EXECUTIVE SUMMARY

Introduction

The Newtown Creek Superfund Site was added to the National Priorities List and published in the Federal Register on September 29, 2010. This *Remedial Investigation Report* (RI Report) presents the results of a comprehensive investigation conducted between 2011 and 2018, designed to characterize the Study Area and to assess potential risks to human health and the environment. This RI Report presents the results of the investigation and, together with the *Baseline Human Health Risk Assessment* (BHHRA; Appendix H) and the *Baseline Ecological Risk Assessment* (BERA; Appendix I), provides the foundation for evaluating remedial alternatives during the Feasibility Study (FS).

The Newtown Creek Remedial Investigation (RI) data collection program was conducted in two phases, which are referred to as Phase 1 and Phase 2 throughout the document, followed by Part 1 of the FS field program. All studies have followed methods and procedures described in U.S. Environmental Protection Agency (USEPA)-approved work plans and conducted directly under USEPA oversight. Specifically, these studies focused on the following objectives:

- Phase 1 sampling: Intended to broadly characterize chemical and physical features of the Study Area.
- Phase 2 sampling: Conducted to fill data gaps and collect additional data needed to support the risk assessments and modeling, as well as the point sources, nonaqueous phase liquid (NAPL), and groundwater evaluations.
- Part 1 of the FS field program: Conducted to collect additional data to support the development and evaluation of remedial alternatives; this data is presented in this RI Report.

Additional FS field program studies will be presented in a subsequent FS-related report.

In addition to the field sampling and surveys, the Remedial Investigation/Feasibility Study (RI/FS) includes a modeling effort consisting of five components: hydrodynamics, sediment transport, groundwater, chemical fate and transport, and bioaccumulation. These models are in various phases of development and will be used to evaluate remedial alternatives in the FS.

Site Setting and Physical Characteristics

Newtown Creek forms part of the border between the boroughs of Brooklyn and Queens, New York City (NYC), New York. It is a tidal inlet to the East River with no natural tributary inflows. It is approximately 3.8 miles long and comprises a main channel and five tributaries (Dutch Kills, Maspeth Creek, Whale Creek, East Branch, and English Kills). A navigation channel extends through the main stem and into portions of Whale Creek and English Kills. The average width of the main stem is approximately 100 meters, and the average depth ranges from approximately 5 to 6 meters, depending on location. All five tributaries tend to be narrower than the main channel and have shallower depths; average widths range from approximately 50 to 70 meters, and average depths range from less than 1 meter to 5 meters. The Administrative Order on Consent (AOC) defines the Study Area as Newtown Creek and the five tributaries extending up to the ordinary high water mark.[1,2]

The land use around Newtown Creek from the 1800s through the present has been predominately industrial. This industrial development occurred in parallel with municipal use of Newtown Creek as a receiving waterbody of both stormwater and wastewater discharges. Newtown Creek continues to be a major receiving waterbody of industrial and municipal separate storm sewer system (MS4) discharges and combined sewer overflow (CSO) discharges (containing combined flows of stormwater, sanitary wastewater, and industrial wastewater), as well as treated effluent from the Newtown Creek wastewater

[1] The Newtown Creek Superfund Site Study Area is described in the AOC as encompassing the body of water known as Newtown Creek, situated at the border of the boroughs of Brooklyn (Kings County) and Queens (Queens County) in the City of New York and the State of New York, roughly centered at the geographic coordinates of 40° 42' 54.69" north latitude (40.715192°) and 73° 55' 50.74" west longitude (-73.930762°), having an approximate 3.8-mile reach, including Newtown Creek proper and its five branches (or tributaries) known respectively as Dutch Kills, Maspeth Creek, Whale Creek, East Branch, and English Kills, as well as the sediments below the water and the water column above the sediments, up to and including the landward edge of the shoreline, and including also any bulkheads or riprap containing the waterbody, except where no bulkhead or riprap exists, then the Study Area shall extend to the ordinary high water mark, as defined in 33 Code of Federal Regulations § 328(e) and the areal extent of the contamination from such area, but not including upland areas beyond the landward edge of the shoreline (notwithstanding that such upland areas may subsequently be identified as sources of contamination to the waterbody and its sediments or that such upland areas may be included within the scope of the Newtown Creek Superfund Site as listed pursuant to Section 105(a)(8) of Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA]).
[2] The term "creek" is used interchangeably with "Study Area" throughout this RI Report.

treatment plant (WWTP) overflow during rainfall events. It is also a designated Significant Maritime and Industrial Area, which will continue to give preference to commercial use of the creek and industrial uses in upland areas. Modifications to Newtown Creek, such as fill placement and bulkheading along shorelines that have occurred over time, have resulted in a system that is largely adapted for industrial, municipal, and navigational purposes.[3] Consequently, the land use history and urban landscape in which Newtown Creek exists shapes the conceptual site model and informs the nature and extent of contaminants of potential concern (COPCs) and potentially significant sources, as well as key fate and transport characteristics, pathways, and exposure scenarios.

