Exponent®

Former Williamsburg Works MGP Site, Brooklyn, New York

Analysis of Available Data to Track Sources of Contamination

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Prepared for:

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Acronyms and Abbreviations

UCM	Unresolved complex mixture
NAPL	nonaqueous-phase liquid
MGP	manufactured gas plant
SCO	soil cleanup objective
MTBE	methyl tert butyl ether
PCBs	polychlorinated biphenyls
CC	coal carbonization
CWG	carbureted water gas
EPA	U.S. Environmental Protection Agency
PAHs	polycyclic aromatic hydrocarbons

1 Introduction

On behalf of National Grid, Exponent conducted an analysis of the chemistry data obtained from soil, sediment, and non-aqueous-phase liquid (NAPL) samples collected from the former Williamsburg Works Manufactured Gas Plant (MGP) site (Parcels 1–4), surrounding parcels (Parcels 5 and 6), Bushwick Inlet, and the East River (see Figure 1.1 for locations). The purpose of this analysis was to provide an understanding of the distribution, concentrations, and potential sources of the contamination in the sampled areas. This purpose was prompted by the presence of chemicals in the sampled areas not known to be associated with typical MGP operations, such as solvents, PCBs, pesticides, elevated metals, and a mix of petroleum products.

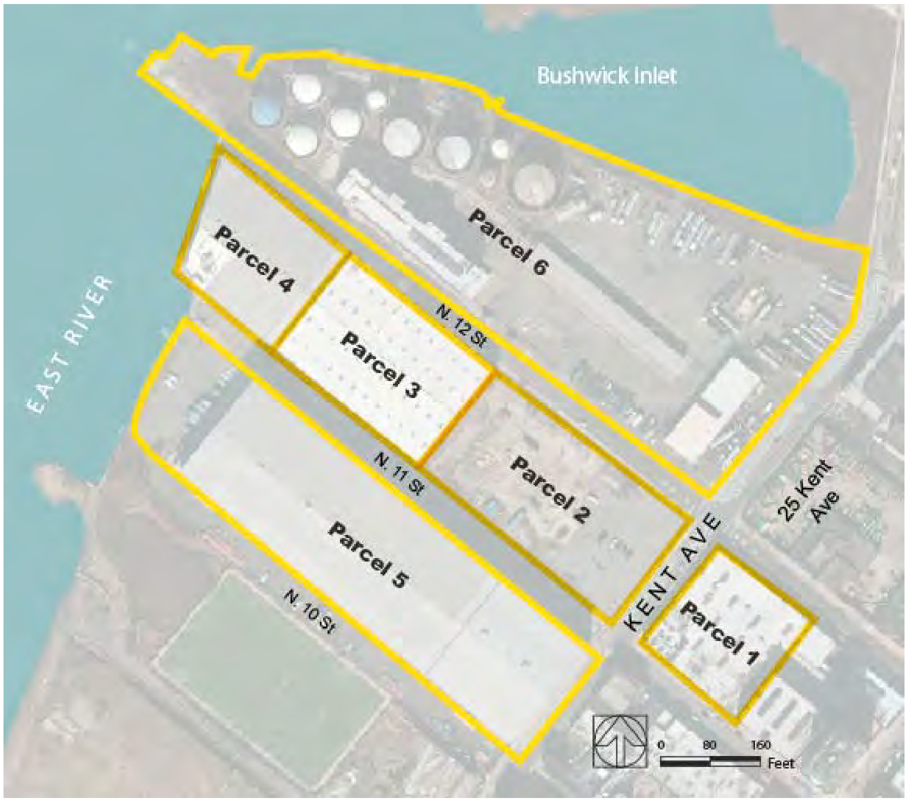

Figure 1.1 Parcel locations map

Several sources may have contributed to the non-MGP contamination. These include the various industrial operations that occupied Parcels 1–4 after the cessation of MGP operations, and the Pratt Works/Standard Oil refining operations that occupied Parcels 5 and 6.

The analysis presented in this report is based on data generated as part of the Remedial Investigation (RI; GEI 2015), and data obtained from the Metcalf and Eddy reports (2006a–d, 2007). While the analysis aimed to track sources of contamination to the extent possible, the data interpretation was limited by the absence of samples from Parcels 3, 4, and 5 (parcels covered by buildings), and from the 25 Kent Avenue property—previously part of the operations on Parcel 6—and by the lack of fingerprinting-quality data for the majority of the soil/sediment samples collected.

2 Summary of Findings

Products associated with the former gas works (Parcels 1–4) included coal tar and petroleum (e.g., gas oil) used as a feedstock in the carbureted water gas process. After the MGP operations ceased, several other operations occupied the site parcels, including sheet metal manufacturing, scrap metal shops, and tanks and oil/water separators, among other operations. The former gas works was sandwiched between the Pratt works/Standard Oil refinery operations, located on Parcel 5 and 6. Sanborn maps showed that Parcel 6 contained tar tanks and coal piles/bins, in addition to petroleum tanks and a tin can factory, among other activities. Historical fires and accidents that occurred on Parcel 6, across the street from the former MGP, resulted in burning of the tar and oil tanks. In one instance, the entire refinery operation was destroyed. Parcel 5, apparently connected to Parcel 6 by pipelines that ran across the former MGP, contained refined-oil storage tanks, railroads, and a chemical storage area. The overlapping of these industrial activities suggests commingling of contamination.

For Parcel 6, tar was found at several locations along the southern boundary, with tar observed near the footprint of a former tar tank, and shallow tar (3-5 ft deep) observed at the southwest corner. The source of the tar at this shallow depth does not suggest subsurface migration from the former MGP, or disposal from the MGP on and near an active refinery property at that time. Because tar tanks were present on Parcel 6 at some point in time, with several documented accidents, one has to consider Parcel 6 as a source of the tar. Further investigation would be needed to define the source of these impacts.

Within the former MGP Parcels 1 and 2, gas chromatograms showed the presence of various petroleum products (e.g., distilled petroleum products in the mid- to heavy boiling-point ranges). In addition, methyl tert butyl ether (MTBE) was detected in Parcel 2 groundwater. Fingerprinting analysis conducted on two shallow soil samples from Parcel 2 showed the presence of various petroleum products. These findings are consistent with industrial operations that included storage of petroleum products after the MGP ceased operations.

Several non-MGP compounds were found in soil samples across all sampled areas. Elevated Polychlorinated biphenyls (PCBs, up to 1.8 mg/kg) were found in surface and shallow soils (down to 7.5 ft bgs). Sheet metal manufacturing, the corrugated containers and scrap metal operations, among other activities that occupied the former MGP parcels are potential PCB sources. Pesticides (e.g., DDT, DDD, DDE, Endrin) were also detected at elevated concentrations compared to the unrestricted-use soil cleanup objective (SCO) at sampling locations in and around the former MGP site.

Many solvents (e.g., PCE, and TCE) were found in soils across all sampled areas, at depths ranging from 0.5 ft to 64.5 ft bgs. Historical operations that may have been associated with these solvents include metal manufacturing, repair shops, and the tin can manufacturing that occurred in Parcels 2, 3, and 6.

The East River sediment, in the area bordering Parcels 4, 5, and 6, was impacted by a mixture of sources including coal carbonization (CC) and carbureted water gas (CWG) tars, and free phase petroleum. Elevated PAHs (greater than 1,000 mg/kg), PCBs (up to 5.2 mg/kg), pesticides (e.g., DDT up to 3.8 mg/kg), and metals were all found in the East River sediment. Further investigations and fingerprinting data would be needed to track these contaminants back to their sources.

NAPL recovery wells were installed inside and along the boundaries of Parcel 2. In 2014, several NAPL samples were collected from these wells. In addition, a NAPL and solid sample were collected from a Verizon manhole located at the intersection of N. 12th Street and Kent Avenue. The NAPL in the Verizon manhole was a mix of diesel- and heavy fuel like products, inconsistent with products from the former MGP operations. PAHs in the NAPL from the remainder of the recovery well samples were predominantly from a pyrogenic source.

3 Products Associated with Industrial Operations at Parcels 1–6

To track sources of contamination at the former MGP parcels and surrounding areas, one needs to know the products associated with the different industrial operations in the area, and any documented releases from those operations. While the chemicals associated with some of the industrial operations are known (e.g., tars from MGPs), other operations are not fully defined (e.g., Pratt Works operations). This section describes the products that are expected to be associated with the industrial operations in the different parcels based on available historical information.

3.1 Parcels 1–4: Former Williamsburg Gas Works Site

The ownership and historical operations for Parcels 1 to 4 are described in detail in the Remedial Investigation Report (GEI 2015), and is presented in Figure 3.1. In summary, the former gas works produced coal carbonization (CC) and carbureted water gas (CWG). In addition, petroleum products such as gas oil (and probably naphtha) were used as feedstocks in the CWG process. After 1941 (after the MGP operations had ceased), several operations occupied the site, including garages with gasoline tanks, underground storage tanks with oil/water separators, sheet-metal product manufacturing, railroads, parking lots, repair shops, and scrap metal storage, among others (see Figure 3.1). At present, Parcels 3 and 4 are occupied by buildings and therefore were not part of the environmental investigations.

