Department of Environmental Conservation

Division of Environmental Remediation

Record of Decision

Brookfield Avenue Landfill Site

Operable Unit No. 2

New York City, Richmond County,New York

Site Number 243006

March 2007

New York State Department of Environmental Conservation
ELIOT SPITZER, *Governor*

DECLARATION STATEMENT - RECORD OF DECISION

Brookfield Avenue Landfill Inactive Hazardous Waste Disposal Site
Operable Unit No. 2
New York City, Richmond County, New York
Site No. 243006

Statement of Purpose and Basis

The Record of Decision (ROD) presents the selected remedy for: Operable Unit #2 the Brookfield Avenue Landfill Site, a Class 2 inactive hazardous waste disposal site. The selected remedial program was chosen in accordance with the New York State Environmental Conservation Law and is not inconsistent with the National Oil and Hazardous Substances Pollution Contingency Plan of March 8, 1990 (40CFR300), as amended.

This decision is based on the Administrative Record of the New York State Department of Environmental Conservation (the Department) for: Operable Unit 2 of the Brookfield Avenue Landfill Site inactive hazardous waste disposal site, and the public's input to the Proposed Remedial Action Plan (PRAP) presented by the Department. A listing of the documents included as a part of the Administrative Record is included in Appendix B of the ROD.

Assessment of the Site
Actual or threatened release of hazardous waste constituents from the Brookfield Avenue Landfill Site will be addressed by implementing the OU-1 Remedy identified in this ROD. The capping of the landfill and other engineering controls at the site will significantly reduce the threat to public health and the environment.

Description of Selected Remedy
Based on the results of the Remedial Investigation and Feasibility Study (RI/FS) for the Brookfield Avenue Landfill Site and the criteria identified for evaluation of alternatives, the Department has selected the following remedy for OU-2: Alternative #2, Institutional Controls and Monitoring, in combination with the OU-1 selected alternative as the remedy for this site. This remedy includes:

> institutional controls consisting of an environmental easement for portions of OU-2 that are listed on the New York State Registry of Inactive Hazardous Waste Disposal Sites. Under the remedy required for OU-1, institutional controls will be applied to the entire listed site including portions of OU-2. These controls will include: prohibition from use of groundwater for potable purposes; prohibition from vegetable gardening; performance of site inspections and filing of a periodic certification that the remedy remains in place and continues to perform as designed; and management of residual contamination under a Site Management Plan. The property owner will provide a periodic certification of

institutional and engineering controls, prepared and submitted by a professional engineer or such other expert acceptable to the Department, until the Department notifies the property owner in writing that this certification is no longer needed. This submittal will: (a) contain certification that the institutional controls and engineering controls put in place are still in place and are either unchanged from the previous certification or are compliant with Department-approved modifications; (b) allow the Department access to the site; and (c) state that nothing has occurred that will impair the ability of the control to protect public health or the environment, or constitute a violation or failure to comply with the site management plan unless otherwise approved by the Department.; and

- monitoring the chemical characteristics of surface waters and sediment to augment monitoring conducted as part of the OU-1 Site Management Plan. This will include monitoring the chemical characteristics of surface waters and sediment in the 5th year, 10th year and 20th years after the OU-1 remedy is complete (this would augment monitoring conducted as part of the OU-1 post-closure monitoring program).

In addition, following public comment on the PRAP and FS, the New York City Department of Environmental Protection (NYCDEP) has agreed to install a visual demarcation fence (a wooden post and rail fence is envisioned) between OU-1 and OU-2 and install signage along the demarcation line that provide notification of the current fish consumption advisory that has been placed by the NYSDOH for waters in New York Harbor. While these controls are not a mandated component of this ROD, they have been agreed to by the NYCDEP in order to address community concerns and interests.

The OU-1 remedy includes a Title 6, Official Compilation of Codes, Rules and Regulations of the state of New York Part 360 landfill cap to prevent water infiltration into the landfill and generation of leachate; a subsurface, low permeability barrier wall around the entire landfill to a depth ranging from 25 to 40 feet to halt lateral migration of leachate already generated; a series of leachate collection pipes and wells inside the barrier wall (between the landfill and Richmond Creek) to collect leachate already generated and to create an inward hydraulic head to minimize potential leakage of leachate through the barrier wall; and a system for leachate treatment. Treatment will include both pretreatment onsite and final treatment offsite to ensure that future loading of contaminants into Richmond Creek does not occur; a landfill gas collection and flaring system; and wetlands enhancements.

New York State Department of Health Acceptance

The New York State Department of Health (NYSDOH) concurs that the remedy selected for this site is protective of human health.

Declaration

The selected remedy is protective of human health and the environment, complies with State and Federal requirements that are legally applicable or relevant and appropriate to the remedial action to the extent practicable, and is cost effective. This remedy utilizes permanent solutions and alternative treatment or resource recovery technologies, to the maximum extent practicable, and satisfies the preference for remedies that reduce toxicity, mobility, or volume as a principal element.

MAR 3 0 2007

Date

Dale A. Desnoyers, Director
Division of Environmental Remediation

TABLE OF CONTENTS

SECTION **PAGE**

1: SUMMARY OF THE RECORD OF DECISION 1

2: SITE LOCATION AND DESCRIPTION 2

3: SITE HISTORY 3
- 3.1: Operational/Disposal History 3
- 3.2: Remedial History 7

4: ENFORCEMENT STATUS 8

5: SITE CONTAMINATION 8
- 5.1: Summary of the Remedial Investigation 8
- 5.2: Interim Remedial Measures 13
- 5.3: Summary of Human Exposure Pathways: 13
- 5.4:Summary of Environmental Assessment 14

6: SUMMARY OF THE REMEDIATION GOALS 15

7: SUMMARY OF THE EVALUATION OF ALTERNATIVES 15
- 7.1: Description of Remedial Alternatives 15
- 7.2 Evaluation of Remedial Alternatives 18

8: SUMMARY OF THE SELECTED REMEDY 20

9: HIGHLIGHTS OF COMMUNITY PARTICIPATION.....21

Tables	-	Table 1:	Remedial Alternative Costs.....
Figures	-	Figure 1:	Site Location Map . . . . .
	-	Figure 2:	Historic Topographic .....
		Figure 3:	Site Plan.....
		Figure 4:	OU2 SW, Sediment and Biota sampling locations.....
		Figure 5:	SCG Exceedances in Surface Water.....
		Figure 6:	SCG Exceedances in SW at Biota sampling locations.....
		Figure 7:	SCG Exceedances in Creek Sediment 0-6 inches.....
		Figure 8:	SCG Exceedances in Creek Sediment 6-12 inches.....
		Figure 9:	SCG Exceedances in Creek Sediment 24-30 inches.....
		Figure 10:	SCG Exceedances in Creek Sediment 72-78 inches.....
		Figure 11:	SCG Exceedances in Creek Sediment at Biota Loc.0-6.....
		Figure 12:	SCG Exceedances in Marsh Sediment 0-6 inches
		Figure 13:	SCG Exceedances in Marsh Sediment 6-12 inches

Figure 14: SCG Exceedances in Marsh Sediment 24-75 inches
Figure 15: Closure Plan for BALF OU-1.....
Figure 16: End Use Plan BALF.....

Appendices
- Appendix A: Responsiveness Summary .....
- Appendix B: Administrative Record .....

RECORD OF DECISION

Brookfield Avenue Landfill Site
Operable Unit No. 2
New York City, Richmond **County, New York**
Site No. 243006
March 2007

SECTION 1: SUMMARY OF THE RECORD OF DECISION

The New York State Department of Environmental Conservation (the Department), in consultation with the New York State Department of Health (NYSDOH), has selected this remedy for the Brookfield Avenue Landfill Operable Unit 2. Alternative #2, Institutional Controls and Monitoring, in combination with the OU-1 selected alternative as the remedy for this site. This remedy includes:

- institutional controls consisting of an environmental easement for portions of OU-2 that are listed on the New York State Registry of Inactive Hazardous Waste Disposal Sites; and

  monitoring the chemical characteristics of surface waters and sediment in the 5th year, 10th year and 20th years after the OU-1 remedy is complete (this would augment monitoring conducted as part of the OU-1 post-closure monitoring program).

In addition, following public comment on the PRAP and FS, the New York City Department of Environmental Protection (NYCDEP) has agreed to install a visual demarcation fence (a wooden post and rail fence is envisioned) between OU-1 and OU-2 and install signage along the demarcation line that provide notification of the current fish consumption advisory that has been placed by the NYSDOH for waters in New York Harbor. While these controls are not a mandated component of this ROD, they have been agreed to by the NYCDEP in order to address community concerns and interests.

Operable Unit 2 (OU-2) is located in a portion of Richmond Creek north of the Brookfield Avenue Landfill in Richmond County, New York (see Figures 1-4 for site location and OU-2 boundaries). The designation of OU-2 (the site) is associated solely with contamination that was disposed at, and discharged from, the Brookfield Avenue Landfill (OU-1) in the 1970s. At the close of the Remedial Investigation (RI) for OU-1, it was decided that a RI should be conducted in order to more fully investigate the impact of the landfill on the adjacent Richmond Creek. This investigation was conducted as a separate operable unit. An operable unit represents a portion of the site remedy that for technical or administrative reasons can be addressed separately to eliminate or mitigate a release, threat of release or exposure pathway resulting from the site contamination. Both the RI report and the Feasibility Study (FS) report for OU-2 are now complete. This Record of Decision is based on the information received by the Department from these reports. As more fully described in Sections 3 and 5 of this document, it is alleged that

liquid industrial and hazardous waste material was illegally dumped at several New York City Landfills, including the Brookfield Avenue Landfill. The materials reportedly consisted of waste oil, sludges, metal plating wastes, lacquers and solvents. It was determined that leachate from the landfill has discharged into the surface water and sediment in Richmond Creek and nearby marsh areas. Extensive remedial activities have already been proposed at the Brookfield Avenue Landfill under a Record of Decision for OU-1 to halt the discharge of contamination from the landfill into OU-2. This OU-1 remedy includes a Title 6, Official Compilation of Codes, Rules and Regulations of the state of New York Part 360 landfill cap to prevent water infiltration into the landfill and generation of leachate; a subsurface, low permeability barrier wall around the entire landfill to a depth ranging from 25 to 40 feet to halt lateral migration of leachate already generated; a series of leachate collection pipes and wells inside the barrier wall and between the landfill and Richmond Creek to collect leachate already generated and to create an inward hydraulic head to minimize potential leakage of leachate through the barrier wall; and a system for leachate treatment. Treatment will include both pretreatment onsite and final treatment offsite to ensure that future loading of contaminants into Richmond Creek does not occur; a landfill gas collection and flaring system; and wetlands enhancements.

The selected remedy, discussed in detail in Section 8, is intended to attain the remediation goals identified for this site in Section 6. The remedy must conform with officially promulgated standards and criteria that are directly applicable, or that are relevant and appropriate. The selection of a remedy must also take into consideration guidance, as appropriate. Standards, Criteria and Guidance are hereafter called SCGs.

SECTION 2: SITE LOCATION AND DESCRIPTION

The Brookfield Avenue Landfill is located at 40°33'44" latitude and 74°09'38" longitude in Richmond County, Borough of Staten Island, City of New York, in the State of New York. The site is approximately 272 acres in size and is bounded on the north by Richmond Creek, on the east by the Colonial Square Condominium properties, on the south by Arthur Kill Road, and on the west by Richmond Avenue (see Figures 1, 2, and 3).

Operable Unit (OU) No. 2, which is the subject of this document, consists of a portion of Richmond Creek and associated tributaries and wetlands located north of the Landfill. OU-2 includes Richmond Creek, from the Richmond Avenue overpass to the eastern limit of the landfill; several small tributaries that empty into the creek from the south; and tidal wetlands between the creek and the landfill (Figures 1, 2, 3 and 4). Tidal and freshwater wetland areas located at the southern end of the site, between the landfill and Arthur Kill Road, are addressed as part of OU-1 remedial activities and were not the focus of work performed under OU-2. However, biota samples were collected from both the eastern and western drainage channels between the landfill and Arthur Kill Road at the direction of the Department during the RI for OU-2. An operable unit represents a portion of the site remedy that for technical or administrative reasons can be addressed separately to eliminate or mitigate a release, threat of release or exposure pathway resulting from the site contamination. The remaining operable unit for this site is OU-1: The landfill portion of the Site (OU-1) encompasses approximately 132 acres and is divided into two cells, the eastern and western cells, which represent former solid waste disposal areas. The site is currently inactive with a well-established vegetative cover. A

paved road bisects the west cell and lies above the 48-inch diameter wastewater interceptor that leads to the Eltingville Pump Station. This wastewater pump station is onsite and lies between the east and west landfill mounds. A three-barrel, 16-foot by 6.5-foot storm sewer originates at Arthur Kill Road and Abingdon Avenue and traverses underground between the east and west cells with a terminus into Richmond Creek (Fig. 3).

The landfill is enclosed by fencing with the exception of the boundary along Richmond Creek, which is unfenced. The site is guarded full time by a security guard stationed in a trailer near the front entrance to the landfill on Arthur Kill Road. For public safety purposes, signs have been placed on the perimeter fence identifying the area as an inactive hazardous waste site. A portion of the east cell of the landfill (approximately 38 acres) was covered with a clay cap in 1983. Localized erosion of the cap is now evident. Along the southern perimeter of the landfill, a 525-foot-long passive methane collection trench was installed to halt the migration of methane gas toward the residences south of the landfill. The RI/FS for OU-1 was completed in 1998 and the OU-1 ROD is dated March 2002. The design report for the remedy for OU-1 was approved by the Department on May 29, 2006. Remedial construction on OU-1 is expected to start in 2007.

SECTION 3: SITE HISTORY

3.1: Operational/Disposal History

The New York City Department of Sanitation (NYCDOS) operated the Brookfield Avenue Landfill as a municipal solid waste disposal facility from 1966 to 1980. During the 15 years of operation approximately 132 acres of the site received refuse. The remaining 140 acres (272 acres total) served as a buffer zone around the landfill. The facility operated 24 hours per day, six days per week. Records indicate that approximately 1,000 tons per day of household refuse and construction debris was delivered to the landfill by the city sanitation department and private garbage trucks. The loaded trucks were weighed at on-site scales, and the weight and the type of material they were hauling were recorded. The waste was dumped in lifts up to 15 feet high and in cells approximately 150 feet wide. After each cell was completed, cover material was applied.

Access for public drop-off of refuse was provided on the seventh day of the week. Residents were required to sign in and unload refuse in an area specifically designated for public drop-off. Salvageable material suitable for recycling was removed by a private contractor. The salvage area was located on site in a separate fenced area so as not to interfere with daily operations.

Industrial/Hazardous Waste Dumping

It is alleged that liquid industrial and hazardous waste material was illegally dumped at several New York City landfills, including the Brookfield Avenue Landfill, between 1974 and 1980. The materials reportedly consisted of waste oil, sludges, metal plating wastes, lacquers and solvents. The exact quantities and disposal locations of the wastes are not known. It was reported that volumes disposed of ranged from 11,000 to 55,000 gallons per week in 1974. In 1978, volumes ranged up to 50,000 gallons per night, with the primary disposal point identified

as the Brookfield Avenue Landfill. It was also reported that contaminants such as cyanide, dichlorobenzene, dioctylphthalate, naphthalene, ethyl benzene, toluene, xylene, and alkyl phenol were potentially disposed of at the Site.

City Sewer System Construction
In January 1982, excavation for the installation of 1,500 feet of sewer line (interceptor) through the west cell of the landfill took place.

Environmental Setting

Land Use and Site Topography

The Brookfield Avenue Landfill Site is vacant and undeveloped, except for the Eltingville Pump Station located in the central portion of the site, and the former office and maintenance building near the landfill's main entrance. Land uses surrounding the site include La Tourette Park and golf course to the northeast, residential areas to the east and south, a cemetery to the southeast, the Fresh Kills Landfill complex to the west and the closed Richmond Truck Landfill across Richmond Creek to the north. The Atlantic Ocean and Great Kills Harbor are located less than two miles south of the site.

Before 1960, prior to use as a landfill, the Brookfield Avenue Site was a coastal marshlands area with little topographic relief. Site topography was altered by landfilling, resulting in mounds with inner plateaus and outer slopes exceeding eight percent. The landfill ranges in height from 15 to 40 feet above surrounding grades. Areas of ponded water are located on both the east and west sides of the main landfill access road, and a tidally-influenced pond is located at the southeast corner of the landfill. The landfill site is located in a low-lying area adjacent to the shoreline of Richmond Creek. The topography within one mile south of the site rises from approximately mean sea level (msl) to about 80 feet above msl. Northeast of the site, across Richmond Creek, elevations rise to approximately 250 feet above msl within 1.5 miles.

Site Geology and Hydrogeology

The Brookfield Avenue Landfill is located in a low-lying coastal marsh area that drains to Richmond Creek. From Richmond Creek, surface water flows through the Fresh Kills waterway and into the Arthur Kill. Collectively, Richmond Creek, Main Creek and the Fresh Kills Creek are referred to as the Fresh Kills Estuary. All of these water bodies are tidal and have variable flow directions depending on the tidal stage. This causes intermixing of water throughout the Fresh Kills estuary and from the Arthur Kill.

Richmond Creek is the longest stream of Staten Island's surface drainage system, extending approximately 2.5 miles from the central part of the island to the Fresh Kill. Richmond Creek is tidal to the check dam at St. Andrew's Church and is fed by a Class B freshwater stream upstream of this point and by the Sweet Brook tributary from the south. Freshwater can extend downstream of the St. Andrew's Church check dam, depending on tidal conditions and recent extent of precipitation/stormwater runoff. During heavy precipitation events, Richmond Creek is dominated by freshwater inflow into the main trunk from overland flow and point sources, such

as stormwater culverts and outfalls. During periods of low precipitation, freshwater inflow is minimal and Richmond Creek is dominated by tidal action which moves saltwater from the Arthur Kill through Fresh Kills to Richmond Creek during high tide, and in the opposite direction during low tide.

Stormwater runoff naturally flows from the landfill to Richmond Creek through the marsh or through onsite drainage channels. Area-wide stormwater runoff is routed through a storm sewer that bisects the site and discharges to Richmond Creek. The Fresh Kill system is part of the NYCDEP Outer Harbor Combined Sewer Overflow study area and the New York Harbor National Estuary Program.

The Richmond Creek area has been classified by New York State as Class SC. As per 6 NYCRR Part 701.12, surface waters classified as SC are suitable for fish propagation and survival with best usage for fishing. SC classified waters should also be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes. They are not suitable for shellfishing for market purposes.
Freshwater and tidal wetlands were field delineated by a wetlands specialist in July 2001 as part of one of the OU-1 pre-design tasks.

Hydrogeology

The Site is underlain by approximately 150 feet of unconsolidated sediments which overlay bedrock. The uppermost unit consists of recent marsh deposits including silts, clays, and "meadow mat." This latter unit is as much as 10 to 15 feet thick within the study area. A series of glacial sediments, consisting of glacial till, and glacial outwash type sands lay directly below the marsh deposits in the wetlands, and are in direct contact with the fill material beneath the landfill. The glacial sediments comprise the Upper Glacial Aquifer, which ranges in approximate thickness from 60 to 70 feet within the study area.

