems and habitats in the environment by active human intervention and action.
Environmental Protection Agency (EPA)	An independent federal agency charged with protecting human health and the environment.
Feasibility study (FS)	One of the initial stages of the Superfund process, which happens either concurrently or directly after the remedial investigation (RI). The FS develops and evaluates cleanup options for a site based on the findings of the RI.
Hydrogeology	The study of how water moves under the ground and how ground water and surface water are connected.
In situ stabilization	A process used in situ (in place) to reduce the leachability of a waste. Stabilization often involved chemical reactions that immobilize hazardous materials. These chemical reactions may or may not change the physical nature of the waste.
Non-aqueous phase liquid (NAPL)	Liquids that, like oil, do not dissolve readily in water.
Polychlorinated biphenyl (PCB)	Heat-resistant, manmade chemicals. Some PCBs are linked to cancer in humans.
Polycyclic aromatic hydrocarbon (PAH)	A group of chemicals created when products like coal, oil, gas and garbage are partially burned and the burning process is not completed. Some PAHs have been linked to cancer in humans.
Preliminary assessment/site inspection (PA/SI)	The first step in the Superfund process. Historical and other available information is collected to evaluate whether a site poses a threat to human health and the environment and/or whether further investigation is needed. This information is used to evaluate the risks posed by the site and if the site needs to be proposed for listing on the NPL.

Glossary of Terms Continued

Proposed Plan	An EPA document that describes the cleanup alternatives considered for a site, identifies the preferred cleanup alternative, and provides the rationale for this preference.
Record of Decision (ROD)	The ROD explains which cleanup alternative will be used at an NPL site. The document also includes the site's history, a site description, site characteristics, community participation, enforcement activities, past and present activities, contaminated media, the contamination present, a description of the response actions to be taken, and the remedy selected for site cleanup.
Remedial Design/Remedial Action (RD/RA)	The Superfund phase when the bulk of the cleanup at a site is prepared for and conducted. EPA community involvement staff keep community members advised about the progress of the cleanup through periodic public events, newsletters, fact sheets and presentations.
Remedial Investigation (RI)	One of the initial stages of the Superfund process. Data is collected to help EPA characterize site conditions, determine the nature of the waste (contamination), assess risk to human health and the environment, and do tests to evaluate the potential performance and cost of treatment technologies.
Superfund National Priorities List (NPL)	EPA's list of the most contaminated hazardous wastes sites in the United States.
Technical Assistance Services for Communities (TASC)	An EPA program that provides independent educational and technical assistance to communities.
Thermal desorption	The use of heat to vaporize contaminants in sediment. The vaporized contaminants are then collected or destroyed by heat.

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