One would expect to find several contaminants from these operations, including solvents (e.g., metal manufacturing), petroleum products and gasoline additives (e.g., from underground storage tanks, garages, and other operations that use fuel), waste oils (e.g., oil separators, garages), PCBs (e.g., sheet metal manufacturing, the corrugated containers and scrap metal operations), metals (e.g., railroads), and other contaminants. As discussed below, several non-MGP contaminants were indeed found at the former MGP parcels, including petroleum products inconsistent with those used in the CWG process, MTBE (gasoline additive), solvents (e.g., chlorinated solvents, ketones), PCBs, pesticides, and metals, in addition to tar.

3.2 Parcel 5

The former Gas works site was sandwiched between Parcels 5 and 6, both of which hosted the Pratt works/Standard Oil operations. Parcels 5 and 6 were apparently connected via a pipeline that ran across Parcel 4. Parcels 5 and 6 also had several piers located on the East River (see Figure 3.2.1).

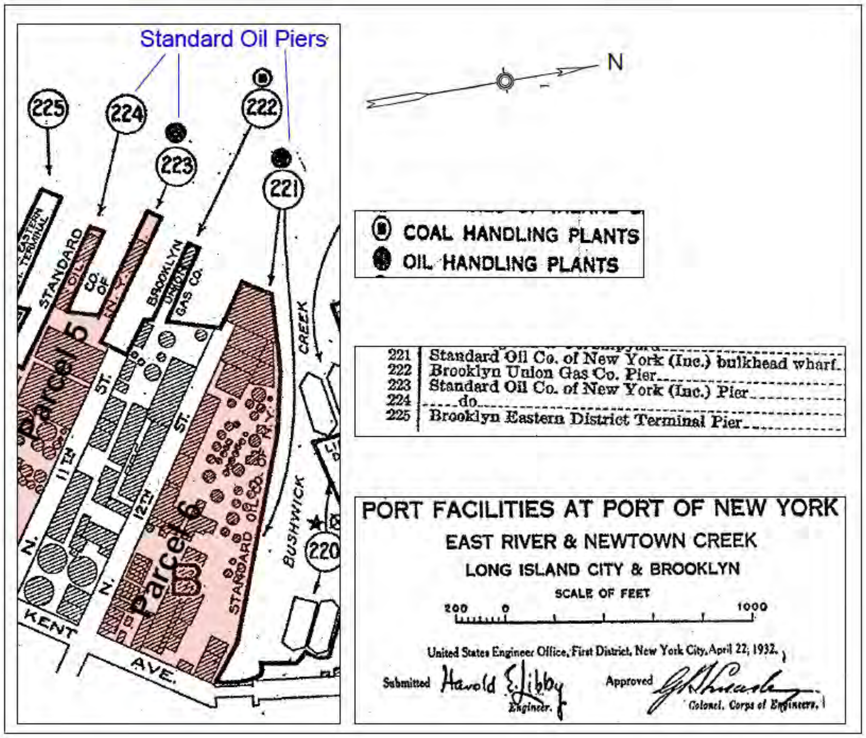

Figure 3.2.1 Standard Oil pier locations (from Port Facilities at Port of New York map, U.S. Engineer's Office, New York [April 22, 1932]).

Figure 3.2.2 presents a summary of the historical operations on Parcel 5. This parcel was operated by Pratt Works and Standard Oil Company (1905 and 1916 Sanborn maps), and was occupied by refined oil storage tanks, barrel storage and shipping, and barrel printing and storage. In 1941, the property was occupied by Brooklyn Eastern District Terminal and contained railroad spurs, flour storage, chemical storage, and a garage. By 1982, additional railroads and buildings were added to the site. Currently, Parcel 5 is completely covered by buildings, which confined environmental investigations to the streets surrounding the parcel.

3.3 Parcel 6: Former Pratt Works Site

In 1867, this parcel was occupied by the Pratt's Astral Oil Works refinery to produce kerosene (GEI 2015). Around 1875, Forbes (1959) described that the feedstock oil was brought "in large barges… [W]hen it arrives at the docks…, it is pumped through pipes into the receiving tanks." This oil was then distilled. "The distillation is commenced at 120 F which carries off all the products capable of evaporation at that temperature; the temperature is then steadily raised till it finally reaches about 1,000 F which drives over all except the solid residue" (Forbes 1959). The residue left in the still is called petroleum residuum which is rich in PAHs.

The 1887 Sanborn map shows that tar tanks and coal bins/trestles were present on Parcel 6 (see Figure 3.3). The purpose of storing tar on the Pratt Oil Works is unclear. During that period, coal was distilled to make "kerosene oil" (Gesner 1865). Gesner (1865) stated, "The introduction into common use in America of oils distilled from coal, bitumen, and incidentally petroleum was accomplished by the North American Gas Light Company of New York, in the early part of 1854. This Company… first sold the oil produced by the patentee at the Company's works on Newtown Creek… under the name of Kerosene." This coal distillation process was very similar to the MGP coal carbonization process, and the tar produced from both processes would be chemically similar.[1]

Historically, the alternating use of coal and crude petroleum as feedstock for distillation, to make kerosene, was dependent on the price of oil. Gesner (1865) described, "From a

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[1] Scientific American (New York, February 14, 1874) described the distillation of coal to make hydrocarbon products: "The oil obtained from the decomposition of the coals, having assumed the form of vapor, is collected in a large main having connections with the retorts. Through this main the vapor is conveyed to the condensers, which, as a rule, are similar to those used in gas works."

calculation made in 1861, it was shown that whenever crude petroleum reached an average price of thirty-five cents per gallon in the American markets, the coal oil distiller could afford to resume business." It is not clear whether Parcel 6 historical operations included coal distillation to produce kerosene, or whether tar was brought to the site to be used as fuel to heat boilers. At any rate, the information available shows that Parcel 6 contained tar tanks.

Besides spills and leaks that likely occurred as part of the Pratt Works operations, several accidents were described in newspaper articles in the 1800s and early 1900s (see Figure 3.3). Examples include:

- *New York Times* (November 29, 1871): "Fire in Williamsburg… A fire broke out yesterday morning… but the damage was confined to one of the oil tanks."
- *New York Times* (January 27, 1873): "GREAT OIL FIRE — Total Destruction of Pratt's Astral Oil Works… The light wood-work covering the still was rapidly consumed by fierce flames as they shot upward, sending up great showers of sparks, which drifted amid the falling snow-flakes toward the Williamsburg Gas-Works… although all the oil, amounting to between 5,000 and 6,000 barrels, that was in the works was all destroyed."
- *Watkins Express* (1884): "Pratt's Astral Oil Works at Williamsburg, L.I. burned on Sunday afternoon and Monday morning last, at a loss of about $100,000. At one time five great tanks were filled with blazing oil, and eight tanks of crude oil, four tanks of naphtha and one of tar were burned during the progress of the fire."
- *New York Times* (March 22, 1891): "An Oil Still Explodes… An oil still in the yard of the Pratt Oil Works, on Kent Avenue, near Bushwick Creek, Williamsburg, exploded… It is customary to steam out the stills after letting off the oil in them in order to expel all explosive gas inside... The cause of the explosion was the ignition of the gases which had collected in the upper portion of the still where there is a circular drum."
- *New York Times* (November 19, 1895): "Disaster at Pratt's Astral Works – Originated in Distilling Tank and Destroyed Engine Building – Damage $15,000… Two men were killed last night by the explosion of a distilling tank in Pratt's astral oil works, at the foot of North Twelfth Street, Williamsburg."

- *New York Times* (October 13, 1909): "Oil Fire Rode in on the Tide… Bushwick Creek, in the neighborhood of Wythe Avenue and North Thirteenth Street, Williamsburg, was on fire for a while yesterday from burning oil, and the blaze was communicated to spars chained together in the water… Drainage from the Standard Oil Company works at the mouth of the creek was carried up the stream"

In summary, one would expect contaminants from Parcel 6 to include tar, petroleum products, and petroleum residuum.

4 Background on PAH Sources Using Forensic Data

In environmental investigations, polycyclic aromatic hydrocarbon (PAH) data are commonly limited to the U.S. Environmental Protection Agency (EPA) 16 PAH Priority Pollutant analytes.[2] Typically, the regulatory focus on site characterization has driven the use of this priority pollutant list to screen for PAH concentrations, identify hot spots, delineate contamination, and in general, to apply the resultant PAH data to the cleanup of contaminated sites. However, this regulatory-driven PAH list was not designed nor intended to be applied to detailed PAH source characterization via chemical fingerprinting methods.