The shallow sediments were further characterized during a geotechnical investigation conducted in the fall of 2002 as part of the remedial design for OU-1. The investigation confirmed the presence of fine-grained marsh deposits at the northern toe of the landfill. The fine-grained marsh deposits are thin to non-existent in the sandy zone. A lower aquifer, known as the Cretaceous aquifer, consists of marine sands, silts and clays, and is also present within the study area. Both of these aquifers contain a number of sub-aquifers. A continuous, leaky, confining unit made up of overlapping glacio-lacustrine clay, glacial till, and Cretaceous clay separate the Upper Glacial and Cretaceous aquifers.

Regional groundwater flow in the recent sediments and the Upper Glacial aquifer is to the north. Regional flow in the Cretaceous aquifer is to the south although locally under the landfill a northward flow component has been identified. Groundwater is present within a few feet of the ground surface throughout most of the landfill except under landfill plateaus. Mounding of the water table within the landfill reaches elevations as high as 12 feet above mean sea level resulting in a radial flow pattern within the landfill. Shallow groundwater discharges to the surface waters and wetlands to the north, east, and west of the landfill. On the south side of the landfill, the southward component of radial flow encounters northward regional groundwater

flow and is deflected toward surface waters to the east and west. While data suggests that leachate has impacted groundwater in localized areas just south of the site boundary, the regional northward flow limits the extent of this impact.

The OU-1 RI and previous studies have concluded that Richmond Creek and its associated wetland areas are the local discharge point for the Upper Glacial aquifer, and portions of the Cretaceous aquifer. To the north side of the Site, the Cretaceous leaks upward to the Upper Glacial aquifer and eventually into Richmond Creek. Over the rest of the site, the Upper Glacial aquifer leaks downward into the Cretaceous aquifer. This results in a very complex local flow pattern in the Cretaceous aquifer.

The Upper Glacial aquifer near Richmond Creek is moderately influenced by tidal fluctuations in the creek, however, the influences are not strong enough to reverse flow directions over any significant areas. Tidal influences in the Cretaceous aquifer are slight and hydraulically insignificant.

Habitat

OU-2 and adjoining areas of Richmond Creek constitute a complex and valuable habitat that has developed over several thousand years. Three classifications of tidal wetlands are present within OU-2 including high marsh, intertidal marsh, and littoral zone. The overall importance of tidal wetlands in New York State is emphasized in the tidal wetland regulations which state, "*Intertidal marsh and coastal fresh marsh tidal wetlands are the most biologically productive of all tidal wetlands areas. ...Because of these high values and their sensitive location at the land and water interface, intertidal and coastal fresh marshes must be the most stringently protected and preserved tidal wetlands zones. Even small portions of these zones are critically important resources. Consequently, only very limited types of land use and development are compatible with the values of these areas*" (6 NYCRR Part 661.2(d)).

The tidal wetlands present in OU-2 currently perform many beneficial functions, some of which are summarized below:

The tidal marshes of Richmond Creek are important to a broad assemblage of birds and other wildlife due mainly to the availability of cover for nesting and the abundance of prey.

The extensive network of tidal creeks and freshwater inflows provide potential spawning and nursery habitats for freshwater fishes and invertebrates.

Many of the juvenile fish and larval invertebrates that reside within tidal wetlands serve as a primary food source for local crustacean and bird populations.

- Wetlands, such as those within OU-2, are the primary source of much of the organic matter and nutrients forming the basis of the coastal and estuarine food web.

- Encompassing 73 acres, the tidal wetlands of OU-2 provide a significant amount of flood control and storage. During heavy rain events, storm flows from the freshwater portion of

Richmond Creek and Sweet Brook undergo attenuation as they reach the tidal wetlands within OU-2. Reduction of flow velocities by the wetland vegetation present in OU-2 also contributes to flood control.

Pollutants are removed in the natural wetlands of OU-2 via various physical, chemical, and/or biological processes. Some of the specific contaminant attenuation processes likely to be occurring in the wetlands of OU-2 include biodegradation, diffusion, dilution, adsorption, volatilization, chemical reaction or destruction, and burial by clean material. The net result of such processes is a reduction in the concentration of the contaminants within the sediment and surface water, and the overall water quality improvement in the estuary.

Elevated concentrations of various contaminants from multiple sources within the Fresh Kills estuary and the Arthur Kill were identified in earlier studies of the area of OU-2 performed in the mid-1990s. However, more recent studies conducted in 2003 have shown improvements in surface water and sediment quality in OU-2. Continued improvements are expected over time, particularly after all discharges of contaminants from OU-1 are terminated by pending remedial work under the approved ROD.

All remedies considered under this PRAP must consider the impacts to habitat value of OU-2 caused by remedial construction activities once the remedy is complete. Remedial actions that impair or destroy the wetlands (for instance, excavation or dredging) would cause irreparable environmental damage to complex habitats that must be weighed against any environmental benefits that result from the remedy. Wetland restoration has been used to attempt to reconstruct vital habitats in areas where they have been destroyed. While this may be considered as a means to mediate the impacts caused by a destructive excavation or dredge remedy, the current state of the science of habitat restoration suggests that replacing the functions and values of a natural wetland system are difficult, if not impossible, to achieve through a habitat restoration construction project. Further, there are many other sources of pollution in the Arthur Kill watershed that would continue to contribute a contaminant load to the restored area, thus compromising the quality of the newly placed sediments.

3.2: Remedial History

Landfill Closure

In 1986, the Department listed the Brookfield Avenue Landfill Site as a Class 2 site in the New York State Registry of Inactive Hazardous Waste Disposal Sites. A Class 2 site is a site where hazardous waste presents a significant threat to the public health or the environment and action is required. When the site became inactive in 1980, NYCDOS designated 38 acres in the eastern section of the Site for closure. Phase I closure construction started in October 1982 and was completed in 1984. Phase I of landfill closure included regrading, capping with 24 inches of clay and topsoil, and seeding the area. Ten passive vertical methane gas vents were also installed. A passive methane-venting trench was constructed in 1984. The truck scale was demolished in 1981.

Phase II Closure Design was conducted between 1981 and 1983, and consisted of a series of design investigations, and the development of a Preliminary Engineering Report and Preliminary Technical Specifications. The selected remedy was grading, venting, capping, and covering the Phase II area, however, the plans were never implemented. The passive methane-venting trench was extended in 1986 to provide greater control of methane migration, and two 550-gallon diesel fuel tanks were removed from the area of the Site entrance in 1995. Interim Remedial Measures (IRMs) were conducted at areas designated hot spots 3 and 5 at the southern and western site borders in 1998 and 1999. A sorbent boom was also deployed to contain an oil seep at hot spot 5.

A soil vapor extraction system and flare were installed to control gas migration at hot spot 3 in February 2001. The Department issued a Record of Decision for OU-1 in March 2002. The design report for the ROD was approved by the Department on May 29, 2006.

SECTION 4: ENFORCEMENT STATUS

The Department and the City of New York entered into Consent Orders index numbers 2-0952 and 2-43-006 on December 16, 1985 and April 17,1990, respectively to properly remediate the landfill. The responsible City agency at that time was the New York City Department of Sanitation (DSNY). On May 15, 1992, the New York City Department of Environmental Protection (NYCDEP) entered into a consent order with the Department to perform a remedial program at the site. The Order obligates the City of New York to implement a full remedial program and allows reimbursement to the City of New York of up to 75 percent of the eligible remediation cost.

SECTION 5: SITE CONTAMINATION

A remedial investigation/feasibility study (RI/FS) has been conducted at OU-2. A summary of the RI/FS is presented in the following sections.

5.1: Summary of the Remedial Investigation

The purpose of the RI was to define the nature and extent of any contamination resulting from previous activities at the site. The RI was conducted between October 2003 and September 2005. The field activities and findings of the investigation are described in the RI report.

During the RI sampling and analysis of surface water, sediment and biota was conducted. In addition, a bathymetric survey of Richmond Creek was conducted.

5.1.1: Standards, Criteria, and Guidance (SCGs)

To determine whether the surface water, sediment and biota contain contamination at levels of concern, data from the investigation were compared to the following SCGs:

Surface water SCGs are based on the Department's "Ambient Water Quality Standards and Guidance Values" and Part 5 of the New York State Sanitary Code.

Sediment SCGs are based on the Department's "Technical Guidance for Screening Contaminated Sediments."

More complete information can be found in the RI report.

5.1.2: Nature and Extent of Contamination

Surface water, sediment, and biota samples were collected at the site to characterize the nature and extent of contamination.

The following activities were conducted during the RI:

- Collection of a total of 13 surface water samples, including one high-tide and one low-tide surface water samples from each of six sampling stations in Richmond Creek and one surface water sample from a background location;
  Collection of ten composite sediment samples for waste characterization from ten sampling stations in Richmond Creek;
- Collection of one shallow- and one deep-sediment sample from each of 12 Richmond Creek locations and one background location.
  Collection of one shallow- and one deep-sediment samples from each of 10 marsh locations.
  Collection of biota (tissue) samples from seven locations in OU-2 and two offsite reference locations
  Bathymetric survey of Richmond Creek streambed elevations within OU-2.

The main categories of contaminants that exceed their SCGs are inorganics (metals), volatile organic contaminants (VOCs), semivolatile organic contaminants (SVOCs),pesticides and polychlorinated biphenyls (PCBs). The specific inorganic contaminants of concern are copper, lead, mercury, nickel, antimony, arsenic, cadmium, chromium, manganese, silver and zinc. The specific VOC and SVOC contaminants of concern are chlorobenzene and benzo-a-anthracene. The PCBs and pesticides of concern are 4,4-DDD, 4,4-DDE, 4,4-DDT, alpha-BHC (lindane), PCBs, dieldrin, endosulfan I, endosulfan II and gamma-chlordane. Each contaminant was measured one or more times in surface water, sediment or biota at concentrations exceeding SCGs and was also detected in soil and groundwater during the OU-1 RI.

Consequently, the Brookfield Avenue Landfill is considered to be a possible source of contamination. Other sources are also likely contributors, such as the Fresh Kills Landfill, numerous stormwater outfalls, and industrial sources that discharge to the Arthur Kill. The Fresh Kills Landfill, which prior to the installation of leachate controls in the late 1990s, was estimated to discharge leachate at a rate 16 times greater than that from the Brookfield Avenue Landfill.

Figure 4 is a map showing OU-2 sampling locations. This section describes the findings of the investigation for all environmental media that were investigated.

Figures 5 through 14 summarize the SCG exceedances in the following media: surface water, creek sediments and marsh sediments. These figures present lists of analytes detected above SCGs in the aforementioned media with comparison to applicable SCGs.

Chemical concentrations are reported in parts per billion (ppb) for surface water and for organics in the sediment. Concentrations are reported in parts per million (ppm) for metals in the sediment.

Surface Water

Surface water quality contraventions in OU-2 included chlorobenzene, copper, lead, mercury, and nickel. Copper was the most commonly detected metal exceeding SCGs. Figures 5 and 6 show SW exceedances. These analytes were also detected in landfill leachate and shallow groundwater samples collected and analyzed during the OU-1 RI. This indicates that the Brookfield Avenue Landfill is a potential source of contamination to surface water in OU-2. However, higher concentrations of these contaminants were identified in leachate from adjacent Fresh Kills Landfill, which also had leachate discharge rates 16 times higher than the Brookfield Avenue Landfill.

The OU-2 surface water data indicates that Richmond Creek water quality has improved over the last decade. For instance, the mean copper concentration in surface water of OU-2 during the most recent study (2003-2004) was almost one-half of the mean concentration detected during similar work in 1994 and 1997 during the OU-1 RI. Surface water quality data from the ongoing Fresh Kills Landfill study conducted by IT Corporation further indicates that the surface water and sediments throughout the Fresh Kills estuary and the Arthur Kill are contaminated. That study also indicates that surface water contamination in OU-2 and in portions of Richmond Creek has improved since the installation of leachate controls at the Fresh Kills Landfill in 1998.

Surface water contaminant levels in the portion of Richmond Creek that is adjacent to Brookfield Avenue Landfill are higher than concentrations further to the west (away from the landfill). As noted, lead, mercury, and nickel generally appear at higher concentrations in surface water from the IT sampling station IT SS 12 (seen on Figure 4) that is located within OU-2 limits, compared to the IT sampling stations which are located within Richmond Creek to the west of Richmond Avenue and outside of OU-2. However, an identical pattern was identified in Main Creek, a second tidal tributary to the Fresh Kills estuary. Main Creek has a similar contaminant and contaminant distribution pattern, but is far distant from Brookfield Avenue Landfill and OU-2. Higher contaminant concentrations in the upper reaches of both tidal tributaries is explained in the IT report by contaminant loadings from leachate from Fresh Kills Landfill under the influence of tidal action. At high tide, these contaminants are pushed to the upper reaches of both Richmond and Main Creeks including the area of Brookfield Avenue Landfill and OU-2.

Surface water contamination identified during the RI/FS will be addressed in the remedy selection process.

Sediments

The sediment in Richmond Creek adjacent to the Brookfield Avenue Landfill contains contamination at levels above SCGs. During the initial (OU-1) investigation phases, PCBs, iron, nickel, lead, copper, zinc and mercury were detected above SCGs. In the OU-2 dataset, the most frequently detected metals exceeding criteria were arsenic, copper, iron, lead, mercury, and nickel. Pesticides and PCBs and some SVOCs, poly aromatic hydrocarbons (PAHs) were also present in surface sediment at concentrations exceeding SCGs. In general, impacted sediments are limited to the first two feet of each boring. See Figures 7 thru 9 and 11 thru 14 which show sediment data. However, a few samples at depths of up to 75 inches contained some elements or compounds at concentrations above SCGs (see Figure 10).

The Fresh Kills Landfill study data indicate that most contaminants are found at higher concentrations in Richmond Creek sediment west of Richmond Avenue than in the OU-2 portion of Richmond Creek, i.e. the higher concentrations are away from the Brookfield Avenue Landfill and OU-2. No significant differences in the types and concentrations of detected analytes were observed between the southern shore samples (closest to the landfill) and the northern southern shore samples (farthest from the landfill) of Richmond Creek. Thus, no concentration gradients were detected in OU-2 emanating from the Brookfield Avenue Landfill. Concentrations of contaminants in sediment in OU-2 are similar to those in Main Creek, a second tidal tributary to Fresh Kills estuary that is distant from the landfill. Overall, sediment concentrations were similar to those observed in other parts of the Arthur Kill. These factors do not support the dominance of a local source of contaminants discharging from the landfill into OU-2, but rather the dominance of other area-wide sources, such as the Fresh Kills Landfill and extensive industry along the Arthur Kill. Failure to identify higher concentrations in the vicinity of the Brookfield Avenue Landfill is not supportive of local contaminant hotspots within OU-2 that would require removal by dredging. Collectively, these data suggest that hotspots do not exist within OU-2.

Differences in marsh sediment samples and creek sediment samples generally showed marsh sediments to contain higher contaminant concentrations. This is expected because marsh vegetation absorbs dissolved metals that wash in from the tidal system and consolidates particulate bound contaminants into their root mat. Marsh sediment sampled from locations SM-1 and SM-4 (Figures 12, 13 and 14),closest to the west mound of OU-1 (within 120 feet), contained significantly lower concentrations of metals compared to sediment from sampling locations SM-2 and SM-3 which are farther away (approximately 400 feet north of the west mound). The samples closer to the landfill are at a higher elevation and represent the high marsh zone, which was built up long ago and is now flooded only once or twice a year. Contamination in this high marsh zone, is primarily in the first 6 inches, with no contamination above SCGs found below 12 inches.

The marsh sampling locations farther from the landfill, called the intertidal marsh, are likely at a lower elevation and represent areas of more recent deposition. Since these are different depositional environments, they are generally not comparable.

The OU-2 RI concluded that the contaminants detected above SCGs in sediment during the OU-2 investigation were also detected in landfill leachate and shallow groundwater sampled during the OU-1 RI. As such, the Brookfield Avenue Landfill must be considered a potential source of

some of the contaminants found in OU-2 sediments. However, tidal action and higher concentrations of similar leachate contaminants and much higher rates of leachate discharge from the Fresh Kills Landfill complex suggests that Fresh Kills Landfill is the dominant contaminant source within the Fresh Kills estuary. Leachate controls installed at the Fresh Kills Landfill in the late 1990s have had a positive impact in reducing contaminant concentrations in shallow sediment.

Outside of the Fresh Kills estuary, many sources of contaminant discharges to the Arthur Kill have been identified. Tidal action regularly carries dissolved and particulate forms of these contaminants into the Fresh Kills estuary (including Richmond Creek and OU-2) where deposition has occurred. This explains the generally comparable concentrations of contaminants in sediment in OU-2 (Richmond Creek) compared to those in Main Creek and the Arthur Kill. These concentration patterns and gradients are not supportive of a predominant localized source of contaminants in OU-1.

Sediment contamination identified during the RI/FS will be addressed in the remedy selection process.

Biota

Biota samples were obtained from seven locations in and around OU-2 during October 2003 and analyzed for pesticides/PCBs, mercury, cadmium, and copper. The targeted and collected biota were generally grouped based on size, trophic level, and foraging range as follows:

- Small, sedentary bivalves-ribbed mussel
  Forage fish-mummichog
- Medium and large, migratory fish-striped bass, white perch, American shad, gizzard shad
- Large reptile-snapping turtle

4,4'-DDD, 4,4'-DDE, Aroclor-1254, copper, and mercury were detected in all biological tissue samples from the OU-2 sampling locations. Alpha-chlordane, gamma-chlordane and cadmium were detected in a portion of samples from all biota groups.

Mean contaminant concentrations in tissues of the mummichog were found to be within the same range as the concentrations detected in those collected from the reference site. Mean contaminant concentrations in tissues of the ribbed mussel were found to be higher from OU-2 locations than concentrations detected in the same species collected from the reference site. The contaminants detected in biota were also found in OU-2 surface water and sediment, although not always at concentrations above SCGs.

Waste Characterization

Ten composite sediment samples for waste characterization were collected. Waste characterization analyses included hazardous waste characteristics testing (toxicity characteristic leachate procedure-TCLP, corrosivity, ignitability, reactivity) plus physical characterization, including grain size distribution (sieve and hydrometer) and water content. Waste

characterization laboratory analytical results did not identify any sediment samples as exhibiting characteristics for hazardous waste, i.e. no hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA) was identified in OU-2. No TCLP failure for organics was detected in any of the composite samples collected.

5.2: Interim Remedial Measures

There were no IRMs performed at this site during the RI/FS.

5.3: Summary of Human Exposure Pathways:

A more detailed discussion of the human exposure pathways can be found in Section 6 of the RI report. An exposure pathway describes the means by which an individual may be exposed to contaminants originating from a site. An exposure pathway has five elements: [1] a contaminant source, [2] contaminant release and transport mechanisms, [3] a point of exposure, [4] a route of exposure, and [5] a receptor population.

The source of contamination is the location where contaminants were released to the environment (any waste disposal area or point of discharge). Contaminant release and transport mechanisms carry contaminants from the source to a point where people may be exposed. The exposure point is a location where actual or potential human contact with a contaminated medium may occur. The route of exposure is the manner in which a contaminant actually enters or contacts the body (e.g., ingestion, inhalation, or direct contact). The receptor population is the people who are, or may be, exposed to contaminants at a point of exposure.

An exposure pathway is complete when all five elements of an exposure pathway exist. An exposure pathway is considered a potential pathway when one or more of the elements currently does not exist, but could in the future.

This section describes the types of human exposures that may present added health risks to persons at or around the site. A more detailed discussion of the exposure pathways and potential health risks can be found in Section 1.3.6 of the OU-2 Feasibility Study Report (August 2006). Exposure pathways evaluated for OU-2 include:

- Dermal contact with Creek and marsh sediment
- Ingestion of Creek and marsh sediment;
- Dermal contact with surface water;
- Ingestion of surface water; and
- Consumption of contaminated biota.