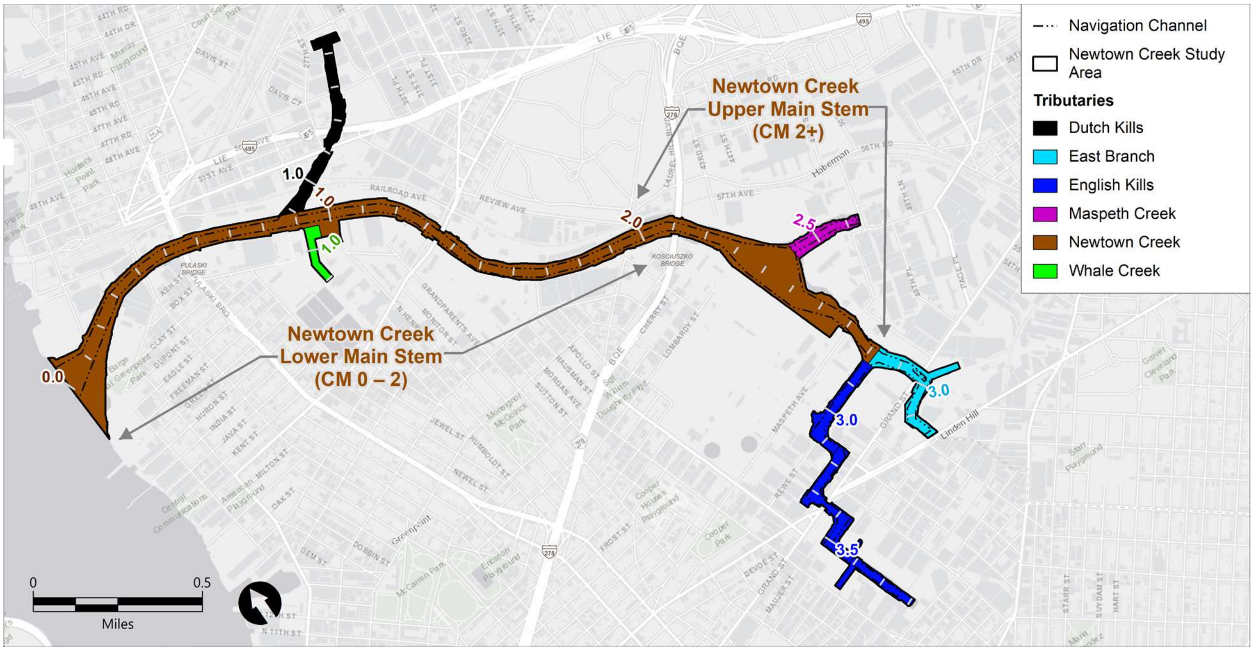
The natural hydrodynamics of the Study Area are dominated by twice-daily tidal exchange with the East River and by rainfall-related flows from point sources and overland flow. Tidal mixing with East River water is most pronounced in creek mile (CM) 0 – 2 of the main stem but continues to a significant degree beyond CM 2. Suspended solids are introduced into the Study Area water column primarily by the twice-daily tidal inflows from the East River and from periodic discharges from CSO, MS4, and other point source stormwater discharges; overland stormwater flow; and the Whale Creek WWTP treated effluent overflow. These solids are transported and mixed within the surface water, and a portion of them eventually settle, continuously adding to, covering, and mixing with the existing sediment bed. The sediment bed throughout Newtown Creek is a cohesive (muddy) bed that is primarily net depositional, due to the low near-bed current velocities. Hydrodynamic processes (i.e., tidal currents and density-driven circulation) generate relatively low, near-bed current velocities

[3] To meet the goals of the Clean Water Act, the New York City Department of Environmental Protection (NYCDEP) has developed a Long-Term Control Plan (LTCP) to reduce CSO discharges and improve water quality in Newtown Creek. The Newtown Creek LTCP (NYCDEP 2017) was approved on June 27, 2018 (NYSDEC 2018a). The LTCP includes plans to construct two "preferred" CSO controls. Timing of CSO controls is an important consideration for the Newtown Creek RI/FS. The first control will reroute the Dutch Kills CSO, is scheduled to be completed in 2029, and is predicted to reduce annual CSO volume to Newtown Creek by 110 million gallons per year (MGY; 20% flow reduction). The second control will provide underground tunnel storage for CSOs from the three largest Newtown Creek outfalls, which are located in English Kills, East Branch, and Maspeth Creek. The storage tunnel project is scheduled to be completed in 2042 and is predicted to reduce annual CSO volume to Newtown Creek by 584 MGY (an additional 61% flow reduction, for a total of 69% CSO volume reduction from current levels). The uncontrolled CSO discharges that will remain during and after the proposed LTCP action is implemented—along with discharges from the Newtown Creek WWTP treated effluent overflow and stormwater discharges—will contribute to "site-specific background" conditions in Newtown Creek.

throughout large portions of the Study Area, which result in minimal or near-zero erosion of the sediment bed, except in areas where vessel traffic may cause periodic scouring of the bed.

Based on some of the unique, site-specific Study Area characteristics noted previously, Newtown Creek is evaluated in this RI in the following three primary reaches (Graphic ES-1):

- **The lower main stem, from the mouth to approximately CM 2 (CM 0 – 2)**
  - CM 0 – 2 is characterized by extensive tidal exchange with the East River. Depositing solids originate primarily from the East River.
- **The upper main stem, including the Turning Basin (CM 2+)**
  - CM 2+ is a more complex portion of the Study Area. Depositing solids originate both from downstream (the East River) and upstream (primarily CSO and stormwater outfalls). Depositional characteristics within CM 2+ vary relative to position of the navigational channel, influences of vessel traffic, and shoreline features.
- **The tributaries**
  - The tributaries exhibit low surface water current velocities under typical conditions. CSO and storm-related point source inflows provide nearly all the solids that deposit on the sediment bed in the upper tributaries (i.e., Maspeth Creek, East Branch, and English Kills). Each tributary differs in circulation, deposition characteristics, and solids sources.



Graphic ES-1. Study Area Reaches

Nature and Extent of Contamination and Fate and Transport Characteristics

A primary focus of the RI field program was to delineate the nature and extent of contamination in the Study Area. Based on the results from the BERA and BHHRA, total polycyclic aromatic hydrocarbon (17) (TPAH),[4] total polychlorinated biphenyl (TPCB), and copper (Cu) are primarily relied on to characterize the nature and extent of contamination, though the RI Report summarizes other contaminants as well.[5] The distribution of these

[4] This includes the 16 USEPA priority pollutant polycyclic aromatic hydrocarbons (PAHs), as well as 2-methylnaphthalene.