The scientific community has expanded the EPA analytical list to include a longer, more comprehensive or expanded list of PAH target analytes, because many non-Priority Pollutant PAH compounds that are present in environmental samples may be used for source determinations. The intention of this longer PAH list (typically including parent and alkylated PAH compounds; more than 40 PAH compounds) is to support chemical fingerprinting of PAH sources.[3]

PAHs originate from two major sources: pyrogenic (e.g., tar) and petrogenic (e.g., petroleum products and residuum). (Both sources are/were present at the sampled areas.) A discussion on the use of the expanded PAH target list to differentiate between the major PAH source types (petrogenic vs. pyrogenic), and the available data are presented below.

4.1 Petrogenic PAHs

In petrogenic PAHs, the relative abundance of the alkylated PAH compounds far exceeds the abundance of the parent (unsubstituted) compounds (e.g., Boehm 2006). The fact that

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[2] The EPA 16 Priority Pollutant List includes: naphthalene, acenaphthylene, acenaphthene, fluorene, anthracene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(j,k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene. benzo(g,h,i)perylene.

[3] The Federal Register has published the appropriate PAH target list for fingerprinting and provides the required analytical guidance as well (40CFR Subchapter J, Part 300, Appendix C, Sections 4-6-3 to 4-6-5; 7-1-99 edition).

concentrations of alkylated PAHs are significantly higher than those of parent PAHs is a main diagnostic feature of petrogenic PAHs. This is illustrated in Figure 4.1.

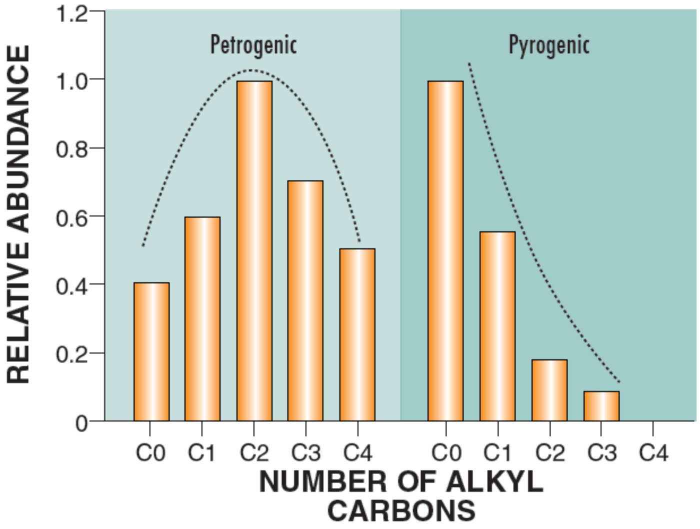

Figure 4.1 Representative distribution of alkylated PAHs formed at different temperatures within the phenanthrene series (C0 = parent phenanthrene; C1–C4 represent alkylated phenanthrenes).

4.2 Pyrogenic PAHs

Pyrogenic PAHs are formed under the high-temperature and oxygen-deficient conditions reached in the processing of coals into coal tars and coal tar products (e.g., CC tar, CWG tar, creosote). The major feature of pyrogenic PAHs is that the parent PAHs are significantly higher than those of alkylated PAHs. Figure 4.1 shows an example of pyrogenic PAH distribution. This profile comparison can be used to define the origin of the PAH compounds (i.e., petrogenic vs. pyrogenic).

4.3 Available PAH Data

In 2014, three soil samples from Parcel 2 and NAPL samples collected from seven recovery wells and one manhole in and around Parcel 2 were analyzed for the full PAH analyte list. This enabled distinguishing sources of contamination in these samples. However, the remainder of the available PAH data for soil and sediment samples were limited to 17 PAH compounds.[4] The lack of the full PAH data limited the ability to distinguish PAH sources.

Gas chromatograms available for soil and sediment samples provided information on the presence and the general classification of petroleum products in the samples (e.g., mid- or heavy range petroleum products). This information, coupled with the knowledge of the historical operations (e.g., equipment locations), visual description of contamination from soil boring logs, and the presence of contamination in shallow versus deep soils all aided in interpretation of the data.

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[4] The available PAH data included the 16 priority pollutant PAH compounds in addition to 2-methylnaphthalene.

5 Analysis of the Chemical Data

5.1 Solvents

In Parcels 1, 2, and 6, fill material consisting of soils mixed with wood, brick, and concrete fragments had variable thicknesses, generally within the range of 5 to 20 ft thick. Solvents such as PCE, TCE, 1,1-DCE, 1,1,2-TCA, VC (vinyl chloride), and ketone were found in soils/fill across all sampled areas, at depths ranging from approximately 0.5 ft to 64.5 ft bgs. These solvents were not associated with the former MGP operations. The highest concentration of TCE (22 mg/kg; 34 ft bgs) was detected in a sample collected from a soil boring located at the Pratt Works site (Parcel 6), along N. 12th Street. Elevated TCE concentrations at that depth may suggest the presence of a chlorinated solvent source area that resulted in the downward migration of the DNAPL[5] TCE. Figure 5.1 presents the distribution and concentration of solvent detections.

Ketone, an industrial solvent, was detected in several soil samples collected from streets surrounding Parcel 5, and was highest (260 mg/kg; 9–10 ft bgs at WW-MW-12) near the northwestern corner of Parcel 5. Based on its frequent detections in soil samples collected from the north and south boundaries of Parcel 5, ketone appears to be originating mostly from Parcel 5.

The available information and data are not sufficient to determine the precise sources of the solvents. Candidate historical operations include the metal manufacturing, repair shops, and tin can manufacturing that occurred in Parcels 2, 3, and/or 6, in addition to operations on Parcel 5.[6]

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[5] DNAPL: Denser than water non-aqueous-phase liquid.

[6] Metcalf and Eddy (2006d) described historical ship yard near Franklin Street/Kent Ave/Bushwick Creek inlet area and suggested that solvents may have been used as part of the shipyard operations.

5.2 PCBs and Pesticides

PCBs are non-MGP compounds that were detected in surface soil samples (0–0.2 ft), and shallow soil samples (down to 7.5 ft bgs) at locations throughout the different parcels (see Figure 5.2.1). The highest PCB concentration in surface soils (1.8 mg/kg) at the Parcel 2 boundary with N. 12th Street was higher than the unrestricted-use SCO of 0.1 mg/kg. Within Parcel 2, PCB levels up to 0.54 mg/kg (2–4 ft; SB-09) were found. PCBs were also detected in soil samples from Parcel 6 and from around Parcel 5. Sheet metal manufacturing, the corrugated containers and scrap metal operations, among other activities that occupied the former MGP parcels are potential PCB sources.

Pesticides were detected at elevated concentrations compared to the unrestricted-use SCO at all sampled areas. In the surface soil samples (0–0.2 ft), DDT concentration was up to 0.15 mg/kg, higher than the unrestricted-use SCO of 0.0033 mg/kg. In Parcel 2, the highest DDT concentration of 0.42 mg/kg (two orders of magnitude higher than the unrestricted SCO) was detected in a sample collected from 0.75–5 ft (at location WW-MW-05). Other pesticides (e.g., DDD, DDE, and Endrin), with concentrations above their respective unrestricted-use SCOs, were also detected throughout the different parcels (see Figure 5.2.2).

5.3 Metals

Co-occurrence of several metals (e.g., zinc, copper, lead, and arsenic) at elevated concentrations were observed in many soil/fill samples collected from the sampled parcels (and in Bushwick Creek and the East River sediments – discussed later in this report). These elevated concentrations dropped at 20 ft in Parcels 1 and 2, and at 10 ft in Parcel 6. This abrupt change in metal concentrations with depth indicates that these metals are associated mainly with historic fill.

In the top 20 ft of the former MGP site (Parcels 1 and 2), zinc concentrations were up to 2,000 mg/kg, while concentrations were generally less than 109 mg/kg (the unrestricted-use

SCO for zinc in soil) in soils deeper than 20 ft (see Figure 5.3.1). This pattern was also observed in Parcel 6 (Figure 5.3.2). Elevated copper concentrations were also found in the shallow soil/fill samples from Parcels 1, 2, and 6 compared to the deeper soils (Figures 5.3.3 and 5.3.4).

Areas with the highest co-occurrence of metals concentrations included the western portion of the boundary between Parcel 6 and N. 12th Street (location WW-SB-36 at 9–10 ft bgs: arsenic 300 mg/kg, copper 1,180 mg/kg, chromium 435 mg/kg, and lead 3,980 mg/kg), and within Parcel 2 at the intersection of N. 11th Street and Kent Avenue (copper 84.3 mg/kg, zinc 570 mg/kg; lead 2,980 mg/kg, location TP-06 at 6–6.5 ft). The abrupt drop in metal concentrations with depth indicates that these metals are associated mainly with historic fill. Other sources that potentially contributed to the metals in the fill material include the former railroads in Parcels 2, 3, 5, and 6; metal works in Parcel 2; and the former tin can factory in Parcel 6. The collective presence of solvents, PCBs, pesticides, and elevated metals across all sampled areas clearly indicates that these contaminants and their sources were not related to the former MGP activities.