These pathways are further discussed below, organized by media type.

Sediment

Current public access to OU-2 adjacent to the landfill is limited since the landfill is enclosed by fencing and is guarded full-time by security. Therefore, direct dermal contact and incidental ingestion of contaminated creek and marsh sediment is unlikely. In the future, if adults and

children wade in the creek or traverse the marsh they may be exposed to contaminated sediments. However, implementation of the remedy for OU-1, a barrier wall and leachate collection system, would stop leachate from migrating into Richmond Creek. Unacceptable human health risks to adults and children due to exposure to creek sediment were not identified based on the levels of contaminants documented in the OU-2 RI. Additional contaminant reductions in creek sediment are expected following implementation of the OU-1 remedy. The potential for unacceptable risk to children due to exposure to marsh sediment were identified; however, this exposure pathway is considered unlikely.

Surface Water

As with dermal contact to sediments, only limited current dermal contact with surface water is expected. Ingestion of surface water is considered to be unlikely. Unacceptable human health risks to adults and children due to exposure (dermal contact and ingestion) to surface water were not identified.

Biota

Extensive fish advisories (issued by the New York State Department of Health) apply to the Arthur Kill and its tributaries, including Richmond Creek. These advisories are based primarily on contamination with PCBs and dioxin (in finfish and crabs) and cadmium (in crabs) and are unrelated to the Brookfield Avenue Landfill. Despite the presence of fish advisories, human exposures to contaminants in fish and shellfish may still occur if people are unaware of, or ignore, the advisories. The contribution of the Brookfield Avenue Landfill to overall contaminant levels in Arthur Kill is probably limited, and would be reduced further following implementation of the OU-1 remedy.

5.4:Summary of Environmental Assessment

This section summarizes the assessment of existing and potential future environmental impacts presented by the site. Environmental impacts include existing and potential future exposure pathways to fish and wildlife receptors, as well as damage to natural resources such as aquifers and wetlands.

The Fish and Wildlife Impact Analysis, which is included in the RI report, presents a detailed discussion of the existing and potential impacts from the site to fish and wildlife receptors. In summary, mercury in creek sediment, marsh sediment, and in surface water, and copper in creek sediment of Richmond Creek may pose potential risks to aquatic biota. In addition, potential for adverse effects to birds consuming fish from the Richmond Creek may also exist due to exposure to total DDT and PCBs. Considering the similar and often higher levels of the contaminants of potential concern detected in surface water and sediment of Arthur Kill and other parts of the New York/New Jersey Harbor, similar risks to aquatic biota occur elsewhere in the regional waterways, as a result of multiple sources of contamination.

SECTION 6: SUMMARY OF THE REMEDIATION GOALS

Goals for the remedial program have been established through the remedy selection process stated in 6 NYCRR Part 375. In addition to the goals that have been established for OU-1, the following are Remedial Action Objectives (RAOs) for Public Health Protection related to surface water and sediment in OU-2. These RAOs serve as the primary basis upon which the remedial alternatives are developed and evaluated.

- Prevent releases of contaminants from sediments that would result in surface water levels in excess of ambient water quality criteria;
- Prevent or minimize human consumption of aquatic biota in a manner that is incompatible with existing health advisories; and
- Preserve productive ecological habitat created by existing wetlands and marsh areas and open water.

Further, goals for OU-2 related to the extensive remedial work to be performed under OU-1 will ensure compatibility with the OU-1 remedy and the end use plan for the site.

SECTION 7: SUMMARY OF THE EVALUATION OF ALTERNATIVES

The selected remedy must be protective of human health and the environment, be cost-effective, comply with other statutory requirements, and utilize permanent solutions, alternative technologies or resource recovery technologies to the maximum extent practicable. Potential remedial alternatives for the Brookfield Avenue Landfill OU-2 were identified, screened and evaluated in the FS report which is available at the document repositories established for this site.

A summary of the remedial alternatives that were considered for this site is discussed below. The present worth represents the amount of money invested in the current year that would be sufficient to cover all present and future costs associated with the alternative. This enables the costs of remedial alternatives to be compared on a common basis. As a convention, a time frame of 30 years is used to evaluate present worth costs for alternatives with an indefinite duration. This does not imply that operation, maintenance, or monitoring would cease after 30 years if remediation goals are not achieved.

7.1: Description of Remedial Alternatives

Since the OU-1 remedy is common to all the remedial alternatives, the following is a brief description: a 6 NYCRR Part 360 landfill cap to prevent infiltration into the landfill and leachate generation; a subsurface low permeability barrier wall around each landfill cell to a depth ranging from 25-40 feet to halt lateral migration of leachate that has already been generated; a series of leachate collection pipes and wells in the subsurface inside the barrier wall and between the landfill and Richmond Creek to collect leachate that has been generated and to create an inward hydraulic head to minimize potential leakage of leachate through the wall; and a system for leachate treatment onsite and offsite to ensure that future loading of contaminants to Richmond Creek does not occur; a landfill gas collection and flaring system; and wetlands enhancements. Figure 15 shows the major components of the OU-1 remedy.

The following potential remedies were considered to address the contaminated sediment and surface water for OU-2 at the site.

Alternative 1: No Action

The No Action Alternative is evaluated as a procedural requirement and as a basis for comparison. It requires continued monitoring only, allowing the site to remain in an unremediated state. This alternative would leave the site in its present condition and would not provide any additional protection to human health or the environment.

Present Worth: *$0*
Capital Cost: *$0*
Annual Costs:
(Years 1-30): *$0*

Alternative 1 assumes that the source control remedy for OU-1 is implemented. The No Action alternative assumes that the institutional controls currently in place, such as fish advisories, are continued since they are not put in place because of the Brookfield Avenue Landfill and would continue under any circumstance. There would be no monitoring to assess contamination status or to determine if public health is protected. This alternative would leave the site in its present condition and would not provide any additional protection to human health or the environment. Alternative 1 allows for the natural reduction of mass and toxicity of contaminants in the sediments by naturally occurring biological, chemical, and physical processes. It does not involve excavation or dredging of contaminated sediments, and preserves and protects the existing functioning estuary and coastal wetlands in OU-2 and associated habitat for aquatic and terrestrial animals and plants.

Alternative 2: Institutional Controls and Monitoring

Present Worth: *$864,000*
Capital Cost: *$0*
Annual Costs:
(Years 1-30): *$39,800*

Alternative 2 (institutional controls and monitoring) includes institutional controls consisting of an environmental easement for portions of OU-2 that are listed on the New York State Registry of Inactive Hazardous Waste Disposal Sites; and monitoring the chemical characteristics of surface waters and sediment in the 5th year, 10th year and 20th years after the OU-1 remedy is complete (this would augment monitoring conducted as part of the OU-1 post-closure monitoring program).

Like Alternative 1, this alternative allows for natural reduction of mass and toxicity of contaminants in the sediments by naturally occurring biological, chemical, and physical processes. Alternative 2 does not involve excavation or dredging of contaminated sediments, and

preserves and protects the existing functioning estuary and coastal wetlands in OU-2 and associated habitat for aquatic and terrestrial animals and plants.

Common Elements of Alternatives 3 through 5

The following principal components are common to Alternatives 3 through 5. Each design contains unique aspects in addition to the aspects described below.

- Source control via OU-1 remediation as discussed in Section 7.1 above;
- Institutional Controls as for Alternative 2;
- Dewatering excavated and dredged sediments with drying beds, collection of supernatant fluids and testing to ensure water meets New York State Pollutant Discharge Elimination system (SPDES) discharge criteria, addition of polymers to pumped sediment, if necessary, to accelerate dewatering and reduce amounts of contaminant in effluent;
- Transportation of dewatered sediments to nearby Brookfield and Fresh Kills Landfills for beneficial use under the cap or transportation/disposal at a regional disposal facility;

  Capping of creek sediments; and
- A performance monitoring program

Alternative 3: Sediment Removal in Creek and Marsh, Restoration , and Beneficial Use/Disposal

Present Worth: ..... *$19,201,000-$29,271,000*
Capital Cost: ..... *$19,710,000-$30,414,000*
Annual Costs:
(Years 1-30): *$37,700*

In addition to the common elements listed above for Alternatives 3-5, Alternative 3 also includes the following elements:

- In-stream dewatering and excavation of sediments in Richmond Creek and Marsh using conventional earth moving equipment with the use of suction dredges as needed; and
- Placement of marsh substrate material in marsh area to appropriate elevations followed by vegetative habitat replacement

Alternative 4: **Sediment Removal in Creek and Intertidal Marsh, Restoration, and Beneficial Use/Disposal**

Present Worth: ..... *$11,033,000-$16,171,00*
Capital Cost: ..... *$11,100,000-$16,561,000*
Annual Costs:
(Years 1-30): *$37,700*

In addition to the common elements listed above for Alternatives 3-5, Alternative 4 also includes the following elements:

- In-stream dewatering and excavation of sediments in Richmond Creek and intertidal marsh using conventional earth moving equipment with the use of suction dredges as needed; and

- Placement of marsh substrate material within the intertidal marsh area to original or other appropriate elevations followed by vegetative habitat replacement

Alternative 4 differs from Alternative 3 in that only the intertidal portion of the marsh would be subject to sediment excavation. Based on the findings of the RI, it appears the majority of the deposition of contaminated sediments within the marsh has occurred within the intertidal marsh areas; therefore, the high marsh is much less contaminated.

Alternative 5: Sediment Removal in Creek and Beneficial Use/Disposal

Present Worth: ..... *$6,052,000-$9,097,000*
Capital Cost: ..... *$5,788,000-$9,026,000*
Annual Costs:
(Years 1-30): *$37,600*

In addition to the common elements listed above for Alternative 3-5, Alternative 5 also includes the following elements:

- In-stream dewatering and excavation of sediments in Richmond Creek using conventional earth moving equipment with the use of suction dredges as needed with an additional excavation of areas of intertidal marsh bordering the creek so that the slope between the marsh and the creek remains unchanged; and

- Placement of marsh substrate material in excavated areas of intertidal marsh area to original or other appropriate elevations followed by vegetative habitat replacement.

7.2 Evaluation of Remedial Alternatives

The criteria to which potential remedial alternatives are compared are defined in 6 NYCRR Part 375, which governs the remediation of inactive hazardous waste disposal sites in New York. A detailed discussion of the evaluation criteria and comparative analysis is included in the FS report. Concerns of the Community regarding the RI/FS reports and the PRAP have been evaluated. The Responsiveness Summary (Appendix A) presents the public comments received

and the manner in which the Department addressed the concerns raised. In general, the public comments received were supportive of the remedy. Several comments received recommended changes to the selected remedial alternative. Following evaluation of public comments, the Department has made the following changes to the selected remedy, remedial alternative 2: expansion the number of rounds of monitoring from 2 rounds to 3, change in the timing of surface water and sediment sampling (to be performed in the 5th, 10th and 20th year after the remedy is complete), and addition of sediment to the media to be sampled, in addition to surface water.

The preceding sections presented a detailed description of five different remedial alternatives to address the contamination identified at the Brookfield Avenue Landfill OU-2. The alternatives were developed to represent the full range of feasible site remediation alternatives, considering proper application of scientific and engineering principles. As per 6 NYCRR 375-1.10 the alternatives evaluated include a "No action" alternative (Alternative 1) to establish the baseline conditions for comparing the site remedial alternatives and one alternative which will return the site to as close to "pre-disposal conditions" as feasible. This is Alternative 3: Sediment removal in Creek and Marsh, Restoration, and Beneficial Use/Disposal, which will achieve the most contaminant mass removal while also creating the most wetland destruction. Two partial sediment removal alternatives (Alternatives 4 and 5) involve lesser degrees of wetland disturbance and contaminant mass removal in OU-2. Each alternative evaluated is compatible with the selected remedy and end use plan for OU-1, although minor modifications may be required.

Despite the impacts associated with landfill operations and other sources of contaminants to Richmond Creek, the tidal wetlands in OU-2 adjoining the landfill currently exhibit a complex habitat and a fair degree of value and function. While excavation or dredging of the creek bed or salt marsh would remove certain contaminants in the sediment, it would also irreparably destroy the complex habitat that has developed over the last several thousand years. The current state of the science of habitat restoration suggests that recreating the functions and value of a natural wetland system after dredging is difficult to achieve through a habitat restoration project (i.e. the restoration proposed in Alternatives 3, 4 and 5 following excavation/dredging).

The OU-2 sampling has documented improvement of surface water and sediment quality since sampling was performed in 1996 and 1997 as part of the OU-1 RI. This indicates that when the extensive OU-1 remedy is completed and further loading of leachate from OU-1 is halted, natural processes would continue to facilitate improvement of environmental quality in OU-2 without the destruction to the local wetlands ecosystem that would be caused by excavation and dredging.

Additionally, there are many other sources of pollution in the Arthur Kill watershed that would continue to contribute a contaminant load to the restored area, thus compromising the quality of the newly placed sediments under Alternatives 3, 4 and 5. Considering these factors collectively, a non-invasive remedy for OU-2 (i.e. those not incorporating excavation or dredging) provides the least impairment of the existing ecosystem and habitat. In addition, a non-invasive remedy would eliminate the need for double handling of sediments, dewatering and truck transportation which would have negative short-term impacts on the community and the environment.

The primary risk posed by OU-2 to human health is through the consumption of contaminated finfish and shellfish. Extensive fish advisories (issued by the New York State Department of Health) apply to the Arthur Kill and its tributaries, including Richmond Creek. These advisories are primarily due to contamination with PCBs and dioxin (in finfish and crabs) and cadmium (in crabs) and are unrelated to the Brookfield Avenue Landfill. Despite the presence of fish advisories, human exposures to contaminants in fish and shellfish may still occur if people are unaware of, or ignore, the advisories. The contribution of the Brookfield Avenue Landfill to overall contaminant levels in Arthur Kill is probably limited, and would be reduced further following the implementation of the OU-1 remedy.

The risk posed by OU-2 is most rapidly and effectively addressed through the application of consumption advisories as has already been done by the NYSDOH. Given the patterns of occurrence of contaminants in OU-2, Richmond Creek and the Fresh Kills estuary, contaminants from other sources seem to be primarily responsible for existing contamination in OU-2. Even if some sediment was removed from OU-2, consumption advisories would still be required since other pollution sources within the Arthur Kill tidal system remain unchanged and their impacts to surface water and sediment habitats within and outside OU-2 would continue unabated.

Alternative 2 maintains the integrity and functionality of the existing wetlands and associated habitats and is considered the most effective approach to improvement of environmental conditions within OU-2. While Alternative 2 does not meet existing SCGs, such compliance would not be expected given the discharge of contaminants from other sources outside of OU-1 and OU-2. Contaminant source reduction to OU-2 is going to be accomplished as part of the OU-1 remedy. Past reduction of contaminant loading from Fresh Kills Landfill caused by installation of leachate collection systems in the late 1990s and reduction of mass and toxicity of contaminants in the sediment caused by naturally occurring biological, chemical, and physical processes, have already resulted in documented improvements in surface water and sediment quality in OU-2 and continued improvement is expected.

SECTION 8: SUMMARY OF THE SELECTED REMEDY

Based on the Administrative Record (Appendix B) and the discussion presented above, the Department has selected Alternative 2, Institutional Controls and Monitoring, in combination with the OU-1 selected alternative as the remedy for this site. The elements of this remedy are described below.The proposed remedy is based on the results of the RI and the evaluation of alternatives presented in the FS. Alternative 2 is protective of public health and the environment and complements the extensive remedial work to be performed at OU-1.

The estimated present worth cost to implement the remedy is $864,000. The cost to construct the remedy is estimated to be $ 0 and the estimated average annual costs for 30 years years is $ 39,800.

The elements of the selected remedy are as follows:

- institutional controls consisting of an environmental easement for portions of OU-2 that are listed on the New York State Registry of Inactive Hazardous Waste Disposal Sites.

Under the remedy required for OU-1, institutional controls will be applied to the entire listed site including portions of OU-2. These controls will include: prohibition from use of groundwater for potable purposes; prohibition from vegetable gardening; performance of site inspections and filing of a periodic certification that the remedy remains in place and continues to perform as designed; and management of residual contamination under a Site Management Plan. The property owner will provide a periodic certification of institutional and engineering controls, prepared and submitted by a professional engineer or such other expert acceptable to the Department, until the Department notifies the property owner in writing that this certification is no longer needed. This submittal will: (a) contain certification that the institutional controls and engineering controls put in place are still in place and are either unchanged from the previous certification or are compliant with Department-approved modifications; (b) allow the Department access to the site; and (c) state that nothing has occurred that will impair the ability of the control to protect public health or the environment, or constitute a violation or failure to comply with the site management plan unless otherwise approved by the Department. and

monitoring the chemical characteristics of surface waters and sediment to augment monitoring conducted as part of the OU-1 Site Management Plan. This will include monitoring the chemical characteristics of surface waters and sediment in the 5th year, 10th year and 20th years after the OU-1 remedy is complete (this would augment monitoring conducted as part of the OU-1 post-closure monitoring program)..

In addition, following public comment on the PRAP and FS, the New York City Department of Environmental Protection (NYCDEP) has agreed to install a visual demarcation fence (a wooden post and rail fence is envisioned) between OU-1 and OU-2 and install signage along the demarcation line that provide notification of the current fish consumption advisory that has been placed by the NYSDOH for waters in New York Harbor. While these controls are not a mandated component of this ROD, they have been agreed to by the NYCDEP in order to address community concerns and interests.

SECTION 9: HIGHLIGHTS OF COMMUNITY PARTICIPATION

As part of the remedial investigation process, a number of Citizen Participation activities were undertaken to inform and educate the public about conditions at the site and the potential remedial alternatives. The following public participation activities were conducted for the site:

1. Repositories for documents pertaining to the site were established.

2. A public contact list, which included nearby property owners, elected officials, local media and other interested parties, was established.

3. NYSDEC DER staff met with members of the Environmental Subcommittee of Community Board 3 (Staten Island) several times before the issuance of the PRAP to inform them of the upcoming release of the PRAP and to brief them on the selected remedy.

4. NYSDEC DER staff maintained regular contact with the consultants to the Environmental Subcommittee of Community Board 3 (Staten Island), Ransom Environmental, in order to receive their input and keep them informed regarding the technical aspects of the project and the PRAP process.

5. A fact sheet was mailed out to the members of the public regarding the availability of the PRAP and other related documents at the named repositories.

6. The PRAP was made available on the NYSDEC public web site so that members of the public unable to visit the repositories were able to access the document.

7. A public meeting was held on February 1st ,2007 to present and receive comment on the PRAP.

8. Based on comments received by the Department, the following changes were made to the selected alternative:

- expanding the number of rounds of monitoring from 2 rounds to 3;
- change in the timing of surface water and sediment sampling (to be performed in the 5th, 10th and 20th year after the remedy is complete); and
- addition of sediment to the media to be sampled, in addition to surface water.

In addition, based on public comment on the PRAP and FS, the City of New York has agreed to install a visual demarcation fence (a wooden post and rail fence is envisioned) between OU-1 and OU-2 and perform a photographic wetlands survey that includes aerial reconnaissance photography. Finally, the Department has clarified that quarterly inspections will be required for the engineering controls to be implemented on OU-1. These inspections will also include examination of the fence and signage installed at the demarcation boundary.

9. A responsiveness summary (Appendix A) was prepared to address the comments received during the public comment period for the PRAP.