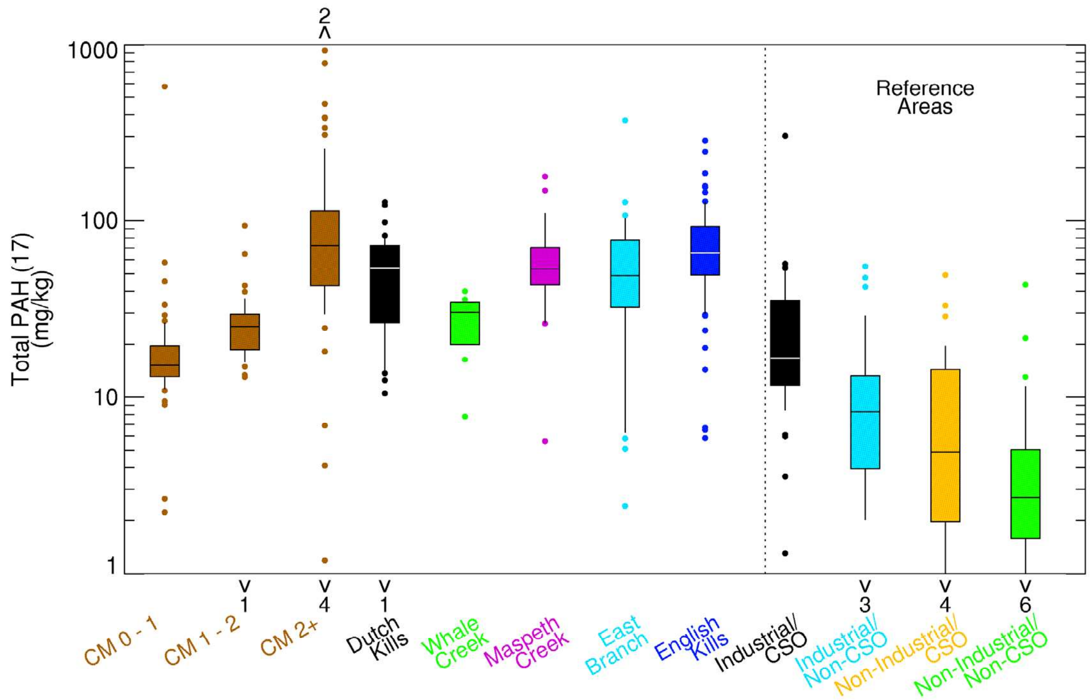
[5] This RI Report focuses on three chemicals: TPAH, TPCB, and Cu. 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), lead, and dieldrin were also included in the nature and extent evaluations for surface sediment. TPAH, TPCB, and Cu were selected based on the overall conclusions of the baseline risk assessments reported in the BHHRA (Appendix H) and the BERA (Appendix I). TPCB is a primary risk driver in the BHHRA. TPAH is a primary risk driver in the BERA. Cu was also selected as a representative metal because of some potential ecological risk, and bulk sediment concentrations are elevated relative to screening benchmarks in sediment in CM 2+. 2,3,7,8-TCDD, lead, and dieldrin were included in the nature and extent evaluation for surface sediment because there is some potential human health and ecological risk from 2,3,7,8-TCDD, potential ecological risk from lead in the tributaries, and dieldrin sediment concentrations are elevated in CM 2+ and the tributaries. The distributions of these three constituents in surface sediment are broadly similar to those of TPAH, TPCB, and Cu.

contaminants in the surface sediment (defined operationally as a depth of 0 to 15 centimeters [cm; 0 to 6 inches]), subsurface sediment (from 15 cm [6 inches] depth to the interface with the underlying native material), native material, surface water, and NAPL in the Study Area are summarized in the following sections.

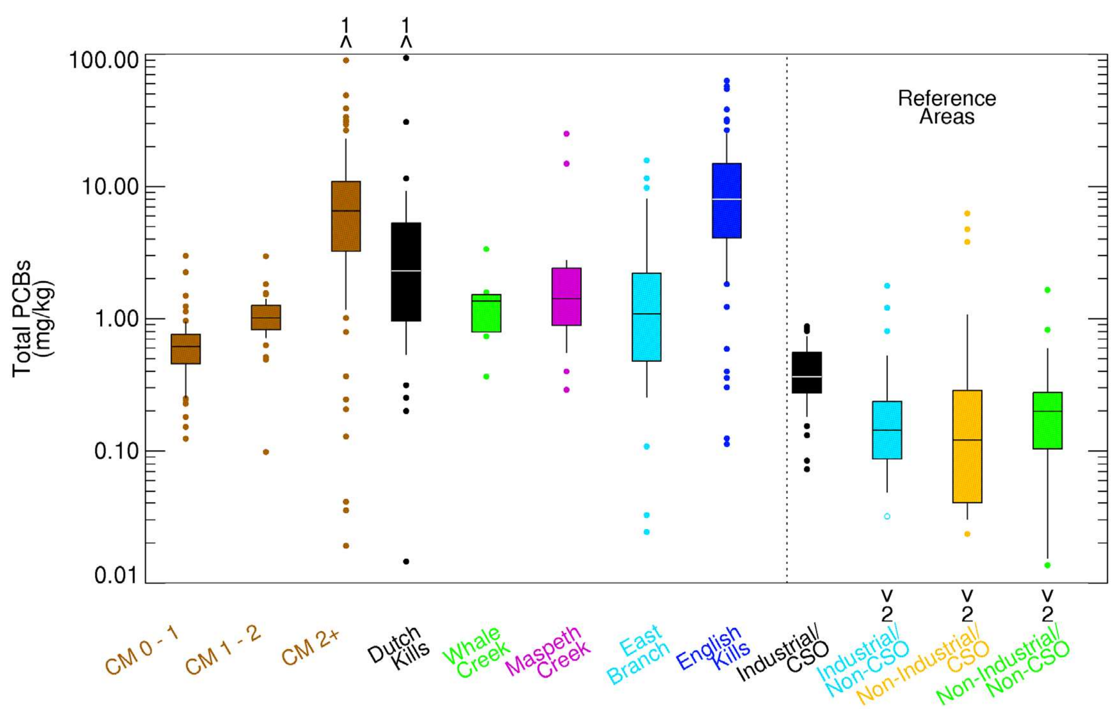
Sediment

TPAH, TPCB, and Cu concentrations in surface sediment are summarized in the following graphics (Graphics ES-2 through ES-4), which present data from the Study Area.[6] In these graphics, the main stem of Newtown Creek, which runs from the mouth of the creek at the East River upstream through the Turning Basin, is divided into three segments: CM 0 – 1, CM 1 – 2 (shown as one reach in Graphic ES-1), and CM 2+; each tributary is represented individually. These graphics also show the surface sediment data from reference areas for comparison. Reference areas were selected by USEPA to evaluate regional physical, chemical, and biological background conditions in waterbodies that span a range of industrial development and influence from CSO discharges.