5.4 PAHs and Gas Chromatograms

In the sections below, PAH concentrations were calculated as the sum of the 17 PAH compounds.

5.4.1 Parcels 1 and 2

Soils in Parcels 1 and 2 were composed of fill material (from approximately 5 to 20 ft bgs) consisting of soils mixed with wood, brick, and concrete fragments. Surface soil samples (0–0.2 ft) were collected along Parcel 2 boundaries (from N. 11th and N. 12th Streets), with PAH concentrations up to 29.5 mg/kg. Gas chromatograms showed the presence of unresolved complex mixture (UCM) in all surface soil samples, consistent with residual-type oil found in road runoff.

In Parcel 1, petroleum odors were reported at and below the water table, with gas chromatograms from soil samples indicating impacts from diesel-like product. In Parcel 2, the fill/shallow soil had gas chromatograms with different UCM profiles, indicating the presence of various petroleum products (see Figure 5.4.1). In addition, MTBE, a gasoline additive, was detected in Parcel 2 groundwater (MW-5 at 2 µg/L; Metcalf and Eddy 2007).

Two shallow soil samples from the middle of Parcel 2 were analyzed for the full PAH list. Total PAHs, as the sum of the 17 PAH compounds, were 77.6 mg/kg (GTP-7 at 3 ft bgs) and 159.7 mg/kg (GD-02 at 2 ft bgs). In both samples, the PAHs originated from petrogenic sources based on the parent and alkylated PAH patterns. The gas chromatograms indicated the presence of a mix of petroleum products, with a dominant product in the heavy oil range (Figure 5.4.1.1). The PAHs were at different degrees of weathering in the two soil samples (GTP-7 was dominated by the lower molecular weight PAH compounds like naphthalene and alkylated naphthalenes, while sample GD-02 PAHs were dominated by the high molecular weight PAH compounds like benzo(a)pyrene). The presence of MTBE, various petroleum products, and petrogenic PAHs in the shallow soils are all consistent with petroleum storage operations that occurred in the area after the MGP operations ceased.

One deep soil sample from Parcel 2 (GD-03 at 38 – 40 ft bgs) was analyzed for the full PAH list. Total PAHs, as the sum of the 17 PAH compounds, was 10,610 mg/kg, with Fl/Py ratio less than 1.0. Based on the parent and alkylated PAH patterns, and the lack of UCM in the gas chromatogram, the PAHs in this sample originated from a pyrogenic source (i.e., CWG tar).

The majority of the soil samples were analyzed for 17 PAH compounds only. For these samples, the PAH profiles in the shallow and deep soil samples were generally different from each other. The PAH profiles in most of the deep soils were dominated by low-molecular-weight PAH compounds, in contrast to the PAH profiles in the shallower soils, which were mostly dominated by heavy-molecular-weight PAH compounds. Additional fingerprinting analysis (e.g., parent and alkylated PAH compound analysis, analysis of total petroleum hydrocarbons [TPH]) would be needed to further define the contamination sources.

In summary, impacts to the shallow soils (above and at the groundwater table) appear to be from a mixture of petroleum products consistent with petroleum storage operations that occurred in Parcels 1 and 2 after the MGP operations ceased. Potential impacts to Parcels 1 and 2 from Parcels 5 and 6 are discussed in the sections below.

5.4.2 Parcel 6 and N. 12th Street

The discussion below is focused on describing contamination at the Parcel 6/ N. 12th Street boundary, across the street from the former MGP Parcels.

On the southwestern corner of Parcel 6, tar comingled with petroleum products was observed, with tar accumulating in monitoring well MW-2 (Metcalf and Eddy 2006a, RI data).[7] The shallowest impact from CC tar (3–5 ft) was at WW-SB-36, located on N. 12th Street at the border of Parcel 6.[8] The source of the tar at this shallow depth does not suggest subsurface migration from the former MGP, or disposal from the gas works on and near an active refinery property at that time. Because tar tanks were present on Parcel 6 at some point in time, with several documented accidents, one has to consider Parcel 6 as a tar source. Other tar impacts, resembling CWG tar, were also found at WW-SB-36.[9] The spatial extent of these mixtures of tar impacts is not known from the available data.

Gas chromatograms for samples collected in the top 10 ft of soil/fill on the western part of Parcel 6 and N. 12th Street showed the presence of petroleum products in the kerosene-, diesel-like, and heavy oil ranges (Figure 5.4.2). This variability in petroleum products indicates impacts from petroleum handling and storage that occurred on Parcel 6 and on the MGP parcels after the MGP operations ceased. The spatial extent of these petroleum impacts is unclear.

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[7] Sampling locations include B-34, MW-2A, BPB-5, and WW-SB-36.

[8] PAHs were 1,049 mg/kg, with Fl/Py ratio greater than 1.0, indicating the presence of coal carbonization tar.

Metal concentrations several times to orders of magnitude higher than the unrestricted-use soil cleanup objective were also found in this area.[10]

At the footprint of the former tin can factory (south central portion of Parcel 6) and along N. 12th Street, tar mixed with chlorinated solvents was found in a lens 34–35 ft below ground.[11] The spatial extent of solvent/tar impacts was not clear from the available data.

The former Pratt Works' tar and naphtha tanks were located at the southeastern part of Parcel 6 (at the intersection of N. 12th Street and Kent Avenue). Near that corner, in a soil boring between Parcel 6 and N. 12th St boundary, "coal tar contamination co-mingled with petroleum contamination was observed…in borings…B-20A" (Metcalf and Eddy 2006a). Boring B-20A "contained visible tar at depths of approximately 17 to 50 feet bgs" (Metcalf and Eddy 2006a). PAHs greater than 1,100 mg/kg were found at location B-20A at 19-21 ft bgs (Fl/Py ratio greater than 1.0, indicating the presence of CC tar) (Metcalf and Eddy 2006a). The source of the visual tar impacts and the elevated PAHs is not clear from the available data (whether the tar tank on Parcel 6 or the former MGP operations). This is compounded by the absence of soil borings at the footprint or in the vicinity of the former tar tank on the southeastern corner of Parcel 6. Because of the many documented accidents at the Pratt Works site, including the burning of tar and naphtha tanks, among other accidents, further investigation would be needed in this southeast corner of Parcel 6.

The lack of samples from Parcel 5 constitutes a data gap that limits the interpretation of PAH sources in N. 11th Street.

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[9] WW-SB-36 (9-10 ft, PAHs 1,310.4 mg/kg), with Fl/Py ratio less than 1.0, indicating CWG tar.

[10] For example, copper (1,180 mg/kg), arsenic (300 mg/kg), zinc (2,470 mg/kg), and lead (3,980 mg/kg) (location WW-SB-36; 9-10 ft bgs).

[11] Location WW-SB-25 (34–35 ft bgs), total PAHs were 3,018 mg/kg, and TCE was 22 mg/kg.

6 Sediment Sample Results

6.1 Bushwick Inlet

Metcalf and Eddy (2006d) collected sediment samples from 11 cores located throughout Bushwick Inlet. The highest PAH concentrations were found at the head of the inlet (395.3 mg/kg)[12] and at the intersection with the East River (371 mg/kg).[13] The remainder of the sediment samples—nine samples collected between 6 and 26 ft deep—had total PAH concentrations ranging between 7 and 75 mg/kg (Metcalf and Eddy 2006d). This range could be within typical background PAH concentrations in urban waterway sediments. However, site-specific background sediment samples were not collected as part of the sampling conducted by Metcalf and Eddy (2006d).

Based on visual observation of soil boring logs located along the Bushwick Inlet southern shoreline, Metcalf and Eddy (2006d) concluded that "petroleum/fuel oil contamination extends to depths from approximately 23 to 27 feet bgs which suggests that contamination has migrated from an off-site source such as the BFOC [Bayside Fuel Oil Company]."

Besides PAHs, metal concentrations were elevated in all sediment cores. This included arsenic and copper (228 and 876 mg/kg, respectively, at the intersection with the East River), lead and chromium (1,870 and 790 mg/kg, respectively, in the middle of the inlet at 8–10 ft deep), and zinc (1,000 mg/kg, the western half of the inlet at 10–12 ft deep). The source of these elevated metals in the sediment is probably a combination of historical fill (observed in soil borings located at the shoreline and at the intersection of the inlet with the East River), and other sources (for example, Metcalf and Eddy (2006d) described a 1942 – 1966 ship yard near Franklin Street/Kent Ave/Bushwick Creek inlet area).