Table 1
Remedial Alternative Costs

Remedial Alternative	Capital Cost ($)	Annual Costs ($)	Total Present Worth ($)
Alternative 1	0	0	0
Alternative 2	0	39,800	864,000
Alternative 3	19,710,000-30,414,000	37,700	19,201000-29,271,000
Alternative 4	11,100,000-16,561,000	37,000	11,033,000-16,171,000
Alternative 5	5,788,000-9,026,000	37,600	6,052,000-9,097,000

APPENDIX A

Responsiveness Summary

RESPONSIVENESS SUMMARY

Brookfield Avenue Landfill Site
Operable Unit No.2
New York City, Richmond County, New York
Site No. 243006

The Proposed Remedial Action Plan (PRAP) for the Brookfield Avenue Landfill Site, was prepared by the New York State Department of Environmental Conservation (the Department) in consultation with the New York State Department of Health (NYSDOH) and was issued to the document repositories on January 4, 2007. The PRAP outlined the remedial measure proposed for the contaminated surface water, sediment and biota at the Brookfield Avenue Landfill Site.

The release of the PRAP was announced by sending a notice to the public contact list, informing the public of the opportunity to comment on the proposed remedy.

A public meeting was held on February 1st , 2007 , which included a presentation of the Remedial Investigation (RI) and the Feasibility Study (FS) as well as a discussion of the proposed remedy. The meeting provided an opportunity for citizens to discuss their concerns, ask questions and comment on the proposed remedy. These comments have become part of the Administrative Record for this site. The public comment period was to have ended on February 2, 2007, however it was extended to February 15, 2007 , at the request of the public.

This responsiveness summary responds to all questions and comments raised during the public comment period. The following are the comments received, with the Department's responses:

Natural Resources
COMMENT 1: When referring to the wetlands in the area of Richmond Creek and Brookfield Avenue Landfill in OU-2, the PRAP refers to the term "fair degree of value and function." What does this mean?

RESPONSE 1: The term "fair degree of value and function" means that the wetland, as it exists today, is adequately serving many of the functions that we attribute to tidal wetlands per the New York State's Part 661 regulations, as follows: the wetland is protecting the inland area from damage from wave energy; is absorbing flood waters, is cleansing the waters of the creek by absorbing and retaining contaminants in the plants and sediments; is serving as habitat for the aquatic organisms (those that are free swimming and those that live at the bottom of the Creek); and is providing nesting, foraging, and other functions for regional wildlife.

COMMENT 2: Are there contaminants in the Creek? What is the degree of contaminants found in the Creek sediment? How will the presence of these contaminants impact the fish and crabs?

RESPONSE 2: There are contaminants in the creek bed and in the marsh sediments. However, though there were hazardous wastes in the landfill, the remedial investigation did not find contaminants at the hazardous level in the creek or the marshes. With regard to the sediment, New York State has sediment criteria that categorize the level of contamination as A, B, or C. Class A is considered relatively clean, and we would not

expect to encounter any impacts to aquatic resources. Class B is the intermediate category, where some level of chronic impacts may occur. Class C levels suggest possible acute impacts to some aquatic biota. Within the creek and salt marsh we found a number of contaminants present, at levels ranging from A to C. The contaminant levels in OU-2 marsh and creek sediments are significantly lower than those found in Brookfield Avenue Landfill soils and similar to many other areas throughout NY Harbor. The inference from data is that there is likely some negative impact to the biota because of the presence of these contaminants. Any uptake of contaminants by the benthic biota can move up the food chain through consumption by fish and crabs. The ubiquitous level of contamination throughout the Harbor is one of the main reasons why there are State-imposed restrictions on the consumption of fish and crabs from New York Harbor waters.

COMMENT 3: Since we are capping the landfill why are we not capping the sediment?

RESPONSE 3: After careful consideration of the remedial alternatives, it was determined that removing or capping the sediments would do more harm than good in that it would destroy all of the identified functions and values of the existing creek/marsh system; functions and values that we may never be able to recreate through artificial means. Moreover, any cap would be quickly contaminated by the loads brought in with tidal and freshwater flows from upstream and downstream of the site. Ultimately, we will achieve a higher level of function sooner by stopping inputs from the landfill and allowing the system to improve on its own.

Public Health

COMMENT 4: Why are you concerned about human consumption of shellfish, such as crabs, from the Richmond Creek in the vicinity of the landfill? If shell fish and other fish can be caught, why shouldn't they be eaten without restriction?

RESPONSE 4: The shell fish and other fish can bioaccumulate many contaminants that they encounter in the environment. This means that contaminant concentrations that are low in small organisms at the bottom of the food chain tend to increase in organisms higher in the food chain. Fish advisories now apply to all waters throughout the entire Arthur Kill, the Newark Bay area and most waters around New York City and are not limited to Richmond Creek. Further, these advisories are not related to Brookfield Avenue Landfill. Contaminants from thousands of sources in the region affect water quality and impact shell fish and other fish. Numerous programs are now in place to reduce the load of pollutants discharged into our local waterways (including the remediation of Brookfield Avenue Landfill). We expect that the regional environment (surface water, sediment and the fish and shell fish that inhabit them) will slowly improve in chemical quality over a long period of time.

COMMENT 5: The report states that "only limited current dermal contact with surface water is expected." Why is this?

RESPONSE 5: For several reasons. First, the access to the creek is limited by dense natural vegetation that makes access difficult. Second, the waters in the creek are not easily navigable because they are relatively shallow, especially at low tide. These sediments are largely organic clay and silt material that provide a very difficult substrate for walking and thus will discourage repeated visits and subsequent long-term dermal contact exposures.

COMMENT 6: Which of the agencies is responsible for putting up signs, particularly the Fish Advisories, around the Brookfield Avenue Landfill Site and how is this done?

RESPONSE 6: The fish advisories apply to the regional water bodies of New York Harbor and are not related in any way to Brookfield Avenue Landfill, nor are they altered by this ROD. Since the advisories are not caused by contaminants from the Brookfield Avenue Landfill, this ROD does not mandate signage as a part of the remedy for the Site. However, with the understanding that the ultimate end use of the Landfill is to build and operate a public park, NYC DEP has agreed to install signage that will notify citizens in the area, including park users, of the existence the New York Health advisory and the recommendations of the New York State Department of Health. This is discussed in greater detail later in this Summary in Response 15.

Sources of Contamination

COMMENT 7: Where did the contamination in the creek come from?

RESPONSE 7: The waters of Richmond Creek are directly connected with those of the Fresh Kills and the Arthur Kill through tidal flows that carry water in and out of the creek twice each day. In addition to leachate discharges from Brookfield Avenue Landfill and the adjacent Fresh Kills Landfill, contaminants enter these water bodies from numerous other sources, including thousands of industries along the shoreline and throughout the large water shed, urban runoff, contaminated storm-water flows, sewage treatment plant overflows and many other contaminated drainage sources. Analysis of data from this and other studies indicates that Brookfield Avenue Landfill is a minor source of the overall contaminant load in Richmond Creek and the adjacent water bodies.

COMMENT 8: Are the Creek sediments hazardous?

RESPONSE 8: Extensive studies show that the sediments in Richmond Creek do not exhibit RCRA hazardous waste characteristics and are therefore not considered a hazardous waste. Additional information is included in Response 2.

COMMENT 9: Is there any evidence to support your conclusion that Brookfield Avenue Landfill is not the principal source of contaminants in Richmond Creek?

RESPONSE 9: During the Remedial Investigation, samples were collected near the landfill and in various directions away from the site. Generally, contaminants tend to cluster adjacent to a primary source and you would expect to see an increase in concentrations as you move closer to that source. This is called an increasing gradient toward the source. Samples in the Creek did not show any pattern of increase in concentrations (increasing gradient) as we moved closer to the Brookfield Avenue Landfill. No 'hot spots', or areas of highly concentrated contamination, were identified in the study area. For many contaminants, the concentrations actually increased the farther we moved away from the landfill. Thus they showed a decreasing gradient toward Brookfield Avenue Landfill, the opposite of what would be expected if the landfill was a major source of contamination. Although contamination was found in Richmond Creek, no hazardous concentrations were

identified at any location. Levels of contamination in the creek were similar to contaminant concentrations elsewhere in the Arthur Kill.

COMMENT 10: Other than a desire to protect wetland habitat, are there any other reasons why NYSDEC and NYSDOH has decided not to dredge the Richmond Creek?

RESPONSE 10: There are a variety of reasons. First, and most importantly, dredging is not necessary. The remedial investigation did not identify any 'hot spots' in the vicinity of the landfill (see above) that would necessitate removal by dredging. Second, the quality of the remedy on the landfill is among the best ever applied to a landfill this size in the U. S. When the remedy is complete, the cap, barrier wall and leachate and gas collection systems will stop contamination from leaving the landfill and entering the creek. Thus, halting future discharge will enable existing contaminant levels to improve under natural processes. Third, monitoring of sediment in the Fresh Kills tidal estuary, including Richmond Creek, has shown substantial improvement over the last 8 years since closure of the adjacent Fresh Kills Landfill. These improvements are attributed to sharp reductions in pollutant loading to the estuary by Fresh Kills Landfill. Improvements from reduction of leachate from Brookfield Avenue Landfill can also be expected, although they will be much less than those registered for the much larger Fresh Kills Landfill. Fourth, if local dredging was performed, contamination in those sediments not removed immediately downstream and upstream would be carried in by tidal action and would recontaminate the area cleansed by dredging. Fifth, dredging would involve movement of large amounts of wet sediment material. Dewatering would require dedication of materials handling on the landfill area and would impede remedial work in these areas until the dredging operations were completed. While feasible, this would add several years to the duration of the remedy. Sixth, dewatering would require multiple handling of the dredge material on the property and would increase the short-term impacts related to potential dust and odors.

COMMENT 11: How will the performance of landfill remedy be monitored?

RESPONSE 11: The landfill remedy, including the cap, barrier wall and leachate and gas collection systems, will be monitored by a series of effective onsite systems. These include hydraulic head monitoring inside and outside of the barrier wall to ensure an inward hydraulic gradient and inward leakage; groundwater monitor wells outside the barrier wall to detect leakage; and flow totalizer readings for leachate that is pumped from the collection systems to monitor performance of leachate removal operations. Also, samples of chemical quality of leachate collected can determine changes over time. The PRAP also called for surface water sampling during two annual events after the completion of the remedy on the landfill. However, this monitoring has less resolution and is less valuable for the purpose of warning landfill managers of a breach in the leachate containment system than those listed above.

COMMENT 12: The community had expressed a desire for additional monitoring in Richmond Creek after the remedy is complete on the landfill. Can more be done in this area?

RESPONSE 12: After discussion with community representatives, NYSDEC has agreed to expand the monitoring program to include sediment samples at each of the surface water stations identified in the PRAP. Further, the number of sampling rounds will be increased from two to three and the timing of the work will be adjusted to accommodate the informed and valuable suggestion by the Science Advisory Committee. It will be

performed in the 5th year, 10th year and 20th year after the remedy is complete. Considerable additional monitoring is planned for Richmond Creek and the Fresh Kills estuary under the closure program for Fresh Kills Landfill. That work includes annual and biannual sampling of surface water and sediments, respectively, and biota sampling. Review of the Richmond Creek component of the Brookfield Avenue Landfill remedial program will also include evaluation of the data and information generated at Fresh Kills Landfill.

Institutional and Engineering Controls

COMMENT 13: What are institutional controls and engineering controls?

RESPONSE 13: Engineering Controls are engineered systems built at remedial sites to provide for protection of public health and the environment. An example of an engineering control is the cap to be built on top of the Brookfield Avenue Landfill to contain and encapsulate the wastes below. This is an engineering control that will protect both public health (from direct contact with waste) and the environment. An institutional control is a restriction or other non-structural requirement that is placed on a property. Institutional controls are often used to insure that engineering controls are properly operated, maintained and monitored. An institutional control for the landfill cap, for instance, would be a requirement for quarterly inspections of the cap to insure that erosion has not occurred and periodic certification to New York State by a qualified environmental professional that the cap continues to perform as it was designed. Other types of institutional controls prohibit certain types of activities on a site. An example would be a prohibition on the use of a site for vegetable gardening. Institutional controls apply to the listed property.

COMMENT 14: Are there any institutional controls to be applied to OU-2?

RESPONSE 14: A portion of OU-2 is part of the site that was listed on the New York State Registry of Inactive Hazardous Waste Disposal Sites (the 'listed site'). That portion is part of the upland marsh area to the west and north of the OU-1. Under the remedy required for OU-1, institutional controls will be applied to the entire listed site including portions of OU-2. Generally, these controls will include: prohibition from use of groundwater for potable purposes; prohibition from vegetable gardening; performance of site inspections and filing of a periodic certification that the remedy remains in place and continues to perform as designed; and management of residual contamination under a Site Management Plan.

COMMENT 15: Are there any additional controls to be applied to OU-2?

RESPONSE 15: Yes. After receiving input from community representatives, NYSDEC and NYSDOH have consulted with NYCDEP. NYCDEP has agreed to several additional controls that are relevant to OU-2. These include (1) the installation of signage acceptable to the NYSDOH at a number of sites along the periphery of OU-2 that provide notification of the current fish consumption advisory that has been placed by the NYSDOH for waters in New York Harbor. These signs will be written in two languages, English and Spanish.; (2) installation of a visual demarcation barrier (fencing of a wooden post and rail type is envisioned) that will be placed along the periphery of OU-2. It is expected that the barrier and the signage locations will coincide. The barrier will be constructed during the construction of OU-1; and (3) performance of a photographic survey of the wetland flora and fauna at the conclusion of the remedy to be used as a baseline for subsequent wetland

assessments. While these controls are not required by NYSDOH as a means to protect public health, and thus are not a mandated component of this ROD, they have been agreed to by NYCDEP in order to address community concerns and interests. The status of the signage and the visual demarcation barrier will be incorporated into the inspections of the site. Under the Site Management Plan, inspections of the site will be performed on a minimum quarterly basis.

COMMENT 16: What is an Environmental Easement and how will it apply to Brookfield Avenue Landfill? Is it different than a deed restriction?

RESPONSE 16: An Environmental Easement is a document regarding real property, created under and subject to provisions of Article 71, Title 36 of the New York State Environmental Conservation Law. The Environmental Easement will apply to the listed property. It provides a permanent notice to title holders of the requirements that apply to a remediated site to manage residual contaminants in perpetuity. It lists all engineering and institutional controls and notes that property owners must adhere to the Site Management Plan approved by NYSDEC. The City of New York would covenant and agree that it shall annually, or such time as NYSDEC may allow, submit to NYSDEC a written statement by an expert the NYSDEC may find acceptable certifying under penalty of perjury that the controls employed at the listed property are unchanged from the previous certification or that any changes to the controls employed at the listed property were approved by the NYSDEC, and that nothing has occurred that would impair the ability of such control to protect the public health and environment or constitute a violation or failure to comply with any Site Management Plan for such controls. It gives access to the listed property to New York State to evaluate continued maintenance of such controls. Environmental Easements are enforceable in law in perpetuity.

The Environmental Easement will be recorded with the County Clerk prior to completion of the remedy for the Site. NYSDEC will not sign off on the completion of the remedy until the Environmental Easement is recorded. An Environmental Easement performs a similar function to a deed restriction. However, an Environmental Easement is more protective in that it yields rights to management of the residual contamination to the State of New York.

COMMENT 17: How long will the inspections and certifications be in place at the Site? What criteria will be used to terminate them?

RESPONSE 17: Inspections and certifications will be required in perpetuity.

COMMENT 18: Is the perimeter fence (now in place) an engineering control?

RESPONSE 18: The perimeter fence is an interim engineering control that provides protection and site security until the remedy is complete.

End Use

COMMENT 19: Do you have any idea when the park is supposed to be available to the public?

RESPONSE 19: While the park is not part of the remedy, NYCDEP has stated that the landscaping on the landfill, the final stage of site preparation, is scheduled to be completed sometime in 2013.

Non-OU-2 Issues

COMMENT 20: Will you guarantee that Hudson dredge material will not be put on the Brookfield Landfill for Operable Unit 1?

RESPONSE 20: No guarantee can be provided that dredge material will not be used for capping of OU-1. Dredge material is routinely used on remedial sites in New York City as a cover material. The design for that work specifies chemical criteria that will apply to all material that will be imported to the site for use as site cap. Imported material must comply with those criteria.

APPENDIX B

Administrative Record

Administrative Record

Brookfield Avenue Landfill Site
Operable Unit No. 2
Site No. 243006

Proposed Remedial Action Plan for the Brookfield Avenue Landfill Site, Operable Unit No.2, dated December 2006, prepared by the New York State Department of Environmental Conservation.

Orders on Consent, Index Nos. 2-0952 and 2-43-006, between the Department and the New York City Department of Sanitation executed on December 16, 1985 and April 17, 1990 respectively and an Order on Consent between the Department and the New York City Department of Environmental Protection executed on May 15, 1992. The DEC index number for the May 15, 1992 order is 2-43-006. In addition, there is a modification to the May 15, 1992 Consent Order. The index number for this modification is A2-0546-0406 executed on July 10, 2006.

3. "Brookfield Avenue Landfill Operable Unit 1 Record of Decision" prepared by the New York State Department of Environmental Conservation (NYSDEC) dated March 2002

4. "Brookfield Avenue Landfill Operable Unit 2 Remedial Investigation/Feasibility Study Workplan" prepared for the New York City Department of Environmental Protection by Camp Dresser & McKee dated June 2003

"Brookfield Avenue Landfill Operable Unit 2 Final Remedial Investigation Report" prepared for the New York City Department of Environmental Protection by Camp Dresser & McKee dated September 2005

"Brookfield Avenue Landfill Operable Unit 2 Final Feasibility Study Report" prepared for the New York City Department of Environmental Protection by Camp Dresser & McKee dated December 2006

Draft CP Plan for the Brookfield Avenue Landfill Project prepared by the New York State Department of Environmental Conservation dated June 28,2006.