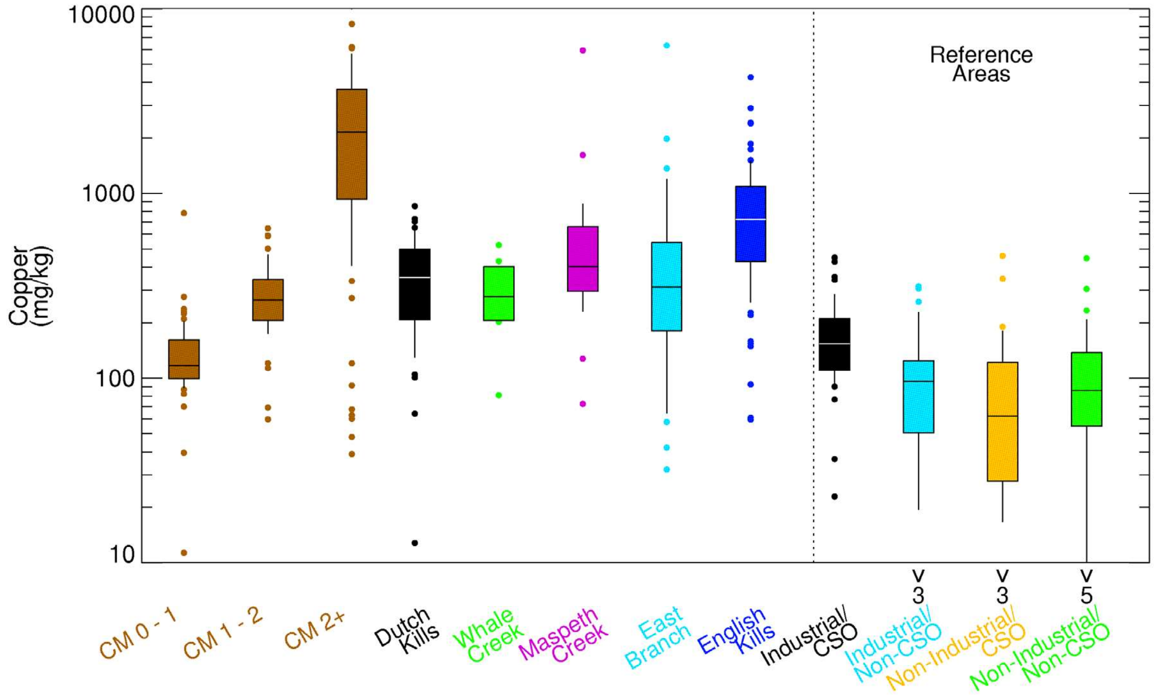
[6] In these graphics, the boxes represent the 25th and 75th percentiles of the data, and the vertical lines represent the 10th and 90th percentiles. The horizontal line through the box represents the median. All values lying outside the 10th and 90th percentiles are indicated individually. The caret symbols represent individual values that are above or below the panel; the number of values outside the panel is also indicated. Surface sediment includes data collected within the top 15 cm (6 inches) of the sediment bed.



Graphic ES-2. TPAH in Surface Sediment



Graphic ES-3. TPCB in Surface Sediment



Graphic ES-4. Copper (Cu) in Surface Sediment

Notable patterns in the surface sediment data are as follows:

- **Surface sediment, CM 0 – 2.** Surface sediment TPAH, TPCB, and Cu concentrations in CM 0 – 1 are generally the lowest in the Study Area and are consistent with regional background,[7] as represented by the Industrial/CSO reference area data. Concentrations in CM 1 – 2 are higher than those in CM 0 – 1, but are consistent with (or approaching) regional background.
- **Surface sediment, CM 2+.** The highest surface sediment concentrations for TPAH, TPCB, and Cu in the main stem are observed in CM 2+, with most values being above regional background.
- **Surface sediment, tributaries.** Concentrations in tributaries are generally higher than in CM 0 – 2 and generally exceed background levels as a result of the mixing of ongoing sources with residual historical contamination. The highest TPAH and Cu concentrations, as well as elevated TPCB concentrations, are observed primarily in

[7] Concentrations in surface sediment samples collected from USEPA-approved reference areas are located throughout the New York Harbor and Jamaica Bay area and are considered representative of regional background sediment concentrations.

the lower 0.5 mile of English Kills. The highest TPCB concentrations are observed in Dutch Kills. In some tributaries, specifically East Branch and English Kills, concentrations decrease upstream, toward the head of each tributary.

In subsurface sediment, TPAH, TPCB, and Cu concentrations are higher than in surface sediment (this is true throughout the Study Area). Similar to surface sediment, subsurface sediment concentrations in CM 0 – 2 are generally the lowest near the mouth of the Study Area and increase upstream, with the highest subsurface sediment concentrations in the main stem being observed in CM 2+. Subsurface sediment concentrations generally increase with depth, reaching a peak several feet below the mudline or increasing until native material is reached. Elevated concentrations generally are not present in the native material.

The subsurface sediment appears relatively stable. This is supported by the following:

- Lower concentrations of COPCs in surface sediment, as compared to subsurface sediment, throughout the Study Area
- Low current velocities throughout the Study Area that result in minimal or no erosion of the sediment bed, except in localized areas owing to propeller wash disturbance
- Net depositional sediment bed throughout the Study Area (deposition rate varies by location), based on multiple lines of evidence (LOEs), including sediment radioisotope studies, bathymetric surveys, and historical dredging records
- Pre- and post-Hurricane Sandy bathymetric surveys, which indicate minimal erosion of the sediment bed during the anomalous current velocities generated by the storm surge

Surface Water

In general, surface water contaminant concentrations exhibited considerably less spatial gradients than surface sediment. This limited spatial pattern is primarily due to mixing and to the influence of the East River. In general, wet weather concentrations were greater than dry weather concentrations, indicating the importance of ongoing point sources and stormwater-related events occurring in the Study Area.