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[12] Location BCS-1 (18–20 ft bgs). Core had petroleum sheen and odor. Fl/Py ratio less than 1.0 in the sediment sample, consistent with petroleum impacts.

[13] Location BCS-11 (18–20 ft bgs). Core had a mix of petroleum and creosote odors. Fl/Py ratio less than 1.0, indicating either petroleum, tar, or a mixture from different sources.

6.2 The East River

The remedial investigation field work (GEI 2015) performed by GEI on behalf of national Grid included 21 sediment cores, with depths from 12 to 84 ft below the mud line, in the East River in front of Parcels 4, 5, and 6. Sediment samples were collected from all depths, to characterize the surface sediment (0–0.5 ft), shallow sediment, and deep sediment, generally in the range of 15 to 25 ft deep.

Elevated PAHs, greater than 1,000 mg/kg and up to 19,905 mg/kg, were encountered at all depths (see Figure 6.2 for sediment sample results). Even though the available PAH data were limited to 17 PAH compounds, this elevated concentrations is indicative of the presence, at least in part, of CWG tar (Fl/Py ratio in these sediment samples were less than 1.0). This was confirmed by the lack of UCM in the available gas chromatograms. Figure 6.2 shows the extent of the elevated PAH impacts in the East River sediment. Several sediment samples collected by Metcalf and Eddy (2006c) at depths between 14 and 54 ft below the mud line also contained elevated PAH concentrations (i.e., greater than 1,000 mg/kg, with variable Fl/Py ratios –greater than or less than 1.0– indicating a mix of CC and CWG tars. Metcalf and Eddy (2006c) described these samples as containing free product (fuel oil and coal tar). This description indicates the presence of a mixture of petroleum and coal tar impacts to the East river sediment. (Figure 6.2 presents example gas chromatograms showing the presence of petroleum in the sediment). The percent contribution of petroleum sources to PAHs in the sediment, and whether significant, cannot be determined from the available PAH data. (Metcalf and Eddy [2006c] described that some of their sediment cores were relocated “this is because underwater (can’t be seen) pilings exist”. These pilings maybe sources of creosote if encountered during drilling/sampling). Additional fingerprinting-quality data are needed to track this contamination back to its upland sources.

In addition to PAHs, PCBs (up to 5.2 mg/kg) and pesticides (e.g., DDT up to 3.8 mg/kg) were found in the sediment samples at all depths, indicating the presence of comingled contamination sources in the East River. Metals were also elevated at all sediment depths. For example, surface sediment (0–0.5 ft) samples had arsenic up to 326 mg/kg, lead up to 2,140 mg/kg, copper up to 1,260 mg/kg, and zinc up to 1,750 mg/kg. Although metal concentrations were generally lower with depth, there were spots of elevated metals in deeper sediment (e.g., arsenic up to 216 mg/kg and lead up to 2,370 mg/kg [both at SED-11 at 22–23 ft], zinc up to 1,060 mg/kg [SED-05 at 19.5–20 ft]). The elevated metals are likely related to historic fill, with additional input likely from activities along the East River, and possibly activities from Parcels 1–6. Sediment samples from upstream and downstream locations would be needed to further assess baseline conditions in the East River sediment and the degree of impact from the upland parcels on the East River.

7 NAPL from Recovery Wells and Verizon Manhole

NAPL recovery wells were installed inside and along the boundaries of Parcel 2 (on N. 11th and 12th Streets; see Figure 7.1). In 2014, several NAPL samples were collected from these wells, including wells NRW-2, -3, -4, -7, -8, -9, and -10. In addition, a NAPL and solid sample were collected from a Verizon manhole located at the intersection of N. 12th Street and Kent Avenue. The collected samples were analyzed for TPH and PAH (full list) analyses.

For the Verizon manhole NAPL and solid sample, the alkylated PAH compounds far exceeded the abundance of the parent PAH compounds, indicating that the PAHs are from petrogenic sources. This was consistent with the gas chromatograms, which showed the presence of a mix of diesel- and heavy-fuel-like refined products, which would be unrelated to the former MGP operations (Figure 7.2).

NAPL samples were collected from recovery well NRW-7 on three occasions (October 9, November 13, and December 12, 2014). These samples showed a dominant pyrogenic PAH signature with a trace contribution from a petrogenic source (see Figure 7.3 for the November 13, 2014 NAPL sample). To show whether a NAPL sample is dominated by petrogenic or pyrogenic sources, a plot was created using the ratio of PAHs (sum of 44 compounds)/TPH on the vertical axis and PAHs (sum of 17 compounds/sum of 44 compounds)) on the horizontal axis (see Figure 7.4). Tar and petroleum source samples, from Exponent library, were plotted on this figure. For well NRW-7, the figure showed what appears to be a trend in the NRW-7 NAPL composition along the vertical axis from coal tar to becoming a mixture of petroleum and coal tar with time.[14] However, additional samples will need to be collected with time to determine if there is, in fact, a trend, and determine whether there is petroleum migrating into the well, and its source. PAHs in the NAPL from the remainder of the recovery well samples

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[14] The gas chromatograms do not show a UCM in any of the NAPL samples.

were predominantly pyrogenic, based on the PAH profiles and the lack of UCM in the gas chromatograms (Figure 7.5).[15]

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[15] NAPL from the remainder of the recovery wells had trace petrogenic PAHs, similar to that in NRW-7.

8 References

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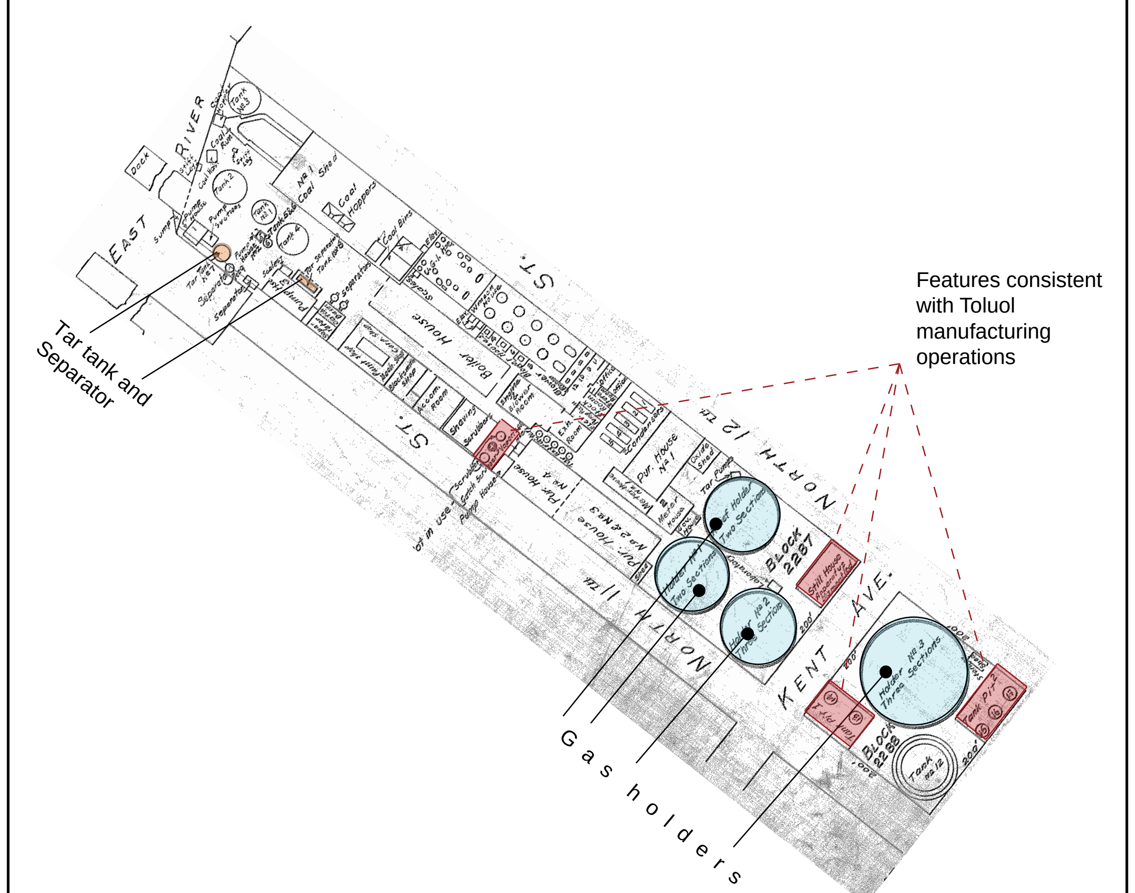
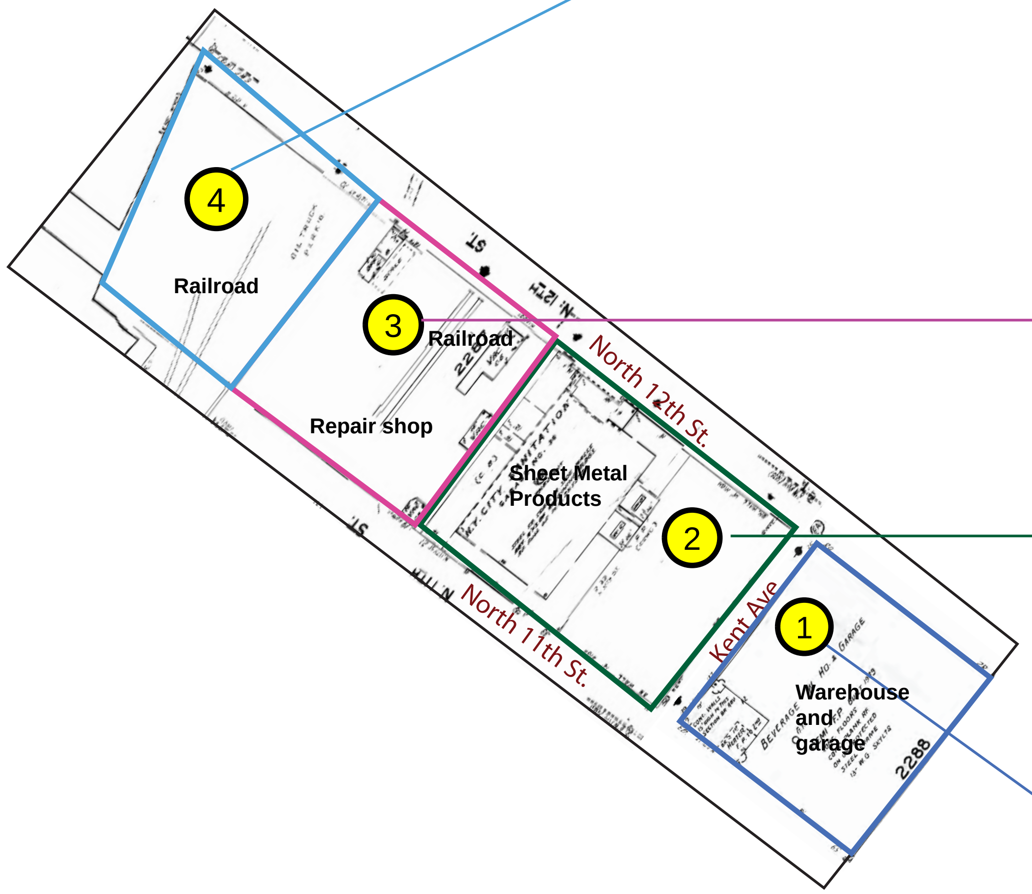
Figures