"Fact Sheet, Proposed Remedial Action Plan Public Meeting Announced" prepared by the New York State Department of Environmental Conservation dated January 2007

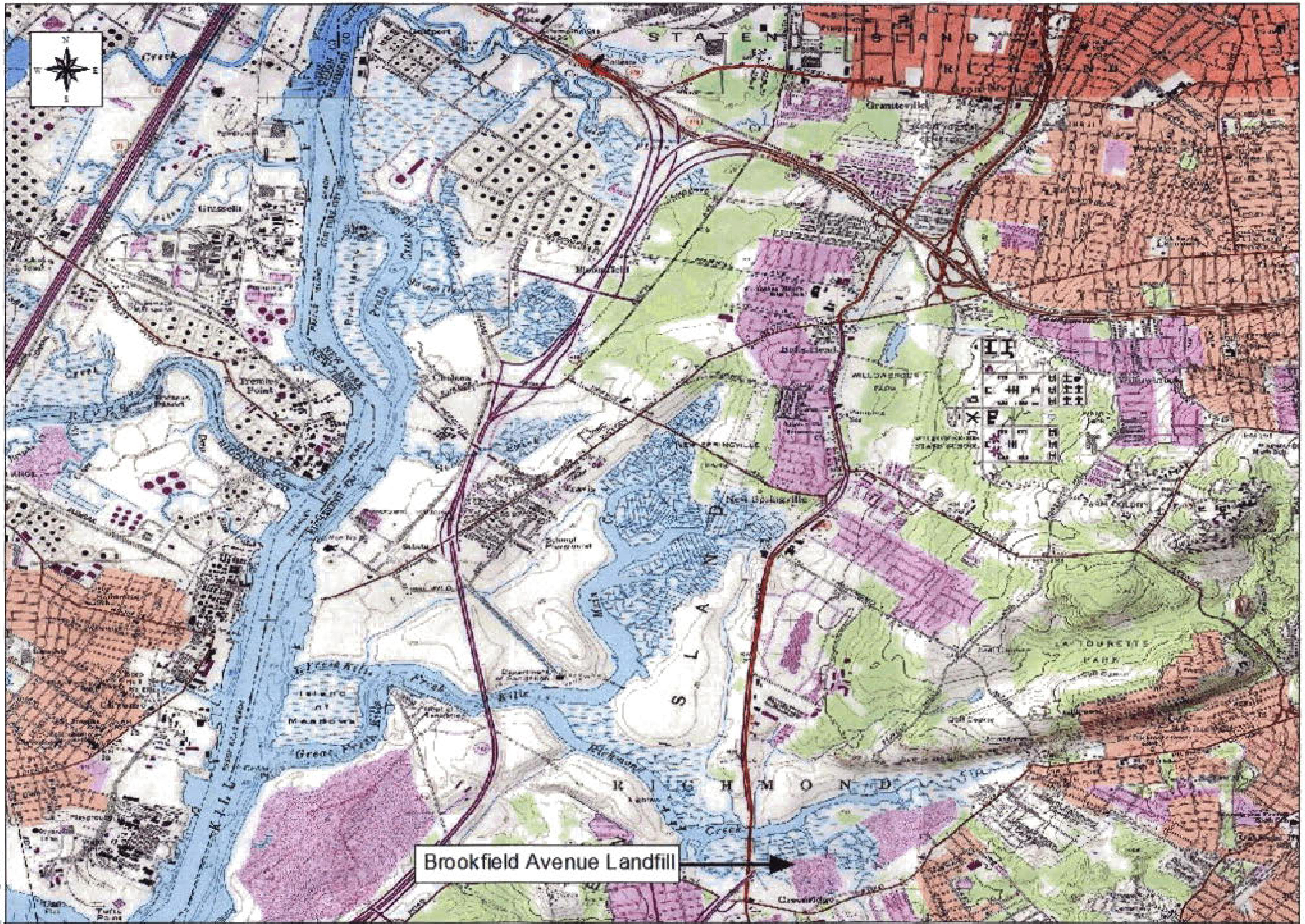
9. Transcript of the OU-2 PRAP public meeting

10. Letter dated February 13, 2007 from Denis Newcomer, Senior Project Manager, Ransom Environmental (Consultant to the Environmental Committee, New York City (NYC) Community Board 3, Staten Island)

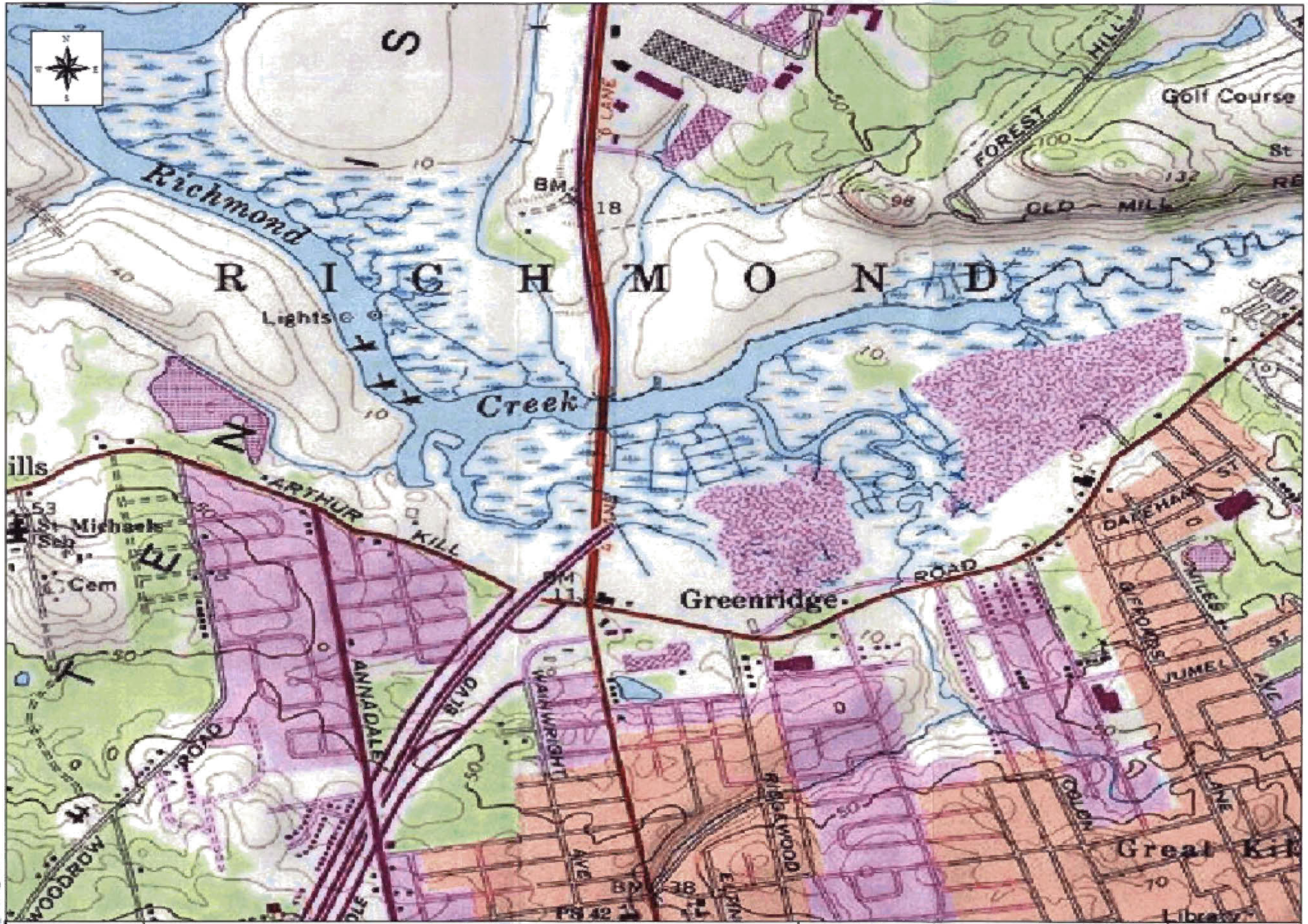
Letter dated February 13, 2007 from Gregory Markow, Chair, Environmental Committee, NYC Community Board 3 (Submitted via email)

12. Email submitted by Barbara Warren, Member, Environmental Committee, NYC Community Board 3 dated January 16, 2007

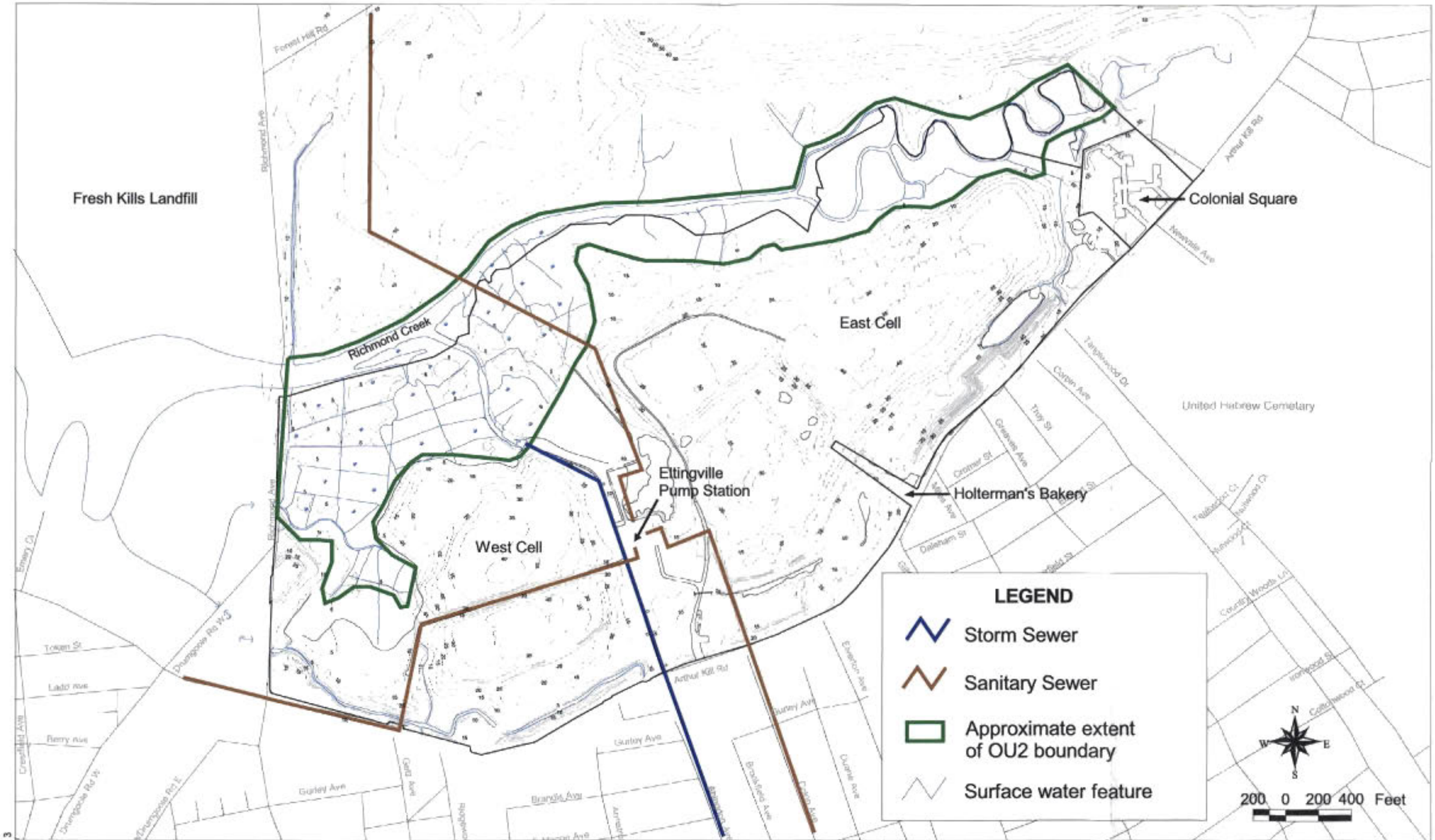
13. Email submitted by Barbara Warren, Member, Environmental Committee, NYC Community Board 3 dated January 29,2007



CDM | New York City Department of Environmental Protection
Brookfield Avenue Landfill Operable Unit 2 | DEP | Site Location | Figure 1



CDM	New York City Department of Environmental Protection Brookfield Avenue Landfill Operable Unit 2	DEP	Historic Topographic Map	Figure 2



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New York City Department of Environmental Protection
Brookfield Avenue Landfill Operable Unit 2

DEP

Site Plan

Figure 3

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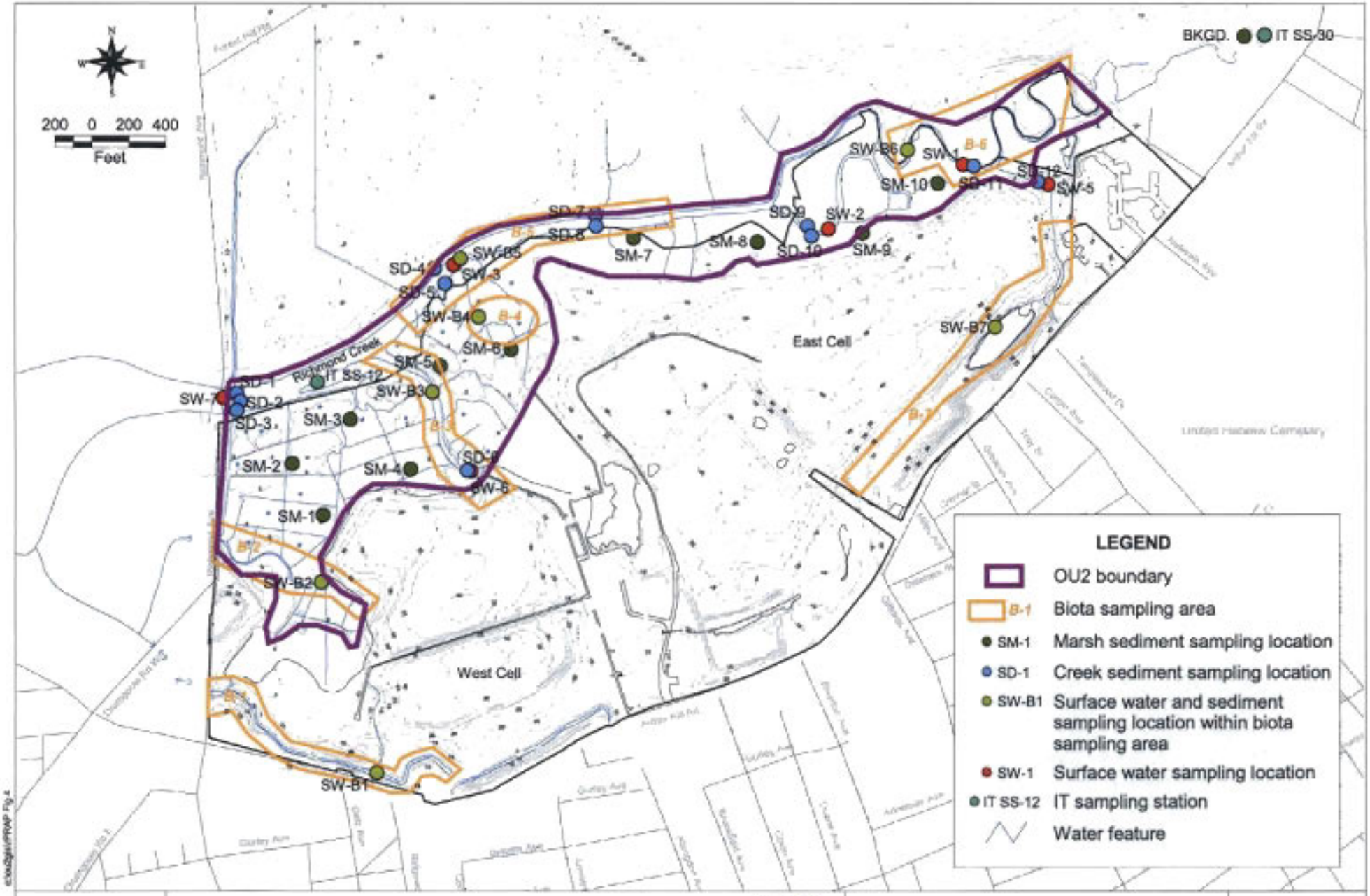

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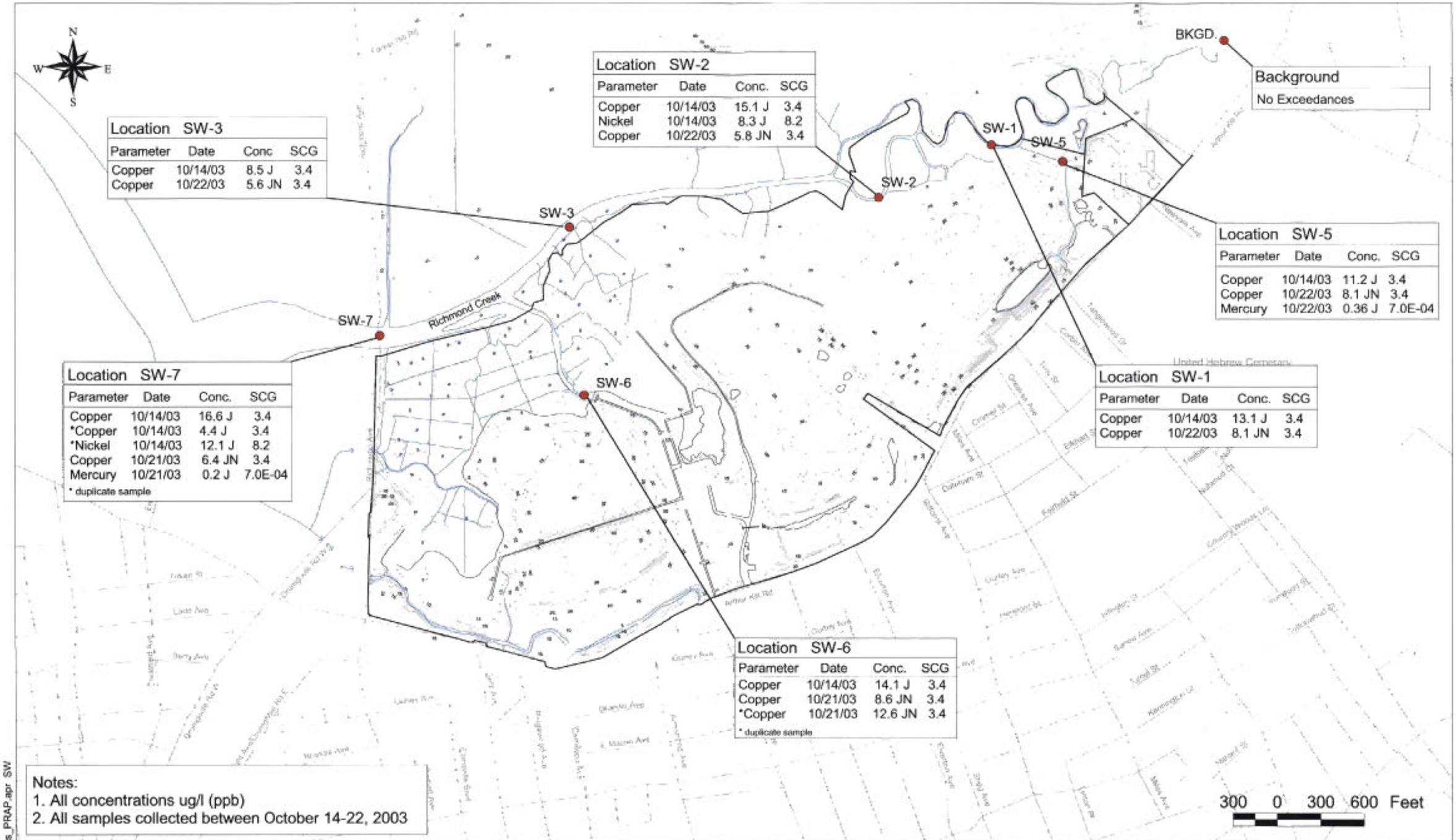
New York City Department of Environmental Protection
Brookfield Avenue Landfill Operable Unit 2