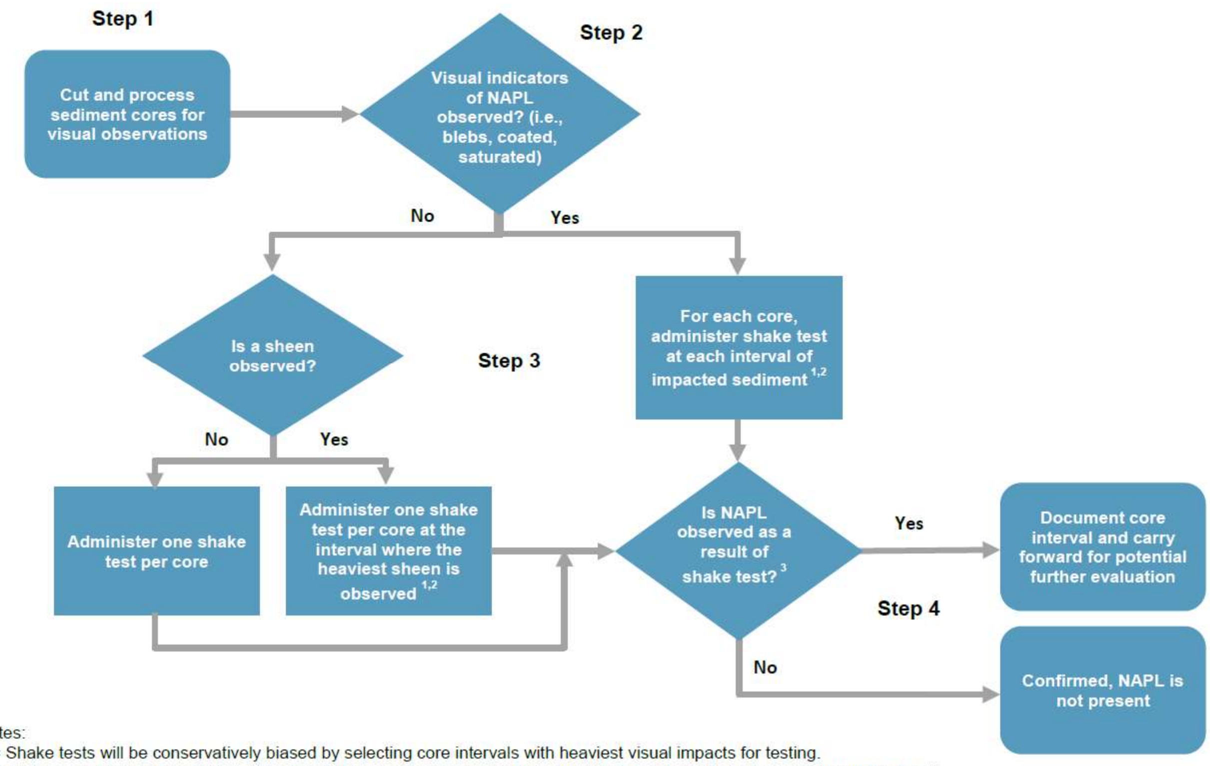
Notable patterns in the data are as follows:

- **Dry weather, CM 0 – 2 and CM 2+.** TPAH, TPCB, and Cu concentrations show little overall gradient in the main stem. Concentrations throughout the main stem are generally within the range of the East River, with increases moving upstream in some cases (e.g., TPCB).
- **Dry weather, tributaries.** The highest dry weather TPAH and TPCB concentrations are observed in English Kills and in East Branch (to a lesser extent). Concentrations in the other tributaries are generally similar to one another and are consistent with those observed in the main stem and in the East River. Dry weather Cu concentrations are similar across all the tributaries and are generally consistent with those observed in the main stem and in the East River.
- **Wet weather.** Wet weather TPAH, TPCB, and Cu concentrations are higher than the corresponding dry weather concentrations in all reaches of the Study Area. In the main stem, wet and dry weather concentrations increase somewhat with distance upstream. These patterns suggest influence from CSOs, other point sources, and overland flow.

NAPL

The presence and extent of NAPL were extensively investigated during the RI and FS Part 1 field programs, which included multiple field investigations and the collection of hundreds of surface sediment grabs and cores used to evaluate NAPL presence and extent in Study Area sediment and native material. As shown in Graphic ES-5, NAPL presence or absence was identified using a two-part process combining direct visual observation of sediment and native material, along with the performance of shake tests and visually observing if NAPL separated from the sediment or native material.[8] The presence of NAPL blebs or a NAPL layer in a shake test indicates that NAPL is present. The lack of NAPL blebs or a NAPL layer (i.e., no observation, or sheen only) confirms that NAPL is not present, as indicated in Note 3 of Graphic ES-5. In sediment and native material samples where shake tests were not performed (e.g., National Grid cores), direct visual observation of blebs, coated, or saturated NAPL, indicates that NAPL is potentially present.

[8] A shake test consists of placing sediment and distilled water into a clean laboratory jar, which is shaken and allowed to equilibrate, to observe whether a separate phase liquid is generated.



Notes:
1 = Shake tests will be conservatively biased by selecting core intervals with heaviest visual impacts for testing.
2 = The core will be split vertically. One side will be used in the shake test, and when available, the corresponding interval of the other undisturbed portion will be retained and archived for potential further evaluation.
3 = Observation of sheen only is not considered nonaqueous phase liquid (NAPL; NYSDEC, date unknown).

Graphic ES-5. Flow Diagram for Field Identification of NAPL

For much of the Study Area, where NAPL was observed, NAPL observations in sediment were intermittent and residual (i.e., shake test blebs, bleb visual observations).[9] A relatively greater magnitude of NAPL (i.e., shake test layer results, coated and saturated visual observations) was observed in three limited areas of the Study Area, referred to as Category 2/3 Areas. Notable patterns in the data are as follows:

- **CM 0 – 2.** NAPL was not observed in surface sediment; however, sheen in surface sediment samples was observed intermittently at a limited number of locations. In subsurface sediment, sheen and NAPL were observed more frequently at various

[9] Residual NAPL is the condition where NAPL saturation is sufficiently low that the NAPL consists of discontinuous blebs trapped by capillary forces, so it is immobile. This classification is specific to the ability of the NAPL to advect (i.e., flow) as a nonaqueous fluid phase. The interpretation that blebs represent residual, immobile NAPL is based on the observation that in core samples, the blebs are present as small, discontinuous droplets; this matches the description of residual NAPL as documented in the literature (Schwille 1988; Cohen and Mercer 1993; Pankow and Cherry 1996; API 2003; ITRC 2004; Sale et al. 2008; ITRC 2009; Kueper and Davies 2009).

locations and depths. Where observed, NAPL was primarily in a residual state. From CM 1.6 to 1.7, a limited number of cores produced shake test layer results, indicating the presence of Category 2/3 NAPL. This area is referred to as the CM 1.7 Category 2/3 Area. With the exception of a few samples, NAPL in CM 1.7 is not present in measurably greater amounts than the surrounding areas in the CM 0 – 2 reach. NAPL mobility testing of CM 0 – 2 subsurface sediment samples demonstrated that, where present, NAPL was immobile, so that NAPL will not migrate to surface sediments or underlying subsurface sediments and native material.