1887 Sanborn indicated coal gas production
1905 Sanborn indicated CWG production





Parcel 4
1947: Havenmeyer and Elder Inc. to expand railroad terminal
1958: Paragon Oil Company
1978 – 1982: Oil truck parking operation
1982: Texaco sold the property to Bridge Lumber Company Inc.
1988 – 1995: Lumber storage

Current, CitiStorage uses the building for offices and document storage

Parcel 3
1947: Havemeyer and Elder Inc.
1958: Paragon Oil Co, Inc.
1965: Metal scrap storage, railroad tracks, repair shop, and office
1982: Lumber company, NYC Industrial Development Agency.
1983: Parking lot
1988 – 1995: UST as oil/water separator for trucks runoff from delivery trucks by the lumber company found.

Current, CitiStorage uses the building for document storage

Parcel 2
1946: Kent industrial Corp
1951: Ferro-Co sheet metal product manufacturing
1965: Commercial Corrugated Container Corp
1971: American Sandfill and Marine Corp
1978 - 2009: NYC Department of Sanitation garage
Currently: NYC Department of Parks and Recreation

Parcel 1
1951: Beverage warehouse and garage
1965, 1978, 1979 maps: garage
1978: NYC industrial development agency
1996: Garage for Colonial Mirror and Glass

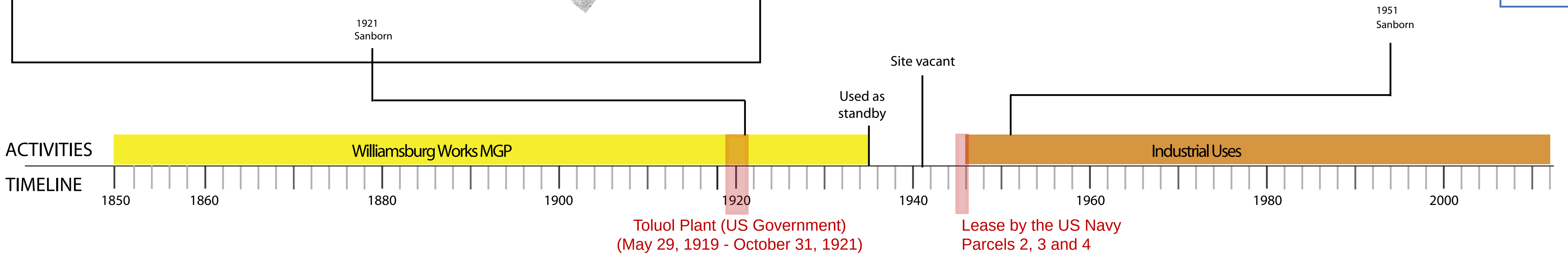


Figure 3.1 Former Williamsburg Works MGP site ownership history and operations (Parcels 1 - 4).