DEP

OU2 Surface Water, Sediment, and Biota Sampling Locations

Figure 4



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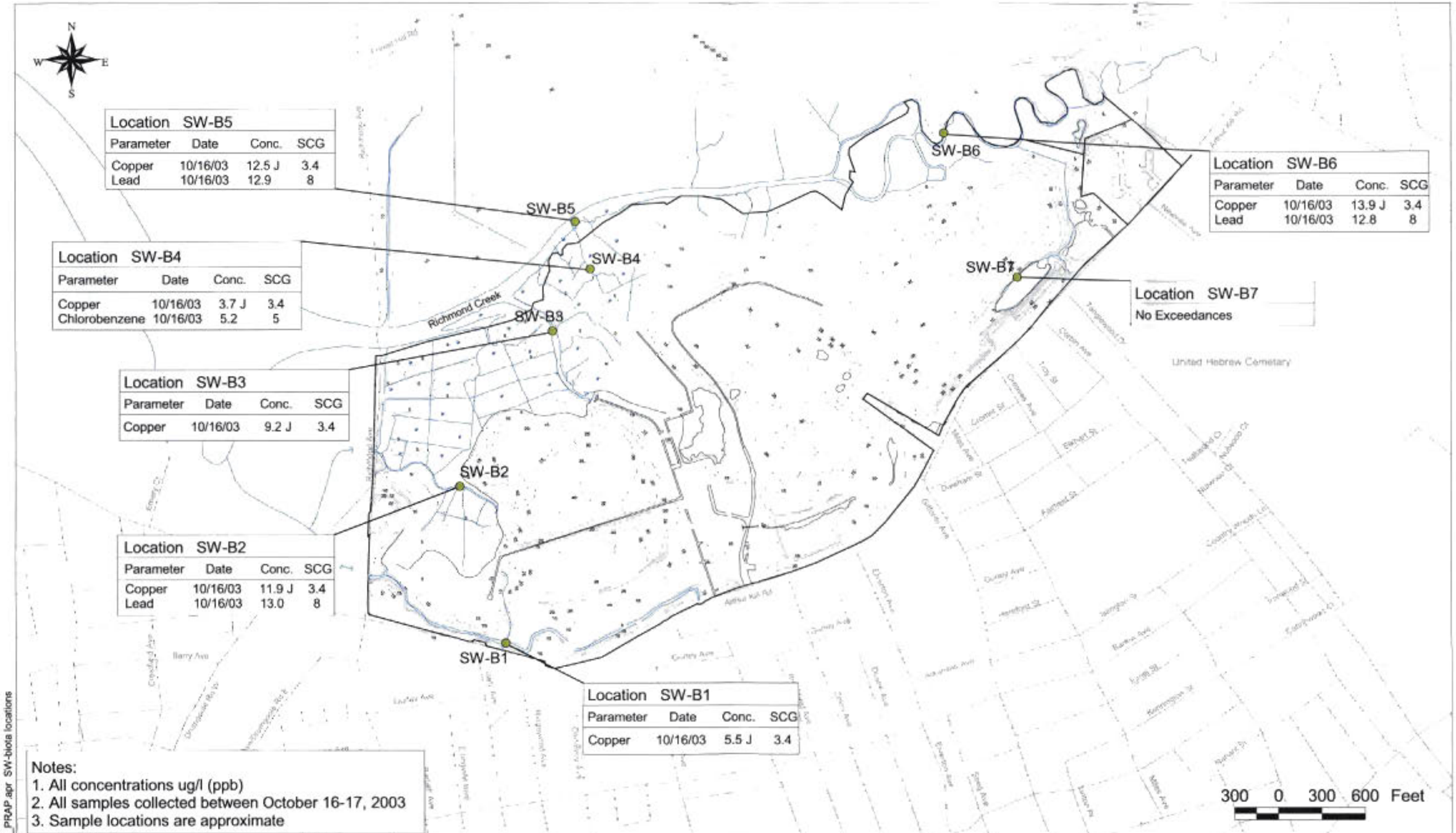
New York City Department of Environmental Protection
Brookfield Avenue Landfill Operable Unit 2

SCG Exceedances in Surface Water

Figure 5



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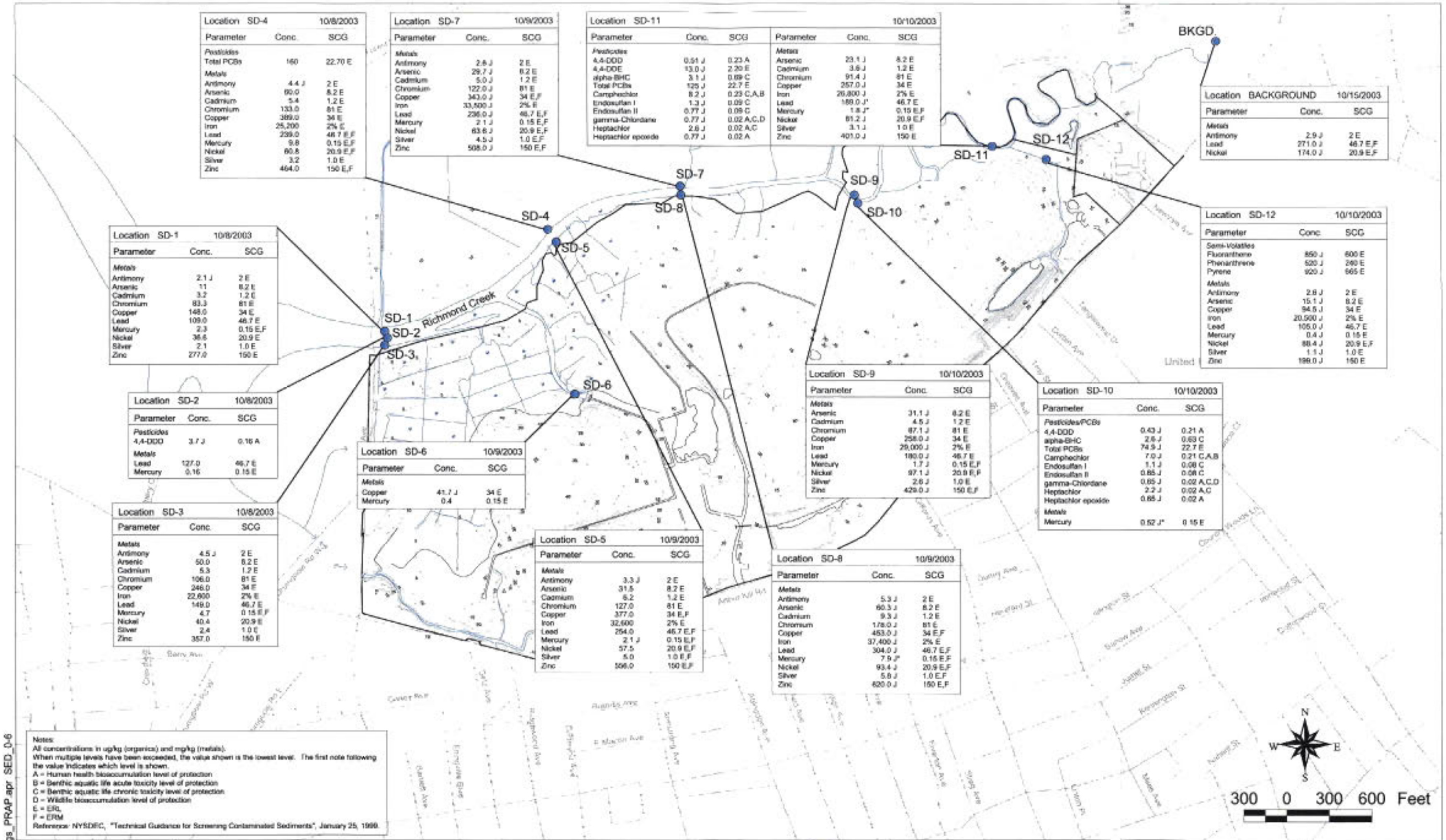
New York City Department of Environmental Protection
Brookfield Avenue Landfill Operable Unit 2

DEP

SCG Exceedances in Surface Water at Biota Sampling Locations

Figure 6



Location SD-4 10/8/2003

Parameter	Conc.	SCG
Pesticides		
Total PCBs	160	22.70 E
Metals		
Antimony	4.4 J	2 E
Arsenic	60.0	8.2 E
Cadmium	5.4	1.2 E
Chromium	133.0	81 E
Copper	389.0	34 E
Iron	25,200	2% E
Lead	259.0	46.7 E,F
Mercury	9.8	0.15 E,F
Nickel	60.8	20.9 E,F
Silver	3.2	1.0 E
Zinc	464.0	150 E,F

Location SD-7 10/9/2003

Parameter	Conc.	SCG
Metals		
Antimony	2.6 J	2 E
Arsenic	29.7 J	8.2 E
Cadmium	5.0 J	1.2 E
Chromium	122.0 J	81 E
Copper	343.0 J	34 E,F
Iron	33,500 J	2% E
Lead	236.0 J	46.7 E,F
Mercury	2.1 J	0.15 E,F
Nickel	63.6 J	20.9 E,F
Silver	4.5 J	1.0 E,F
Zinc	508.0 J	150 E,F

Location SD-11 10/10/2003

Parameter	Conc.	SCG
Pesticides		
4,4-DDD	0.51 J	0.23 A
4,4-DDE	13.0 J	2.20 E
alpha-BHC	3.1 J	0.69 C
Total PCBs	125 J	22.7 E
Camphechlor	8.2 J	0.23 C,A,B
Endosulfan I	1.3 J	0.09 C
Endosulfan II	0.77 J	0.09 C
gamma-Chlordane	0.77 J	0.02 A,C,D
Heptachlor	2.6 J	0.02 A,C
Heptachlor epoxide	0.77 J	0.02 A
Metals		
Arsenic	23.1 J	8.2 E
Cadmium	3.6 J	1.2 E
Chromium	91.4 J	81 E
Copper	257.0 J	34 E
Iron	26,800 J	2% E
Lead	189.0 J*	46.7 E
Mercury	1.8 J*	0.15 E,F
Nickel	61.2 J	20.9 E,F
Silver	3.1 J	1.0 E
Zinc	401.0 J	150 E

Location BACKGROUND 10/15/2003

Parameter	Conc.	SCG
Metals		
Antimony	2.9 J	2 E
Lead	271.0 J	46.7 E,F
Nickel	174.0 J	20.9 E,F

Location SD-12 10/10/2003

Parameter	Conc.	SCG
Semi-Volatiles		
Fluoranthene	850 J	600 E
Phenanthrene	520 J	260 E
Pyrene	920 J	665 E
Metals		
Antimony	2.8 J	2 E
Arsenic	15.1 J	8.2 E
Copper	94.5 J	34 E
Iron	20,500 J	2% E
Lead	105.0 J	46.7 E
Mercury	0.4 J	0.15 E
Nickel	88.4 J	20.9 E,F
Silver	1.1 J	1.0 E
Zinc	198.0 J	150 E

Location SD-1 10/8/2003

Parameter	Conc.	SCG
Metals		
Antimony	2.1 J	2 E
Arsenic	11	8.2 E
Cadmium	3.2	1.2 E
Chromium	83.3	81 E
Copper	148.0	34 E
Lead	109.0	46.7 E
Mercury	2.3	0.15 E,F
Nickel	36.6	20.9 E
Silver	2.1	1.0 E
Zinc	277.0	150 E

Location SD-2 10/8/2003

Parameter	Conc.	SCG
Pesticides		
4,4-DDD	3.7 J	0.16 A
Metals		
Lead	127.0	46.7 E
Mercury	0.16	0.15 E

Location SD-3 10/8/2003

Parameter	Conc.	SCG
Metals		
Antimony	4.5 J	2 E
Arsenic	50.0	8.2 E
Cadmium	5.3	1.2 E
Chromium	106.0	81 E
Copper	246.0	34 E
Iron	22,600	2% E
Lead	149.0	46.7 E
Mercury	4.7	0.15 E,F
Nickel	40.4	20.9 E
Silver	2.4	1.0 E
Zinc	357.0	150 E

Location SD-6 10/9/2003

Parameter	Conc.	SCG
Metals		
Copper	41.7 J	34 E
Mercury	0.4	0.15 E

Location SD-5 10/9/2003

Parameter	Conc.	SCG
Metals		
Antimony	3.3 J	2 E
Arsenic	31.5	8.2 E
Cadmium	6.2	1.2 E
Chromium	127.0	81 E
Copper	377.0	34 E,F
Iron	32,600	2% E
Lead	254.0	46.7 E,F
Mercury	2.1 J	0.15 E,F
Nickel	57.5	20.9 E,F
Silver	5.0	1.0 E,F
Zinc	596.0	150 E,F

Location SD-9 10/10/2003

Parameter	Conc.	SCG
Metals		
Arsenic	31.1 J	8.2 E
Cadmium	4.5 J	1.2 E
Chromium	87.1 J	81 E
Copper	258.0 J	34 E
Iron	29,000 J	2% E
Lead	180.0 J	46.7 E
Mercury	1.7 J	0.15 E,F
Nickel	97.1 J	20.9 E,F
Silver	2.6 J	1.0 E
Zinc	429.0 J	150 E,F

Location SD-10 10/10/2003

Parameter	Conc.	SCG
Pesticides/PCBs		
4,4-DDD	0.43 J	0.21 A
alpha-BHC	2.6 J	0.63 C
Total PCBs	74.9 J	22.7 E
Camphechlor	7.0 J	0.21 C,A,B
Endosulfan I	1.1 J	0.08 C
Endosulfan II	0.85 J	0.08 C
gamma-Chlordane	0.85 J	0.02 A,C,D
Heptachlor	2.2 J	0.02 A,C
Heptachlor epoxide	0.85 J	0.02 A
Metals		
Mercury	0.52 J*	0.15 E

Location SD-8 10/9/2003

Parameter	Conc.	SCG
Metals		
Antimony	5.3 J	2 E
Arsenic	60.3 J	8.2 E
Cadmium	9.3 J	1.2 E
Chromium	178.0 J	81 E
Copper	453.0 J	34 E,F
Iron	37,400 J	2% E
Lead	304.0 J	46.7 E,F
Mercury	7.9 J*	0.15 E,F
Nickel	93.4 J	20.9 E,F
Silver	5.8 J	1.0 E,F
Zinc	620.0 J	150 E,F

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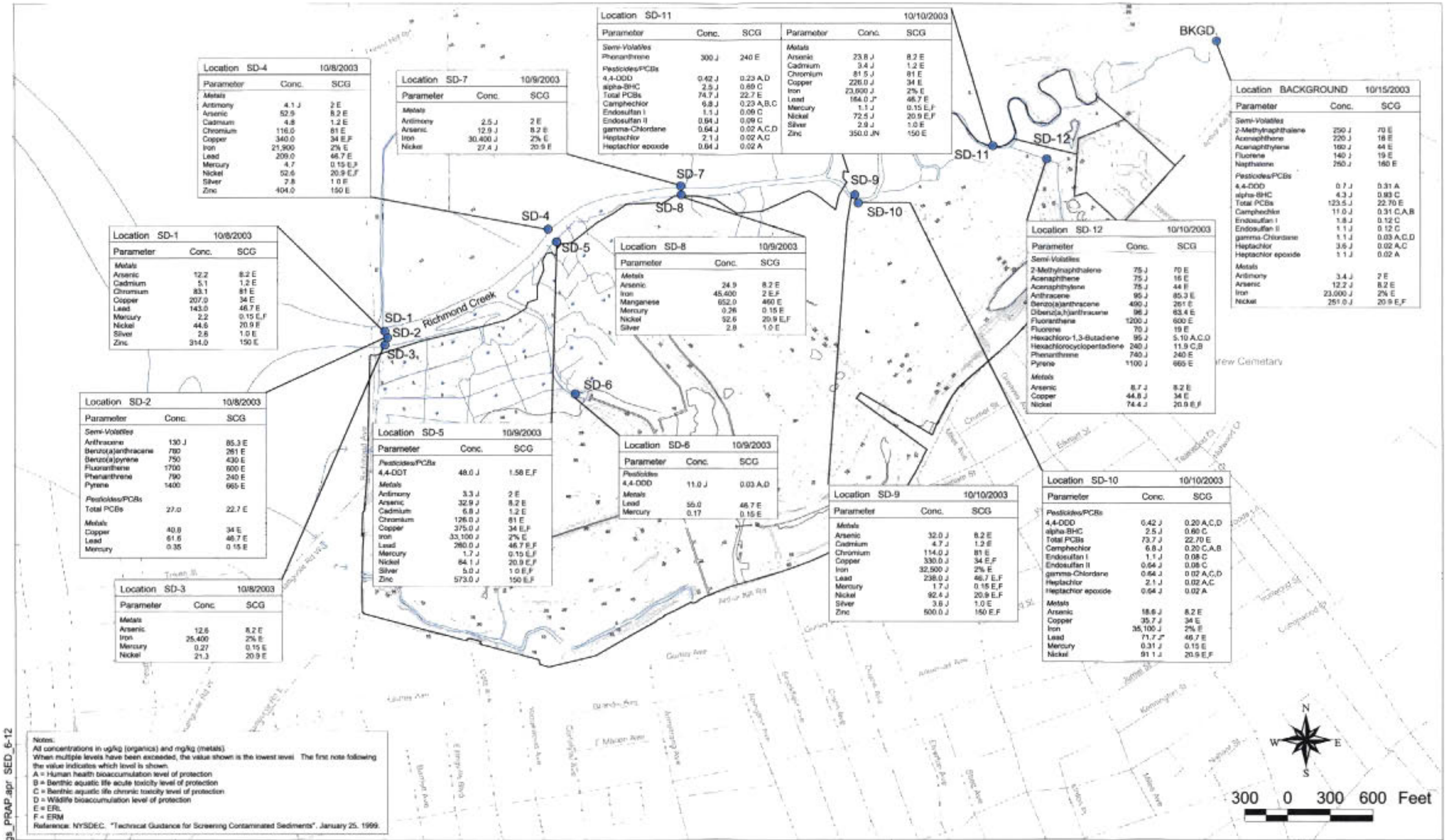
New York City Department of Environmental Protection
Brookfield Avenue Landfill Operable Unit 2

DEP

SCG Exceedances in Creek Sediment
0 to 6 Inch Depth Interval

Figure 7



Location SD-11 10/10/2003

Parameter	Conc.	SCG
Semi-Volatiles		
Phenanthrene	300 J	240 E
Pesticides/PCBs		
4,4-DDD	0.42 J	0.23 A,D
alpha-BHC	2.5 J	0.60 C
Total PCBs	74.7 J	22.7 E
Camphechlor	6.8 J	0.23 A,B,C
Endosulfan I	1.1 J	0.09 C
Endosulfan II	0.64 J	0.09 C
gamma-Chlordane	0.64 J	0.02 A,C,D
Heptachlor	2.1 J	0.02 A,C
Heptachlor epoxide	0.64 J	0.02 A
Metals		
Arsenic	23.8 J	8.2 E
Cadmium	3.4 J	1.2 E
Chromium	81.5 J	81 E
Copper	226.0 J	34 E
Iron	23,600 J	2% E
Lead	164.0 J*	46.7 E
Mercury	1.1 J	0.15 E,F
Nickel	72.5 J	20.9 E,F
Silver	2.9 J	1.0 E
Zinc	350.0 JN	150 E

Location SD-4 10/8/2003

Parameter	Conc.	SCG
Metals		
Antimony	4.1 J	2 E
Arsenic	52.9	8.2 E
Cadmium	4.8	1.2 E
Chromium	116.0	81 E
Copper	340.0	34 E,F
Iron	21,900	2% E
Lead	209.0	46.7 E
Mercury	4.7	0.15 E,F
Nickel	52.6	20.9 E,F
Silver	7.8	1.0 E
Zinc	404.0	150 E

Location SD-7 10/9/2003

Parameter	Conc.	SCG
Metals		
Antimony	2.5 J	2 E
Arsenic	12.9 J	8.2 E
Iron	30,400 J	2% E
Nickel	27.4 J	20.9 E