- **CM 2+.** NAPL was observed in surface sediment at a limited number of locations—primarily in a residual state upstream of CM 2.4, within the Turning Basin Category 2/3 Area. Sheen was observed in surface sediment samples at a number of surface sediment locations in this reach. NAPL was also observed in subsurface sediment in this area. Quantitative NAPL mobility testing for CM 2+, including the Turning Basin Category 2/3 Area, is being performed as one component of the FS Part 2 field program.
- **Tributaries.** NAPL was observed in surface sediment in only one location in lower English Kills. Sheen was observed in approximately half of the surface sediment samples scattered throughout the tributaries. NAPL was observed in subsurface sediments in a limited number of locations scattered in Maspeth Creek, East Branch, and the upper reach of English Kills, and more widely in the lower reach of English Kills. Category 2/3 NAPL was observed in a limited number of cores, all located in the lower portion of English Kills, between CM 2.95 and 3.2. This area is referred to as the Lower English Kills Category 2/3 Area. Quantitative NAPL mobility testing for the tributaries, including the Lower English Kills Category 2/3 Area, is being performed as part of the FS Part 2 field program.

NAPL observations in the native material were primarily limited to the areas of the Turning Basin and English Kills with footprints overlapping where NAPL was also observed in subsurface sediment. Isolated sheens in native material samples were infrequently observed in native material in the main stem, primarily between CM 1.3 and 2.7, in lower English Kills, and at one location in Maspeth Creek.

To understand whether gas ebullition can facilitate NAPL transport from the sediment bed to surface water, qualitative studies of gas ebullition were conducted as part of the Phase 2 investigations during times of the year when gas ebullition is expected to be most active (i.e., during low tides or warmer temperatures). Observations of the location, frequency, and magnitude of bubble generation and sheen blossoms[10] at the water surface were recorded to develop an understanding of conditions where gas ebullition-facilitated NAPL transport would most likely be expected to occur. A quantitative gas ebullition pilot study was conducted in September 2017 to develop and test methodologies for the 2018 to 2019 gas ebullition field program that was conducted under Part 2 of the FS field program (data for the 2018 to 2019 field program are not included in the RI Report and will be presented in a future FS-related report).

Sources

The current distribution of contaminants in the sediment column of the Study Area is due to historical and ongoing sources, historical dynamic fate and transport processes, and changes in contaminant loads over time. As such, the locations of impacts observed today cannot necessarily be directly linked to proximate upland sites. Historically, contaminant loads to surface sediment were much greater, as evidenced by the higher contaminant concentrations in subsurface sediment. Surface sediment concentrations have been declining over time, as a result of the deposition and mixing of these recently deposited cleaner solids with previously deposited solids. Because the constituents that describe the nature and extent of contamination are also commonly present in the urban environment of the Study Area, these contaminants can enter the system from multiple potential sources, described in the following list and whose current loads to the Study Area (by reach) are summarized in Table ES-1:

- **Point sources and overland flow.** The majority of the point source TPAH load (69%) enters the Study Area in CM 0 – 1 from the Con Edison – 11th Street Conduit (*Data*

[10] Not all sheens on the water surface originate from ebullition. Sheen blossoms are sheens that appear with a breaking gas bubble (i.e., ebullition). There can be distinct static sheens, which float on the water surface into the observation area. Potential static sheen sources might be caused by seepage from bulkheads, floatables, outfall discharge, surface scum, vessel movements, or discharges from engine/bilge/deck runoff, as well as unknown sources.

Applicability Report [DAR] No. 110) dewatering system. The majority of the point source TPCB (67%) and Cu (75%) loads enter the Study Area in the tributaries—primarily Maspeth Creek, East Branch, and English Kills—predominantly from CSOs and stormwater.

- **East River.** The East River transports solids that contain contaminant concentrations consistent with the regional background as a load to the Study Area, due to the semidiurnal tides. The East River is the primary source of the solids that deposit on the sediment bed in CM 0 – 2; these solids, along with upstream point sources, contribute to the solids that deposit in CM 2+. Concentrations of TPAH, TPCB, and Cu measured in East River surface water samples collected near the mouth of Newtown Creek are generally similar to those measured in CM 0 – 2 during dry weather, reflecting the strong influence of the river on this reach of the Study Area. Estimating the contaminant loads from the East River to the Study Area requires the use of linked hydrodynamic, sediment transport, and chemical fate and transport models. This work is underway and will be included in FS-related reports.
- **Groundwater.** Groundwater discharge to the Study Area occurs at the base of the Study Area and through vertical permeable shorelines to the surface water (i.e., lateral discharge). The base of the Study Area is defined as the interface between sediment and native material, as well as between sediment and fill. Groundwater discharge to the base of the Study Area may provide chemical loads to subsurface sediment and surface sediment, eventually discharging to surface water. This load is a small fraction of the contaminant mass present in the subsurface sediment, meaning that the subsurface sediment chemical concentrations are from other historical legacy sources. In addition, groundwater contamination, where present, is substantially attenuated in the subsurface sediment before it reaches surface sediment. For example, the total groundwater TPAH load from the base of the Study Area to subsurface sediment in CM 2+ is estimated at 740 kilograms per year (kg/year), but the load of TPAH from subsurface to surface sediment in this reach is approximately 100 times less (7.3 kg/year). In total, groundwater contaminant loads to the surface sediments in the Study Area are minor relative to contaminant loads from point sources.
- **Lateral groundwater discharge.** Lateral groundwater discharge through vertical permeable shorelines also may transport contaminants to the water column.

However, dry weather surface water data adjacent to the five areas with the highest estimated lateral groundwater discharge rates per linear foot of shoreline indicate no observable influence from lateral groundwater discharge on surface water chemical concentrations. Loads from lateral groundwater discharge will be further evaluated with the chemical fate and transport model during the FS through sensitivity analysis.

- **Other sources.** Analyses of data from historical studies, and data collected during FS Part 1 field activities to evaluate shoreline erosion, atmospheric deposition, overwater activities, and contaminant seeps, demonstrate that these inputs represent minor sources of contaminants to surface water and surface sediment in the Study Area.