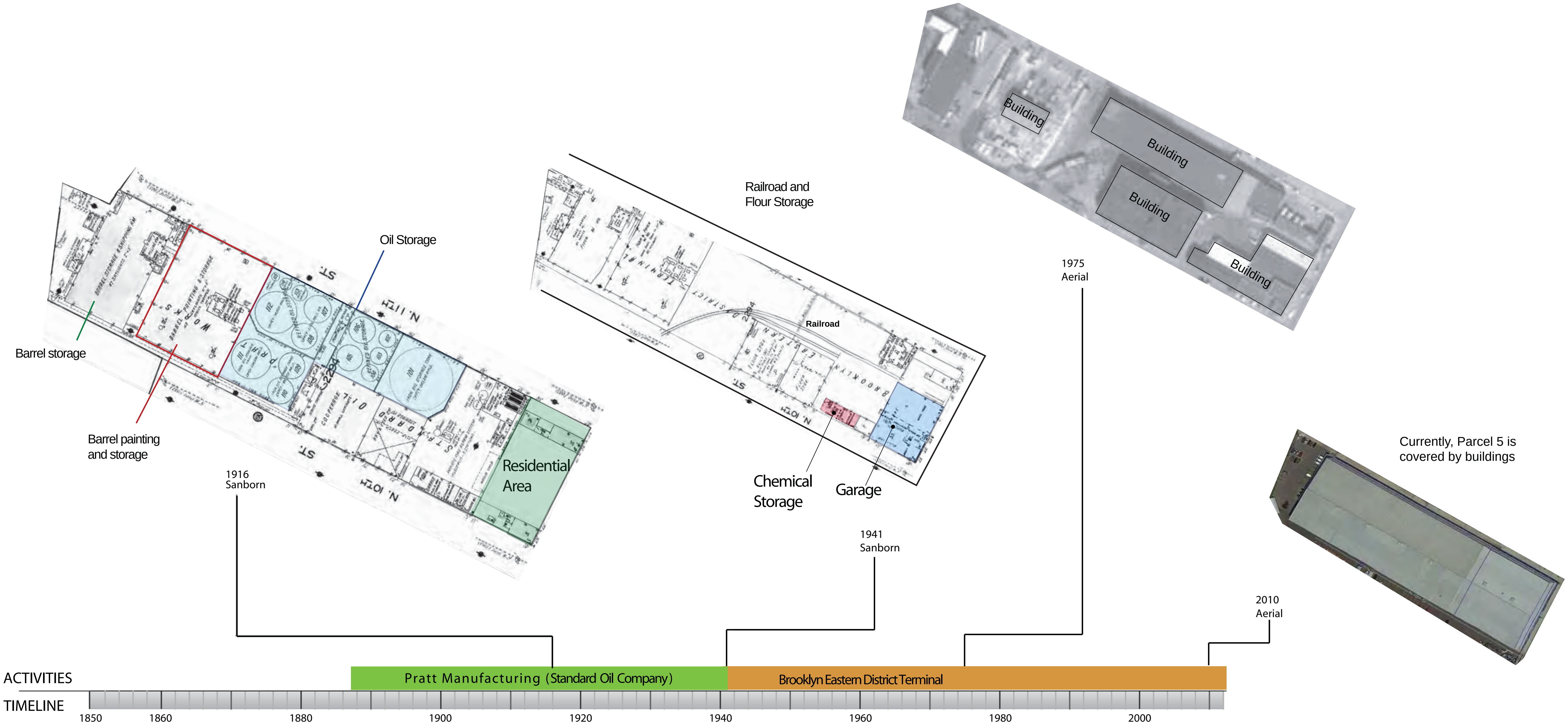
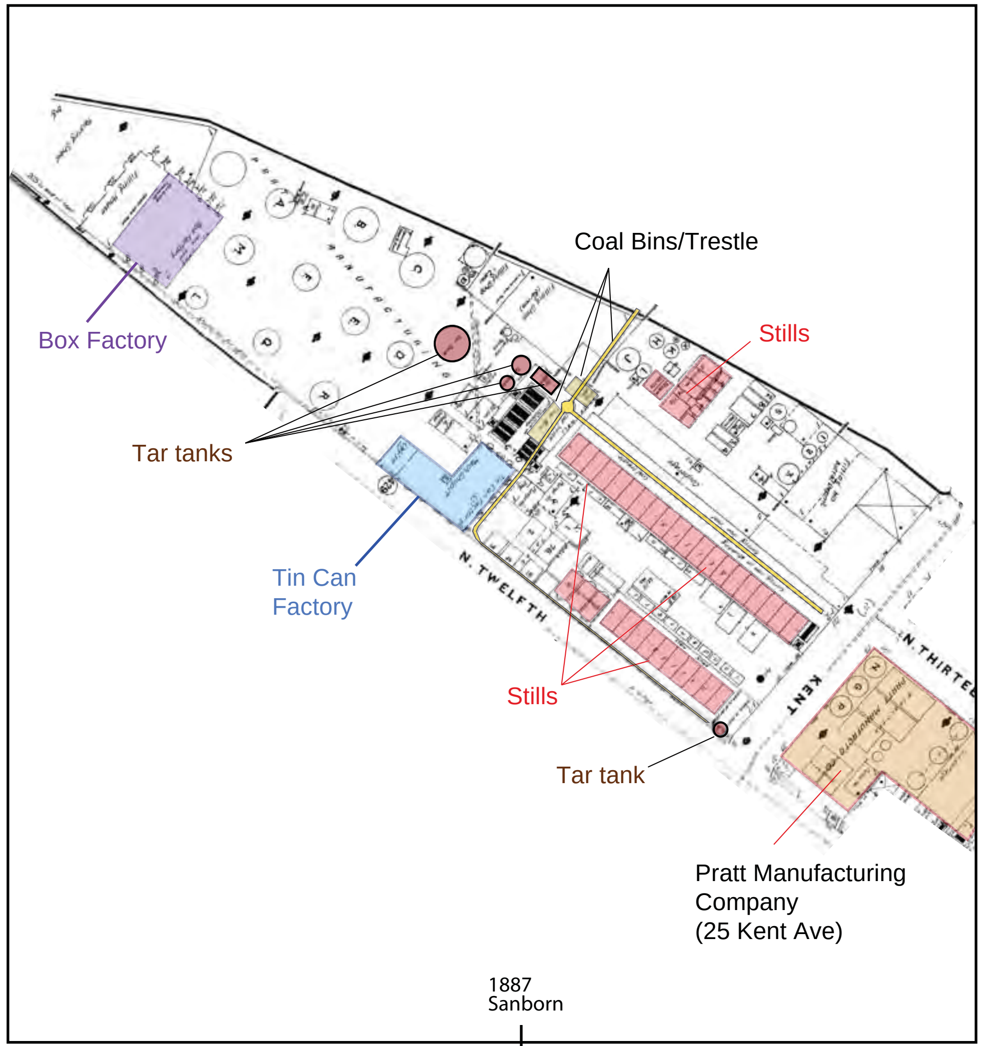
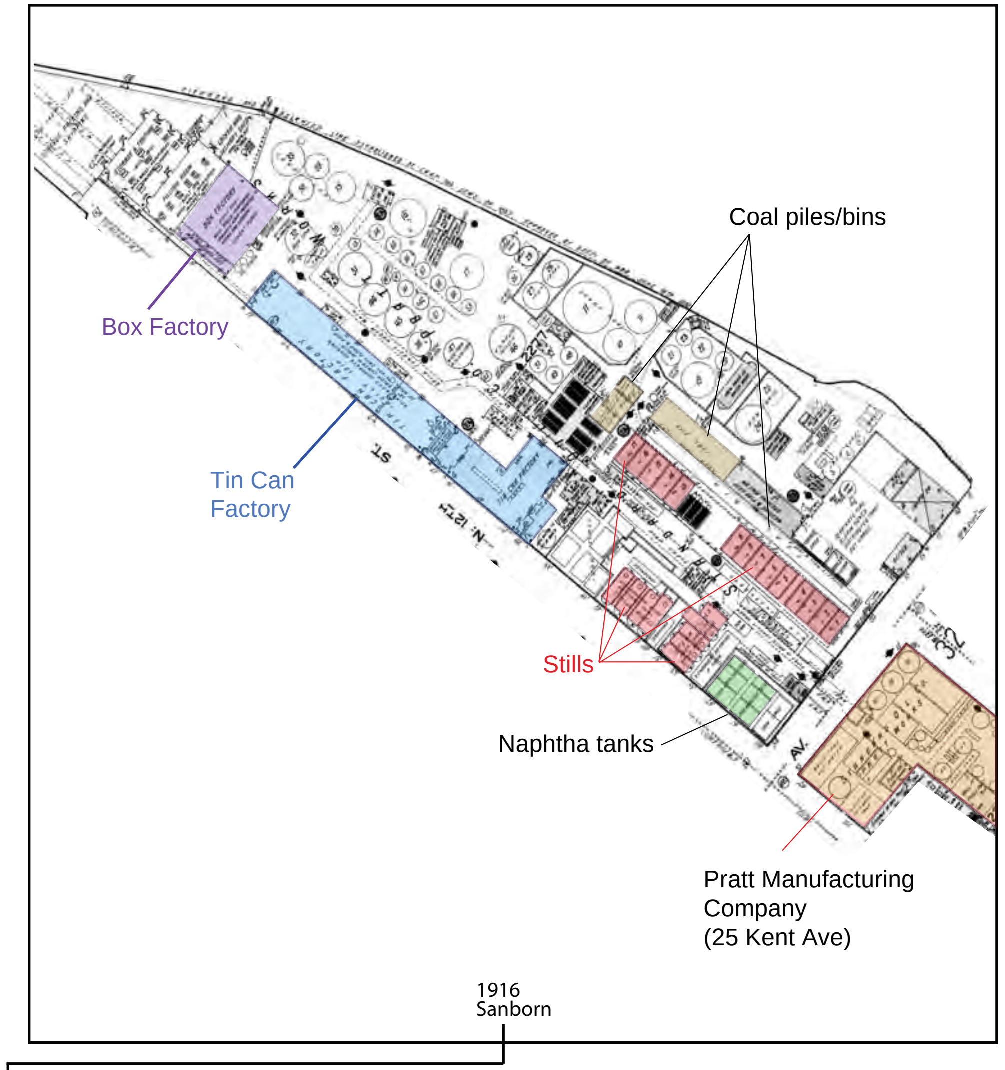


Figure 3.2.2 Parcel 5 ownership history and operations.

1872. “There are seven separate buildings, ten large oil stills, eight immense oil tanks, an engine, boiler, five pumps, and various machinary and fixtures used in the refining, canning, and shipping of astral oil, or refined petroleum...refining carried on at the rate of about 7,000,000 gallons per year” (Business Houses of New York, undated).