Location BACKGROUND 10/15/2003

Parameter	Conc.	SCG
Semi-Volatiles		
2-Methylnaphthalene	250 J	70 E
Acenaphthene	220 J	16 E
Acenaphthylene	160 J	44 E
Fluorene	140 J	19 E
Napthalene	250 J	160 E
Pesticides/PCBs		
4,4-DDD	0.7 J	0.31 A
alpha-BHC	4.3 J	0.93 C
Total PCBs	123.5 J	22.70 E
Camphechlor	11.0 J	0.31 C,A,B
Endosulfan I	1.8 J	0.12 C
Endosulfan II	1.1 J	0.12 C
gamma-Chlordane	1.1 J	0.03 A,C,D
Heptachlor	3.6 J	0.02 A,C
Heptachlor epoxide	1.1 J	0.02 A
Metals		
Antimony	3.4 J	2 E
Arsenic	12.2 J	8.2 E
Iron	23,000 J	2% E
Nickel	251.0 J	20.9 E,F

Location SD-1 10/8/2003

Parameter	Conc.	SCG
Metals		
Arsenic	12.2	8.2 E
Cadmium	5.1	1.2 E
Chromium	83.1	81 E
Copper	207.0	34 E
Lead	143.0	46.7 E
Mercury	2.2	0.15 E,F
Nickel	44.6	20.9 E
Silver	2.8	1.0 E
Zinc	314.0	150 E

Location SD-8 10/9/2003

Parameter	Conc.	SCG
Metals		
Arsenic	24.9	8.2 E
Iron	45,400	2 E,F
Manganese	652.0	460 E
Mercury	0.26	0.15 E
Nickel	92.6	20.9 E,F
Silver	2.8	1.0 E

Location SD-12 10/10/2003

Parameter	Conc.	SCG
Semi-Volatiles		
2-Methylnaphthalene	75 J	70 E
Acenaphthene	75 J	16 E
Acenaphthylene	75 J	44 E
Anthracene	95 J	85.3 E
Benzo(a)anthracene	490 J	261 E
Dibenz(a,h)anthracene	96 J	63.4 E
Fluoranthene	1200 J	600 E
Fluorene	70 J	19 E
Hexachloro-1,3-Butadiene	95 J	5.10 A,C,D
Hexachlorocyclopentadiene	240 J	11.9 C,B
Phenanthrene	740 J	240 E
Pyrene	1100 J	665 E
Metals		
Arsenic	8.7 J	8.2 E
Copper	44.8 J	34 E
Nickel	74.4 J	20.9 E,F

Location SD-2 10/8/2003

Parameter	Conc.	SCG
Semi-Volatiles		
Anthracene	130 J	85.3 E
Benzo(a)anthracene	780	261 E
Benzo(a)pyrene	750	430 E
Fluoranthene	1700	600 E
Phenanthrene	790	240 E
Pyrene	1400	665 E
Pesticides/PCBs		
Total PCBs	27.0	22.7 E
Metals		
Copper	40.8	34 E
Lead	61.6	46.7 E
Mercury	0.35	0.15 E

Location SD-5 10/9/2003

Parameter	Conc.	SCG
Pesticides/PCBs		
4,4-DDT	48.0 J	1.58 E,F
Metals		
Antimony	3.3 J	2 E
Arsenic	32.9 J	8.2 E
Cadmium	6.8 J	1.2 E
Chromium	126.0 J	81 E
Copper	375.0 J	34 E,F
Iron	33,100 J	2% E
Lead	260.0 J	46.7 E,F
Mercury	1.7 J	0.15 E,F
Nickel	84.1 J	20.9 E,F
Silver	5.0 J	1.0 E,F
Zinc	573.0 J	150 E,F

Location SD-6 10/9/2003

Parameter	Conc.	SCG
Pesticides		
4,4-DDD	11.0 J	0.03 A,D
Metals		
Lead	55.0	46.7 E
Mercury	0.17	0.15 E

Location SD-9 10/10/2003

Parameter	Conc.	SCG
Metals		
Arsenic	32.0 J	8.2 E
Cadmium	4.7 J	1.2 E
Chromium	114.0 J	81 E
Copper	330.0 J	34 E,F
Iron	32,500 J	2% E
Lead	238.0 J	46.7 E,F
Mercury	1.7 J	0.15 E,F
Nickel	92.4 J	20.9 E,F
Silver	3.6 J	1.0 E
Zinc	500.0 J	150 E,F

Location SD-10 10/10/2003

Parameter	Conc.	SCG
Pesticides/PCBs		
4,4-DDD	0.42 J	0.20 A,C,D
alpha-BHC	2.5 J	0.60 C
Total PCBs	73.7 J	22.70 E
Camphechlor	6.8 J	0.20 C,A,B
Endosulfan I	1.1 J	0.08 C
Endosulfan II	0.64 J	0.08 C
gamma-Chlordane	0.64 J	0.02 A,C,D
Heptachlor	2.1 J	0.02 A,C
Heptachlor epoxide	0.64 J	0.02 A
Metals		
Arsenic	18.6 J	8.2 E
Copper	35.7 J	34 E
Iron	35,100 J	2% E
Lead	71.7 J*	46.7 E
Mercury	0.31 J	0.15 E
Nickel	91.1 J	20.9 E,F

Location SD-3 10/8/2003

Parameter	Conc.	SCG
Metals		
Arsenic	12.6	8.2 E
Iron	25,400	2% E
Mercury	0.27	0.15 E
Nickel	21.3	20.9 E

Notes:
All concentrations in ug/kg (organics) and mg/kg (metals).
When multiple levels have been exceeded, the value shown is the lowest level. The first note following the value indicates which level is shown.
A = Human health bioaccumulation level of protection
B = Benthic aquatic life acute toxicity level of protection
C = Benthic aquatic life chronic toxicity level of protection
D = Wildlife bioaccumulation level of protection
E = ERL
F = ERM
Reference: NYSDEC. "Technical Guidance for Screening Contaminated Sediments". January 25, 1999.

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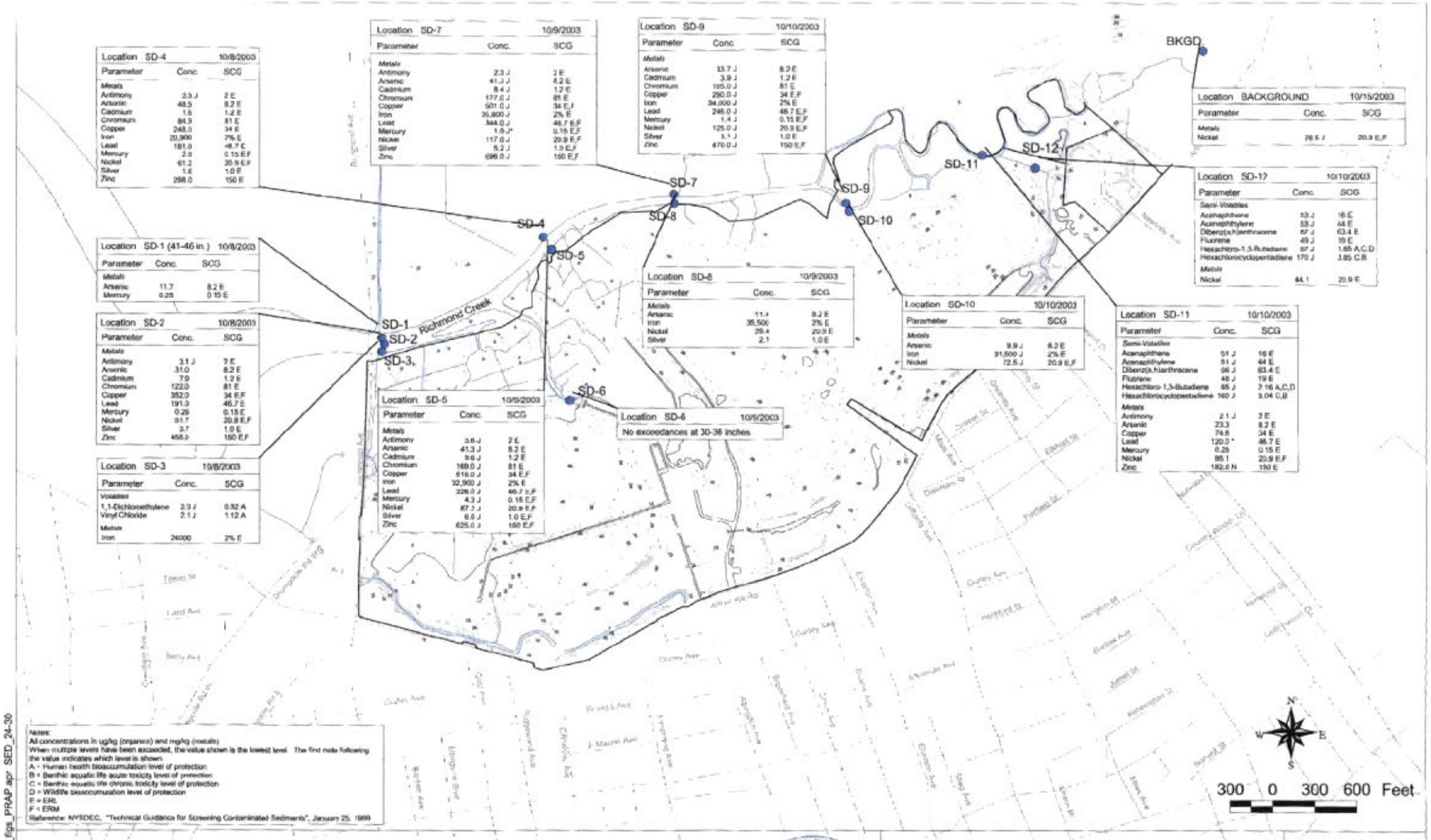
New York City Department of Environmental Protection
Brookfield Avenue Landfill Operable Unit 2

DEP

SCG Exceedances in Creek Sediment
6 to 12 Inch Depth Interval

Figure 8



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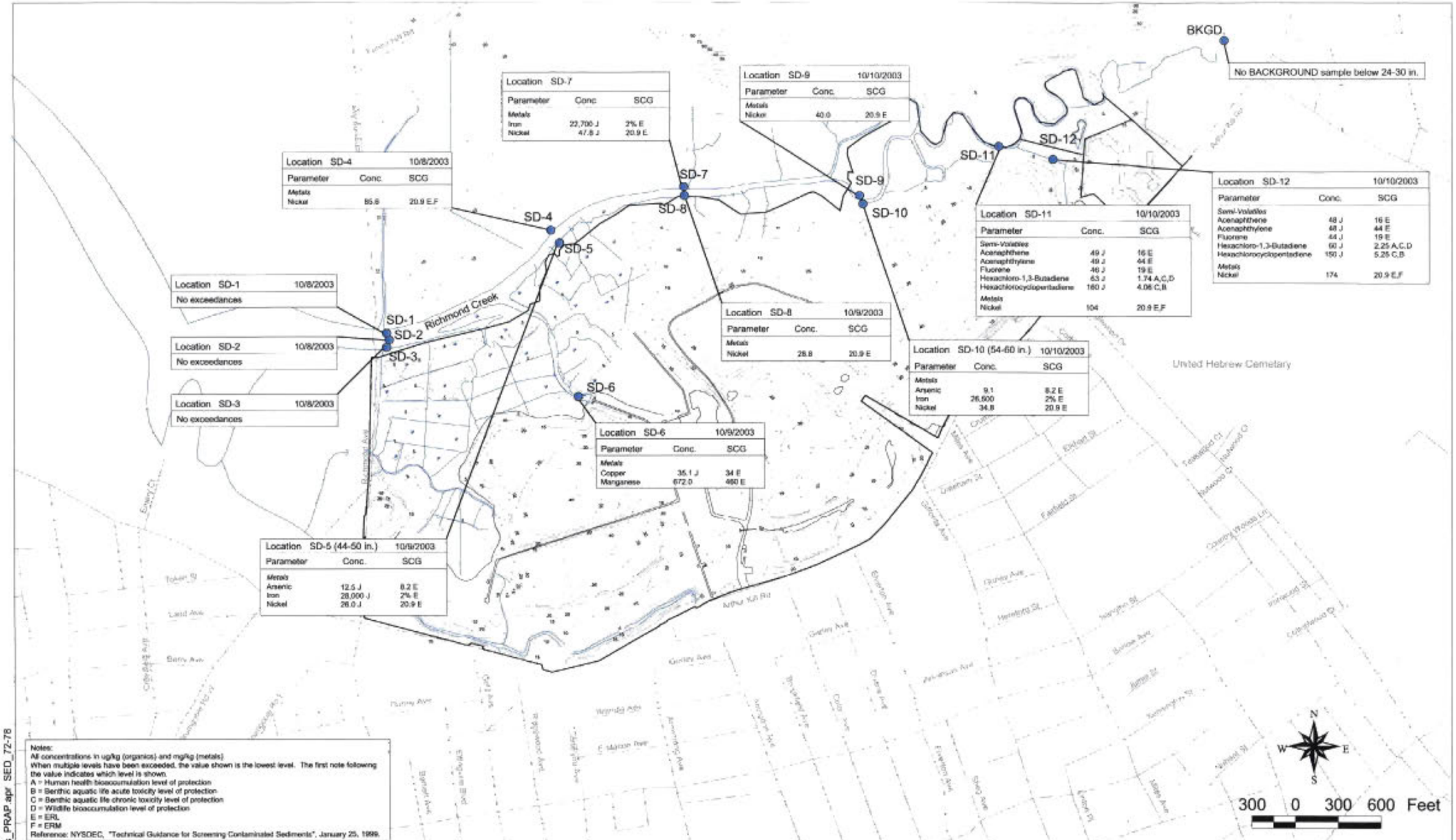
Brookfield Avenue Landfill Operable Unit 2

DEP

SCG Exceedances in Creek Sediment
24 to 30 Inch Depth Interval

Figure 9



Notes:
All concentrations in ug/kg (organics) and mg/kg (metals).
When multiple levels have been exceeded, the value shown is the lowest level. The first note following the value indicates which level is shown.
A = Human health bioaccumulation level of protection
B = Benthic aquatic life acute toxicity level of protection
C = Benthic aquatic life chronic toxicity level of protection
D = Wildlife bioaccumulation level of protection
E = ERL
F = ERM
Reference: NYSDEC, "Technical Guidance for Screening Contaminated Sediments", January 25, 1999.

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Brookfield Avenue Landfill Operable Unit 2

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SCG Exceedances in Creek Sediment
72 to 78 Inch Depth Interval

Figure 10

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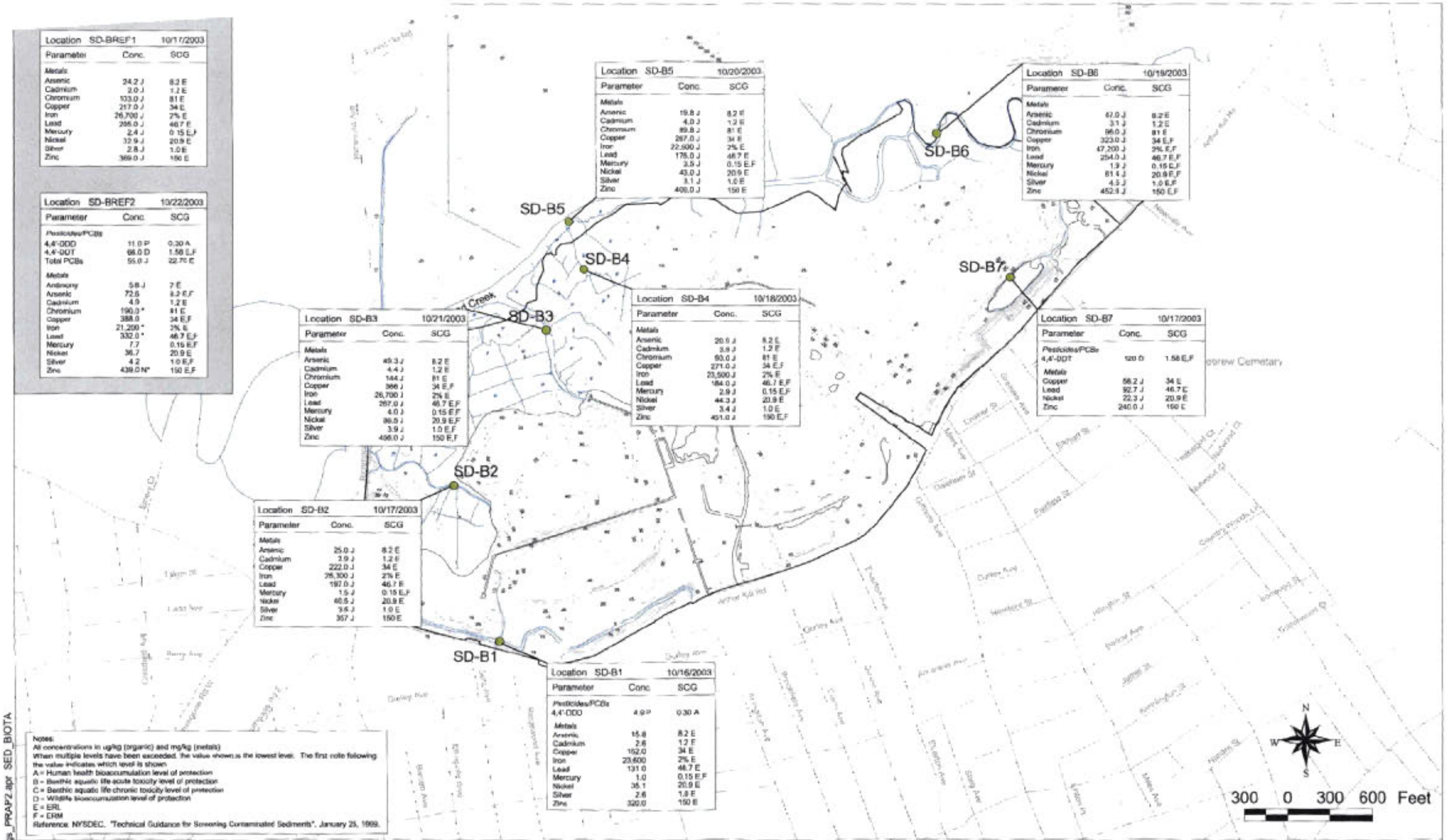

Location SD-BREF1		10/17/2003
Parameter	Conc.	SCG
Metals		
Arsenic	24.2 J	8.2 E
Cadmium	2.0 J	1.2 E
Chromium	103.0 J	81 E
Copper	217.0 J	34 E
Iron	26,700 J	2% E
Lead	285.0 J	46.7 E
Mercury	2.4 J	0.15 E,F
Nickel	32.9 J	20.9 E
Silver	2.8 J	1.0 E
Zinc	389.0 J	150 E

Location SD-BREF2		10/22/2003
Parameter	Conc.	SCG
Pesticides/PCBs		
4,4'-DDD	11.0 P	0.30 A
4,4'-DDT	66.0 D	1.58 E,F
Total PCBs	55.0 J	22.70 E
Metals		
Antimony	5.8 J	2 E
Arsenic	72.6	8.2 E,F
Cadmium	4.9	1.2 E
Chromium	190.0 *	81 E
Copper	388.0	34 E,F
Iron	21,200 *	2% E
Lead	332.0 *	46.7 E,F
Mercury	7.7	0.15 E,F
Nickel	36.7	20.9 E
Silver	4.2	1.0 E,F
Zinc	439.0 N*	150 E,F

Location SD-B5		10/20/2003
Parameter	Conc.	SCG
Metals		
Arsenic	19.8 J	8.2 E
Cadmium	4.0 J	1.2 E
Chromium	89.8 J	81 E
Copper	267.0 J	34 E
Iron	22,900 J	2% E
Lead	175.0 J	46.7 E
Mercury	3.5 J	0.15 E,F
Nickel	43.0 J	20.9 E
Silver	3.1 J	1.0 E
Zinc	400.0 J	150 E