Table ES-1
Summary of Current Contaminant Loadings to Study Area

	TPAH			TPCB			Cu		
	CM 0 – 2	CM 2+	Tributaries	CM 0 – 2	CM 2+	Tributaries	CM 0 – 2	CM 2+	Tributaries
Point Sources									
CSO	0.6	0.3	20	0.01	<0.01	0.3	6.7	3.4	220
Stormwater	5.9	3.2	8.0	0.2	0.1	0.2	69	37	94
Treated Groundwater	83	NA	NA	<0.01	NA	NA	2.5	NA	NA
WWTP Treated Effluent Overflow	NA	NA	0.9	NA	NA	0.05	NA	NA	33
Groundwater									
Base of Study Area	80	740	7.5	<0.01	<0.01	0.04	3.3	3.5	3.3
Lateral Discharge	--	--	--	--	--	--	--	--	--
Other Sources	--	--	--	--	--	--	--	--	--
East River	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Notes:
Units are kilograms per year.
-- = Analysis to date indicates negligible contribution to Study Area.
NA = not available – Discharge type does not occur in this reach.
TBD = to be determined – Load will be calculated based on ongoing modeling analyses.

Risk and Exposure Pathways

The results of the comprehensive site-specific BHHRA and BERA provide one set of criteria to be used during selection of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedy in the FS. Human health risks were evaluated for 12 exposure scenarios. Potential risks to human health in excess of USEPA's acceptable cancer risk range and/or non-cancer hazard threshold were identified for the following exposure scenarios:

- Study Area
  - Cancer risks and non-cancer hazards associated with consumption by recreational anglers/crabbers of fish and crab tissue obtained from the Study Area, primarily due to tissue concentrations of polychlorinated biphenyls (PCBs) in fish, and PCBs and dioxins/furans in crab
  - Non-cancer hazard for general construction worker exposure to surface sediment along the shoreline in limited areas within the Study Area, primarily due to PCBs in surface sediments in these localized areas
- Reference areas
  - Cancer risks and non-cancer hazards associated with consumption by recreational anglers/crabbers of fish and crab tissue obtained from reference areas, primarily due to PCBs in fish and crabs, with some contribution from dioxins/furans to non-cancer hazards in crab. The presence of human health risks in the reference areas suggests that regional background exposure for migratory fish and crab species needs to be considered when evaluating risk management options for Newtown Creek.

The BERA (see Appendix I) evaluated multiple LOEs in a quantitative and qualitative weight-of-evidence approach and identified potential risks to ecological receptors as follows:

- Study Area
  - Surface sediment toxicity to benthic organisms in CM 2+ and the tributaries is greater than toxicity in sediment in the four Phase 2 reference areas. Toxicity at these locations may be associated with polycyclic aromatic hydrocarbons (PAHs, in particular, alkylated PAHs) in porewater, with some contribution from

porewater metals (Cu, lead, and zinc). However, toxicity test results at a subset of sample locations cannot be explained solely by either PAHs or certain metals in porewater. At these locations, toxicity test results appear to be confounded by other stressors, consistent with urban environments with large CSO and stormwater discharges.

- Hazard quotient (HQ) values greater than a threshold of 1 were exceeded in CM 2+ and the tributaries for benthic fish, due to PAHs, Cu, lead, zinc, and TPCB congeners in porewater.
- HQ values greater than 1 were calculated for various avian species, primarily due to dietary exposure to TPCB in CM 2+ and the tributaries.
- HQs ranging from less than 1 to greater than 1 were calculated for bivalves, polychaetes (*Nereis virens*), blue crab (*Callinectes sapidus*), striped bass (*Morone saxatilis*), and mummichog (*Fundulus heteroclitus*), primarily due to exposure to TPCB, with some limited contribution from dioxins/furans and Cu.

- **Reference areas**
  - For the Phase 2 reference areas, potential risks were identified for blue crab, striped bass, and mummichog, primarily due to exposure to TPCB, with some limited contribution from dioxins/furans. The presence of ecological risks in the reference areas suggests that regional background exposure for migratory fish and crab species, as well as more site-specific urban background conditions for more resident species, need to be considered when evaluating risk management options for Newtown Creek.

It is important to note that migratory species such as striped bass, blue crab, and Atlantic menhaden (*Brevoortia tyrannus*) are exposed to contaminants both within and outside the Study Area, including exposure within and beyond the New York Harbor region. Striped bass and blue crab are the primary species consumed by recreational anglers and crabbers, whereas Atlantic menhaden, mummichog, and benthic invertebrates represent components of their food web. TPCB in striped bass and TPCB and dioxins/furans in blue crab are the primary CERCLA hazardous substances driving potential human health risk. Moreover, both chemicals are bioaccumulative. Because TPCB is the primary risk driver in both species, TPCB is the primary focus of the evaluation of bioaccumulation and biomagnification throughout the Study Area food web. The relative contributions of Study Area and regional sources to TPCB in fish and crabs collected in Newtown Creek will be evaluated further as part of the development of the bioaccumulation model.

Key Findings and Conclusions

A key finding of this RI is that the reaches of the Study Area (CM 0 – 2, CM 2+, and each tributary) differ materially in physical characteristics, contaminant distributions, sources of solids and contaminants, relative contributions of historical versus ongoing sources, fate and transport processes, and risk. Those differences will play an important role in identifying, developing, and assessing remedial alternatives in the FS.

The nature and extent of contamination within the Study Area is affected by influences including historical and ongoing discharge, transport, and deposition of contaminants and solids from point sources; surface water and solids exchange with the East River (due to the tides); mixing (due to biological activity within the surface sediment [i.e., bioturbation]); episodic storm events that primarily affect the tributaries near the large outfalls; and marine vessel traffic, which also acts as a sediment mixing process. These influences contribute to the following notable observations of the nature and extent, sources, and fate and transport of contaminants in the Study Area:

- **CM 0 – 2**
  - Concentrations of TPAH, TPCB, and Cu in surface sediment in CM 0 – 2 are generally the lowest in the Study Area and are consistent with (or approaching) regional background, as defined based on regional reference area data. Surface sediments are stable due to low current velocities. Concentrations tend to increase with depth in the subsurface sediment and are low in underlying native materials. Deposition of solids in this reach is primarily from East River tidal exchange. These solids mix with the existing shallow surface sediments that have been influenced by historical and ongoing sources typically found in urban, industrialized waterbodies. NAPL was only observed in subsurface sediments and has been demonstrated to be immobile. Minimal gas ebullition and sheen blossom formation have been observed in CM 0 – 2 during field surveys. Toxicity to benthic macroinvertebrates and risks to other ecological receptors such as fish and

crab in CM 0 – 2 are similar to those in the four Phase 2 reference areas. Surface water concentrations overlap with East River concentrations.