Location SD-B6		10/19/2003
Parameter	Conc.	SCG
Metals		
Arsenic	47.0 J	8.2 E
Cadmium	3.1 J	1.2 E
Chromium	96.0 J	81 E
Copper	323.0 J	34 E,F
Iron	47,200 J	2% E,F
Lead	254.0 J	46.7 E,F
Mercury	1.9 J	0.15 E,F
Nickel	61.4 J	20.9 E,F
Silver	4.5 J	1.0 E,F
Zinc	452.9 J	150 E,F

Location SD-B3		10/21/2003
Parameter	Conc.	SCG
Metals		
Arsenic	49.3 J	8.2 E
Cadmium	4.4 J	1.2 E
Chromium	144 J	81 E
Copper	366 J	34 E,F
Iron	26,700 J	2% E
Lead	267.0 J	46.7 E,F
Mercury	4.0 J	0.15 E,F
Nickel	86.5 J	20.9 E,F
Silver	3.9 J	1.0 E,F
Zinc	496.0 J	150 E,F

Location SD-B4		10/18/2003
Parameter	Conc.	SCG
Metals		
Arsenic	20.0 J	8.2 E
Cadmium	3.9 J	1.2 E
Chromium	93.0 J	81 E
Copper	271.0 J	34 E,F
Iron	23,500 J	2% E
Lead	184.0 J	46.7 E,F
Mercury	2.9 J	0.15 E,F
Nickel	44.3 J	20.9 E
Silver	3.4 J	1.0 E
Zinc	451.0 J	150 E,F

Location SD-B7		10/17/2003
Parameter	Conc.	SCG
Pesticides/PCBs		
4,4'-DDT	120 D	1.58 E,F
Metals		
Copper	58.2 J	34 E
Lead	92.7 J	46.7 E
Nickel	22.3 J	20.9 E
Zinc	240.0 J	150 E

Location SD-B2		10/17/2003
Parameter	Conc.	SCG
Metals		
Arsenic	25.0 J	8.2 E
Cadmium	2.9 J	1.2 E
Copper	222.0 J	34 E
Iron	28,300 J	2% E
Lead	197.0 J	46.7 E
Mercury	1.5 J	0.15 E,F
Nickel	46.5 J	20.9 E
Silver	3.6 J	1.0 E
Zinc	357 J	150 E

Location SD-B1		10/16/2003
Parameter	Conc.	SCG
Pesticides/PCBs		
4,4'-DDD	4.9 P	0.30 A
Metals		
Arsenic	15.8	8.2 E
Cadmium	2.6	1.2 E
Copper	152.0	34 E
Iron	23,600	2% E
Lead	131.0	46.7 E
Mercury	1.0	0.15 E,F
Nickel	35.1	20.9 E
Silver	2.6	1.0 E
Zinc	320.0	150 E

Notes:
All concentrations in ug/kg (organic) and mg/kg (metals)
When multiple levels have been exceeded, the value shown is the lowest level. The first note following the value indicates which level is shown
A = Human health bioaccumulation level of protection
B = Benthic aquatic life acute toxicity level of protection
C = Benthic aquatic life chronic toxicity level of protection
D = Wildlife bioaccumulation level of protection
E = ERL
F = ERM
Reference: NYSDEC, "Technical Guidance for Screening Contaminated Sediments", January 25, 1999.

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Brookfield Avenue Landfill Operable Unit 2

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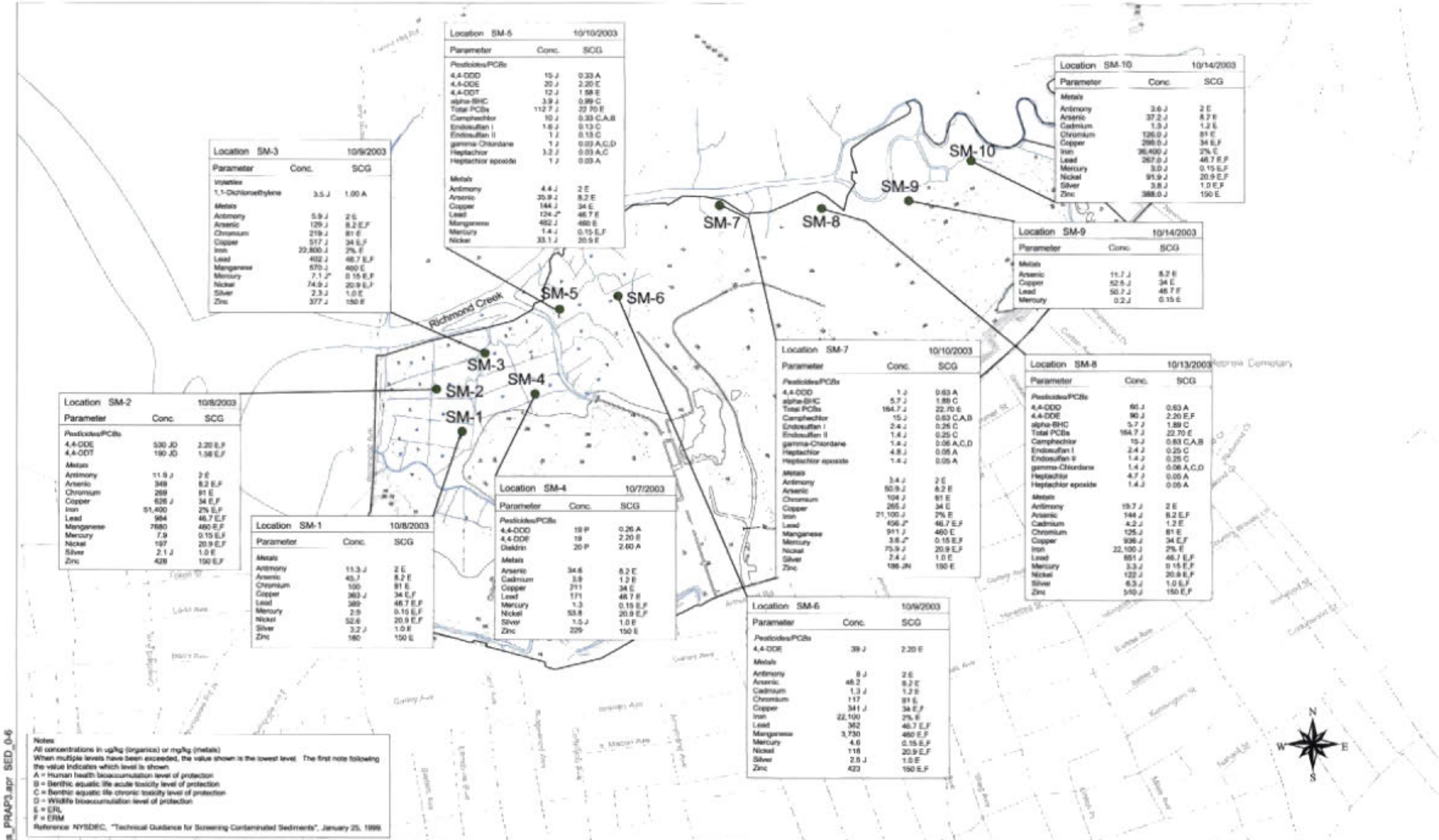
SCG Exceedances in Creek Sediment
at Biota Sampling Locations
0 to 6 Inch Depth Interval

Figure 11



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Brookfield Avenue Landfill Operable Unit 2

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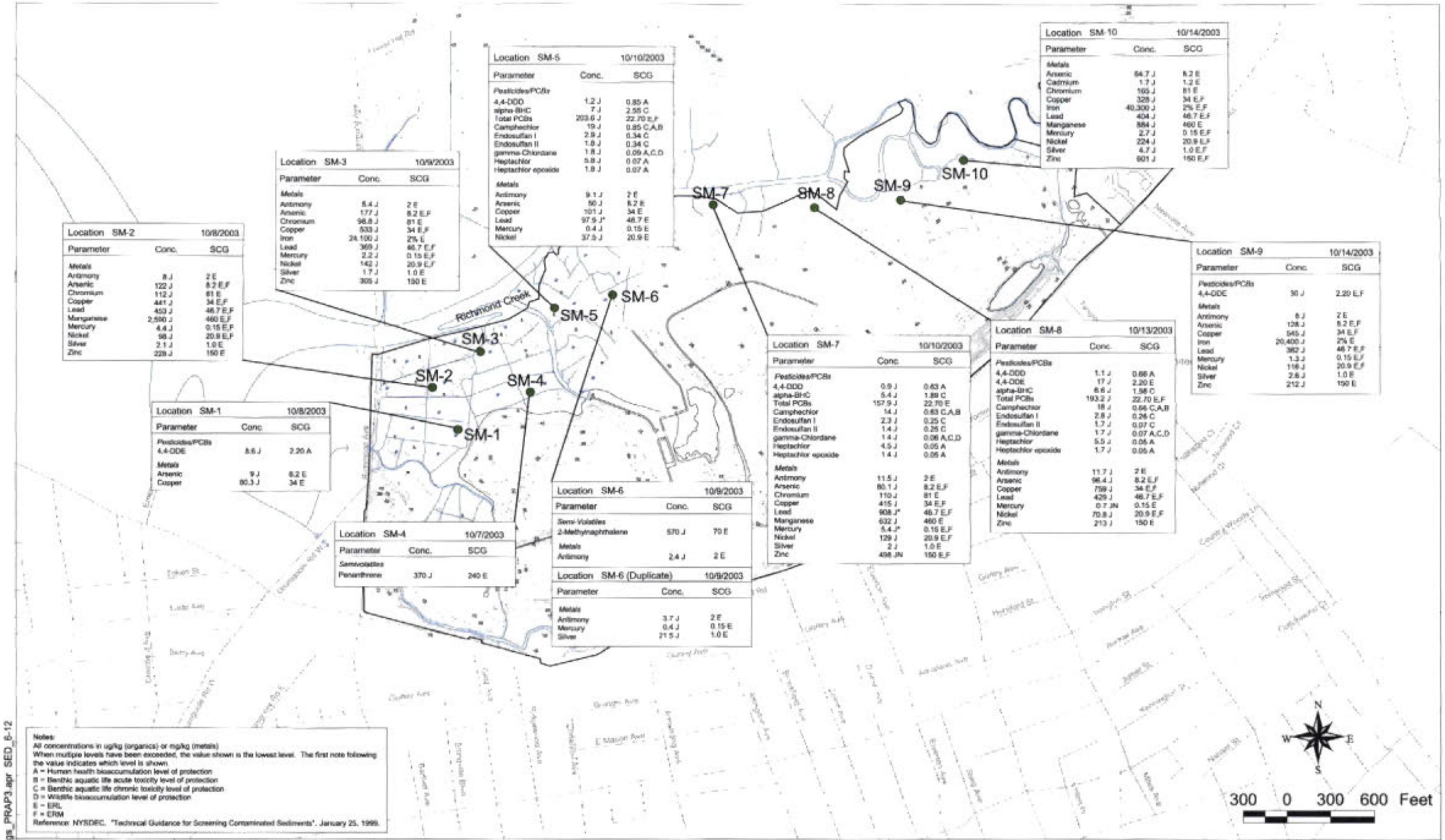
SCG Exceedances in Marsh Sediment
0 to 6 Inch Depth Interval

Figure 12



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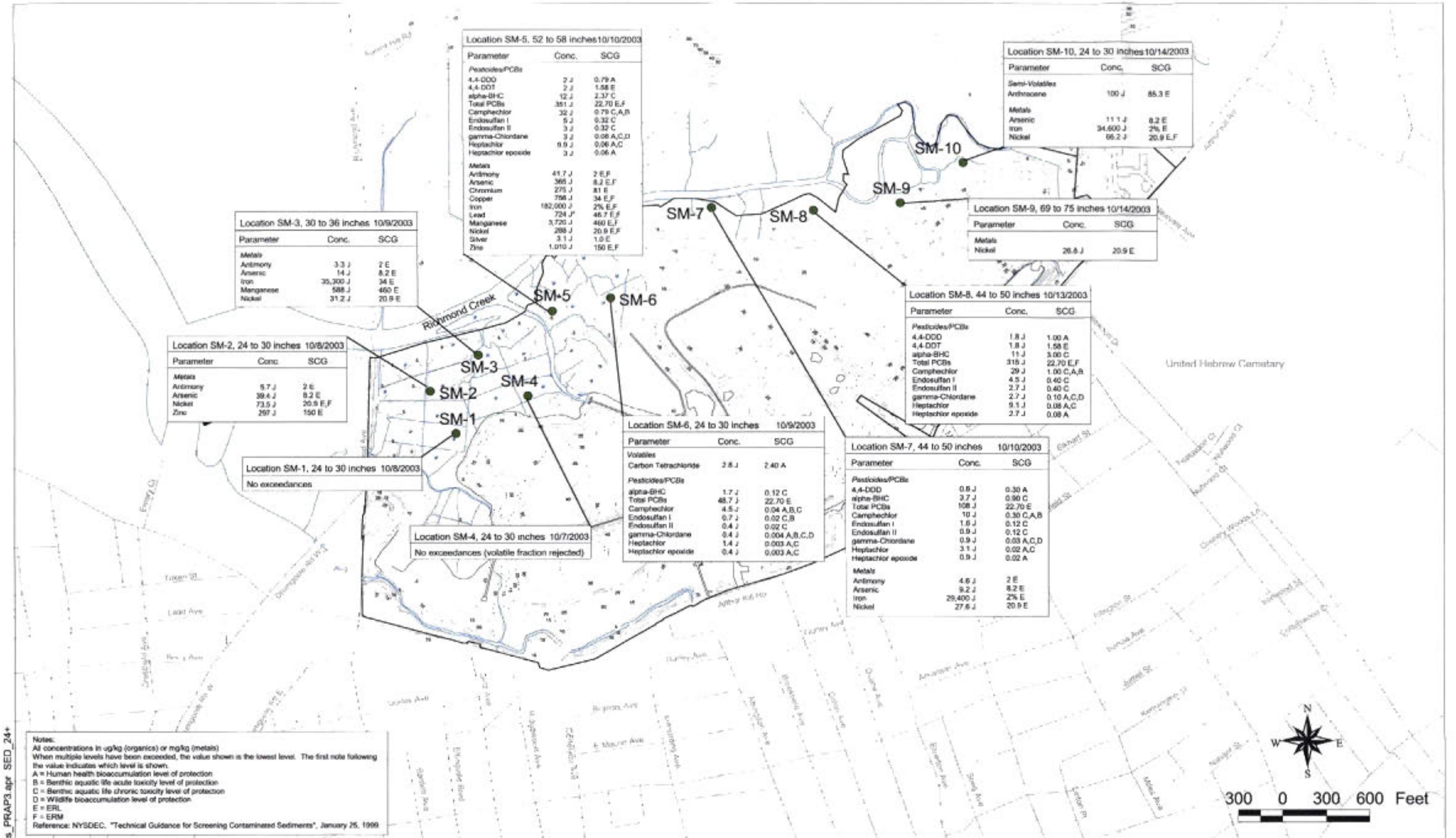
SCG Exceedances in Marsh Sediment
6 to 12 Inch Depth Interval

Figure 13



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Brookfield Avenue Landfill Operable Unit 2

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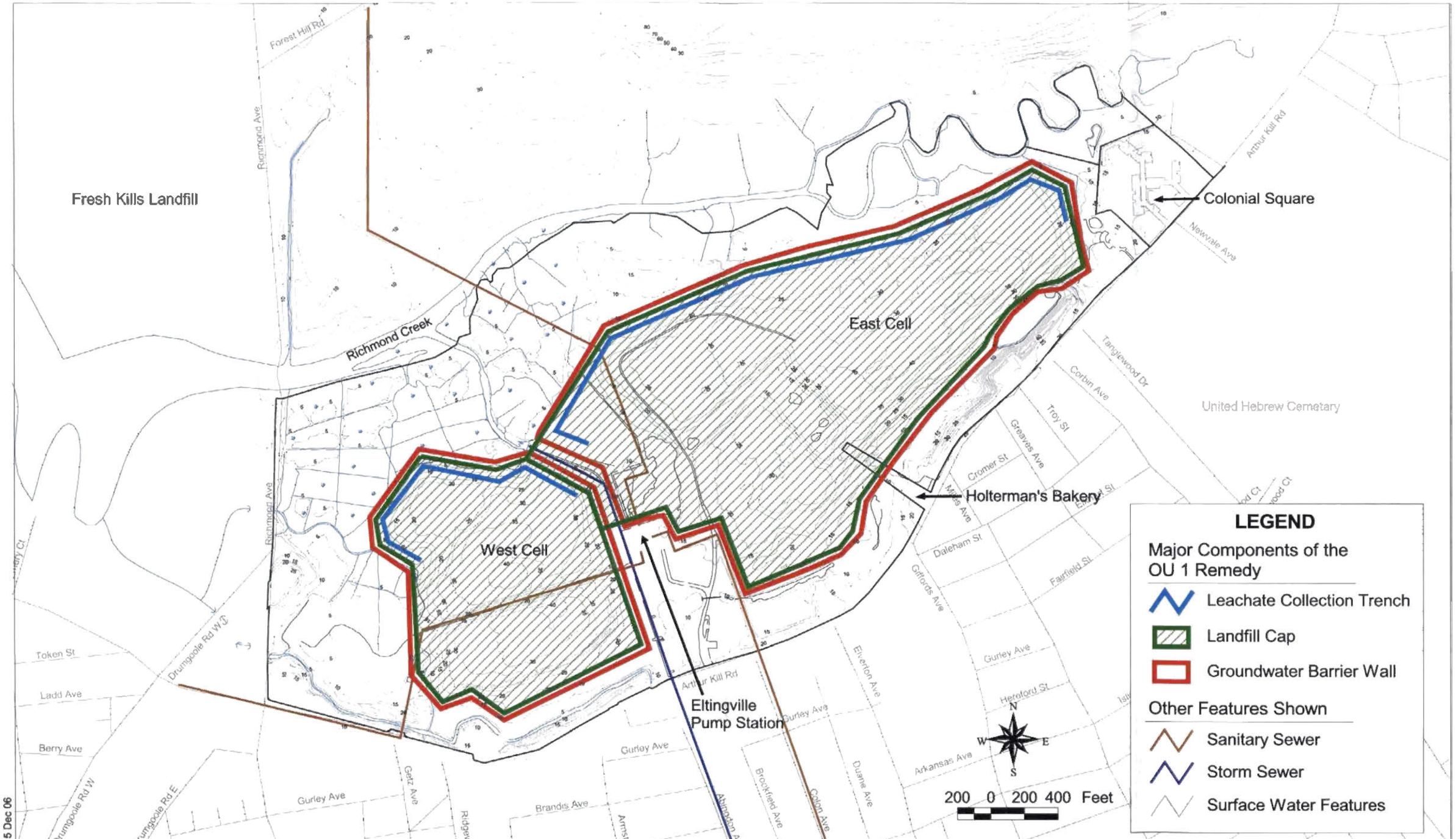
SCG Exceedances in Marsh Sediment
24 to 75 Inch Depth Intervals

Figure 14



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New York City Department of Environmental Protection
Brookfield Avenue Landfill Operable Unit 2

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Closure Plan for the Brookfield Avenue Landfill Operable Unit 1

Figure 15

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NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BROOKFIELD AVENUE LANDFILL REMEDIATION

END USE PLAN

William F. Cosulich Associates, P.C.
Environmental Engineers and Scientists

Figure 16