- **CM 2+**
  - Concentrations of TPAH, TPCB, and Cu in surface sediment are higher than in CM 0 – 2 and are above regional background concentrations. Concentrations tend to increase with depth in subsurface sediment and are generally lower in the native material. Solids deposited from CSOs and MS4s, stormwater inputs and runoff, and to some extent from East River tidal exchange, become mixed within the surface sediment layer via biological and physical processes, resulting in a blend of previously deposited and currently depositing contaminants in the surface sediment. NAPL was observed in several portions of the Turning Basin in subsurface sediment and native material, and less frequently in surface sediment. Areas of gas ebullition and sheen blossom formation were observed in the Turning Basin along the Brooklyn and Queens shoreline at water depths less than 6 meters. Toxicity to benthic macroinvertebrates and risks to other ecological receptors, such as fish and crab, are greater than in the Phase 2 reference areas. Toxicity to benthic macroinvertebrates at some locations cannot be attributed solely to porewater concentrations of PAHs, PCBs, and metals, but may be influenced by other contaminants common to urban, industrialized waterbodies influenced by large CSO and MS4 discharges.
- **Tributaries**
  - Major CSOs present at the heads of English Kills, East Branch, Maspeth Creek, and Dutch Kills are the primary source of solids to the tributaries. Large MS4 outfalls are also located in the tributaries. Surface sediment exhibits very high total organic carbon (TOC) levels, primarily due to discharges of solids from CSO and MS4 point sources. Concentrations of TPAH, TPCB, and Cu in surface sediment are generally higher than in CM 0 – 2 and are above regional background concentrations. Concentrations tend to increase with depth in subsurface sediment, but are lower in the native material. In Maspeth Creek, East Branch, and upper English Kills, NAPL was only observed in a few cores as residual NAPL. In a localized area within lower English Kills, NAPL was observed in coarse-grained beds in subsurface sediment and native material. Areas of gas

ebullition and sheen blossom formation were observed in each of the tributaries. More widespread gas bubbles were observed in the tributaries, where the TOC is higher and water depths are generally shallower than the deeper water in the main stem. Toxicity to benthic macroinvertebrates and risks to other ecological receptors such as fish and crab are greater than in the Phase 2 reference areas. Toxicity to benthic macroinvertebrates in close proximity to significant CSO and MS4 discharges in English Kills, East Branch, Maspeth Creek, and Dutch Kills cannot be attributed solely to porewater concentrations of PAHs, PCBs, and metals, but may be influenced by other contaminants common to urban, industrialized waterbodies influenced by large CSO and MS4 discharges.

In summary, surface sediment contamination drives the ecological and human health risks within the Study Area. Due to the continuous deposition of sediments in the Study Area that are representative of inputs from sources consistent with an urban industrialized environment, background levels of CERCLA hazardous substances and other contaminants will reaccumulate in surface sediments, even after remedial action is undertaken. While the CERCLA process needs to consider the protection of human health and the environment, appropriate background levels must be established and factored into remedial decision-making where risk-based levels are not achievable due to the influence of site-specific background conditions. There are characteristics associated with Newtown Creek, such as the physical structure, surrounding land uses, and hydrodynamic and sediment transport dynamics that are important to recognize when establishing a site-specific background condition.

Specifically, site-specific background conditions in Newtown Creek will continue to reflect contributions from ongoing urban sources to the Study Area that include, but are not limited to, tidal flows from the East River, point source discharges, and overland stormwater flow. Developing an understanding of site-specific urban background conditions in Newtown Creek requires a comparison to conditions in waterbodies that are similar to Newtown Creek, but that are not influenced by the site-specific releases of hazardous substances and other contaminants that are the focus of the RI/FS process being conducted in the Study Area. Understanding these regional background conditions is necessary to understanding the practical limits in the Study Area on the potentially feasible future reductions of contaminant concentrations in surface sediment, surface water, and tissue, as well as the ecological and human health risks in the Study Area that result from exposure to these background concentrations. Regional background conditions have been well characterized in this RI Report and provide a robust basis for determining appropriate background levels of contaminants that must be considered during remedial decision-making.

The East River and various point sources, such as CSO and stormwater outfalls, will continue to contribute a significant background load of constituents (e.g., TPAH, TPCB, and Cu) that are common in the urban environment surrounding the Study Area, in both particulate and dissolved forms. In comparison, groundwater and other non-point sources such as seeps and eroding shorelines currently are minor contributors of these constituents. In addition, some upland properties may potentially contribute these constituents to the Study Area. The FS will need to evaluate the potential for the ongoing contribution of TPAH, TPCB, Cu, and other constituents as part of the remedy evaluation process, consistent with USEPA's first listed risk management principle, which states that significant direct and indirect ongoing sources should be identified and controlled if they have the potential to cause significant recontamination at sediment sites (Horinko 2002). As noted by USEPA guidance, "Identifying and controlling contaminant sources typically is critical to the effectiveness of any Superfund sediment cleanup" (USEPA 2005a). Influences from the East River, CSO and MS4 discharges, other point sources, and overland stormwater flows will continue over the long term into the creek. Accordingly, remedial alternatives evaluated in the FS need to assess these ongoing contributions, and any potential controls, in the context of the timing of the remedy and its long-term effectiveness.

The RI Report represents a comprehensive study that complies with the AOC entered into with USEPA for this site. The voluminous dataset supports multiple LOEs to characterize the nature and extent of contamination in the Study Area. This work also establishes a solid foundation to evaluate a combination of sustainable remedial approaches to utilize in different portions of the creek to achieve practicable risk reduction and ensure long-term success. The FS for Newtown Creek will utilize the information generated in the RI to evaluate cost-effective and sustainable remedies for Newtown Creek.