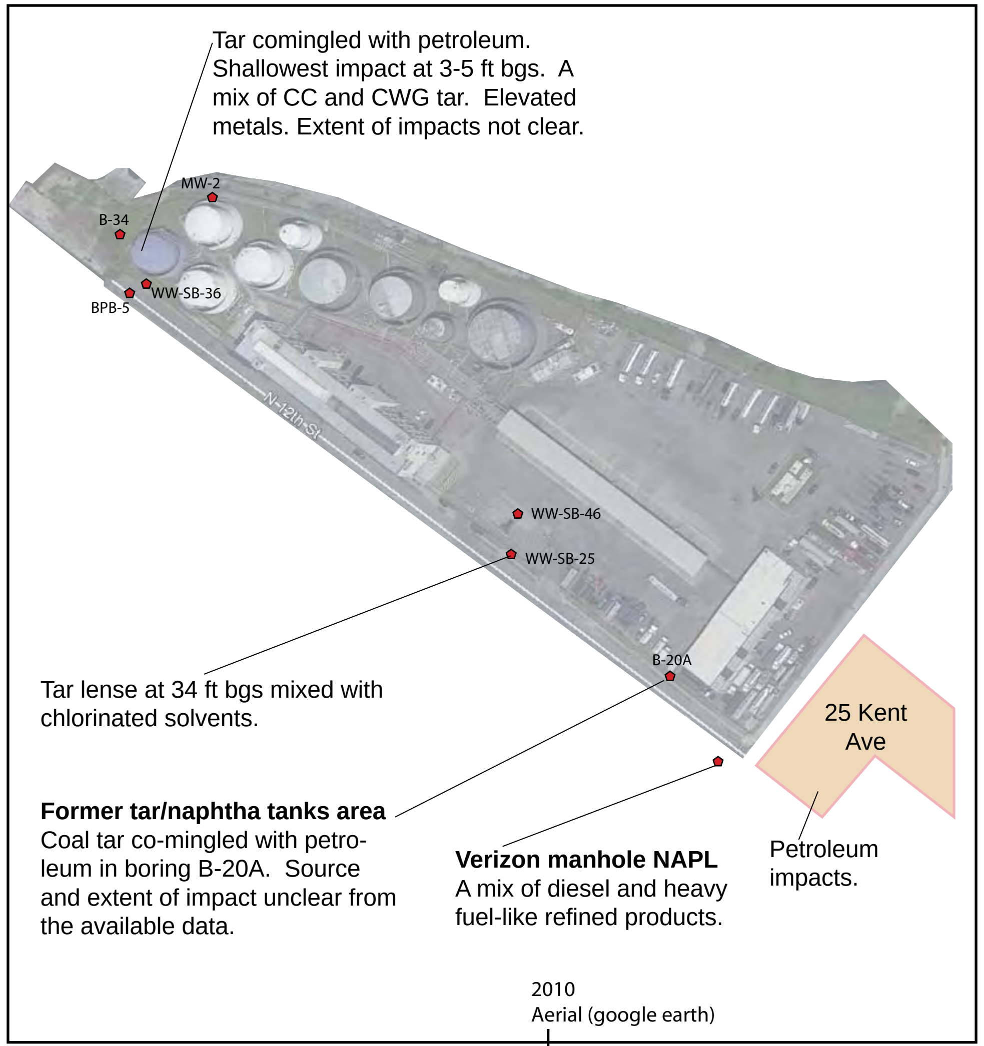


1887 Sanborn



1916 Sanborn

Example impacts at the Pratt Works Site along N.12th Street with spatial extent needing additional investigations



Tar comingled with petroleum. Shallowest impact at 3-5 ft bgs. A mix of CC and CWG tar. Elevated metals. Extent of impacts not clear.

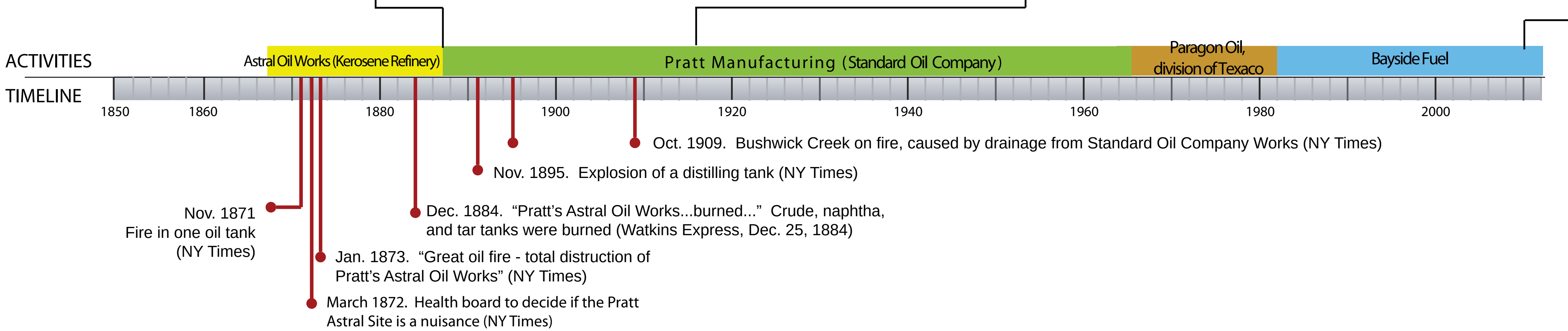
Tar lense at 34 ft bgs mixed with chlorinated solvents.

Former tar/naphtha tanks area
Coal tar co-mingled with petroleum in boring B-20A. Source and extent of impact unclear from the available data.

Verizon manhole NAPL
A mix of diesel and heavy fuel-like refined products.

Petroleum impacts.

2010 Aerial (google earth)



Oct. 1909. Bushwick Creek on fire, caused by drainage from Standard Oil Company Works (NY Times)

Nov. 1895. Explosion of a distilling tank (NY Times)

Dec. 1884. “Pratt’s Astral Oil Works...burned...” Crude, naphtha, and tar tanks were burned (Watkins Express, Dec. 25, 1884)

Nov. 1871
Fire in one oil tank
(NY Times)

Jan. 1873. “Great oil fire - total distruction of Pratt’s Astral Oil Works” (NY Times)

March 1872. Health board to decide if the Pratt Astral Site is a nuisance (NY Times)

Figure 3.3 Parcel 6 ownership history and operations.

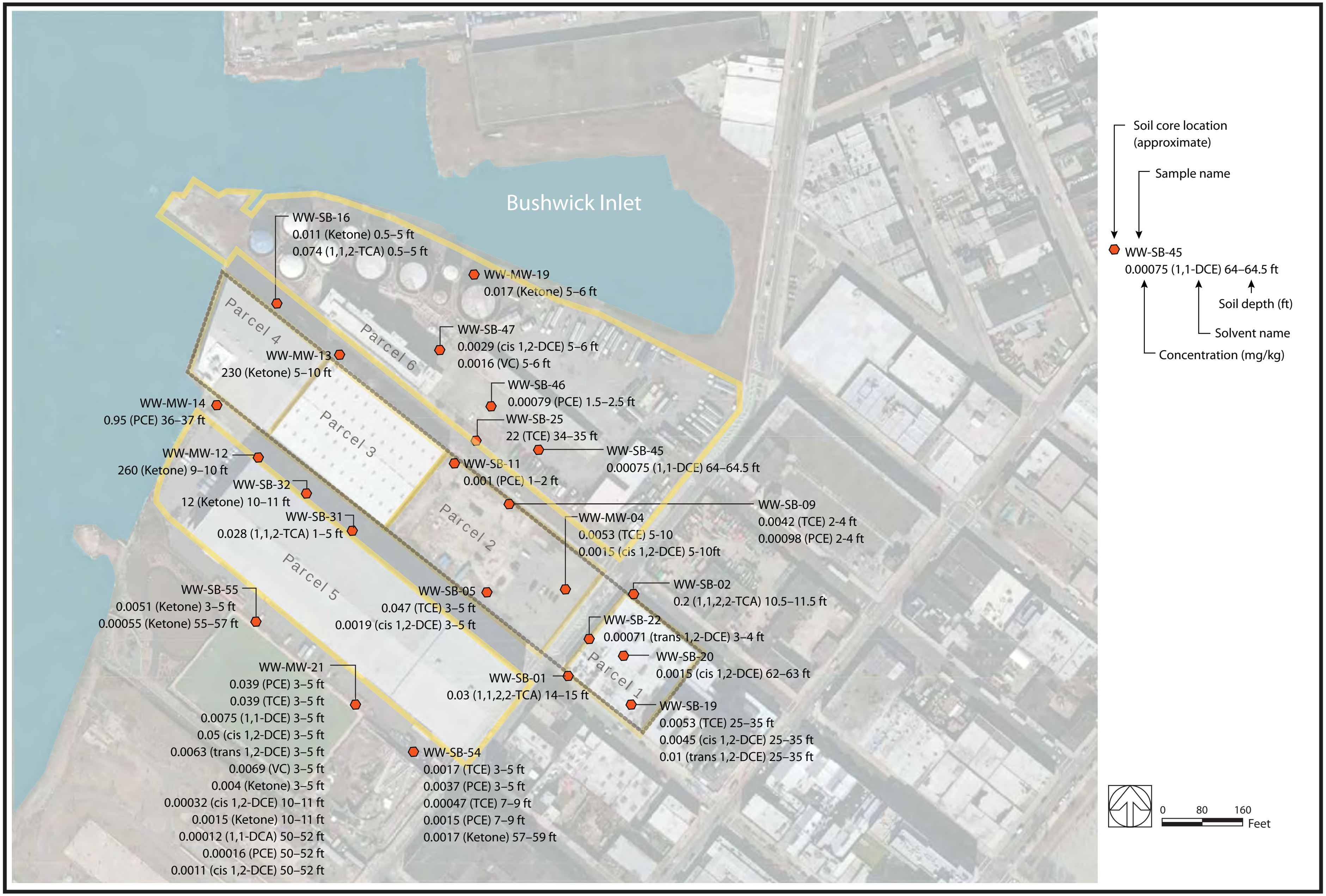


Figure 5.1 Solvents spatial distribution and concentrations in the sampled areas.

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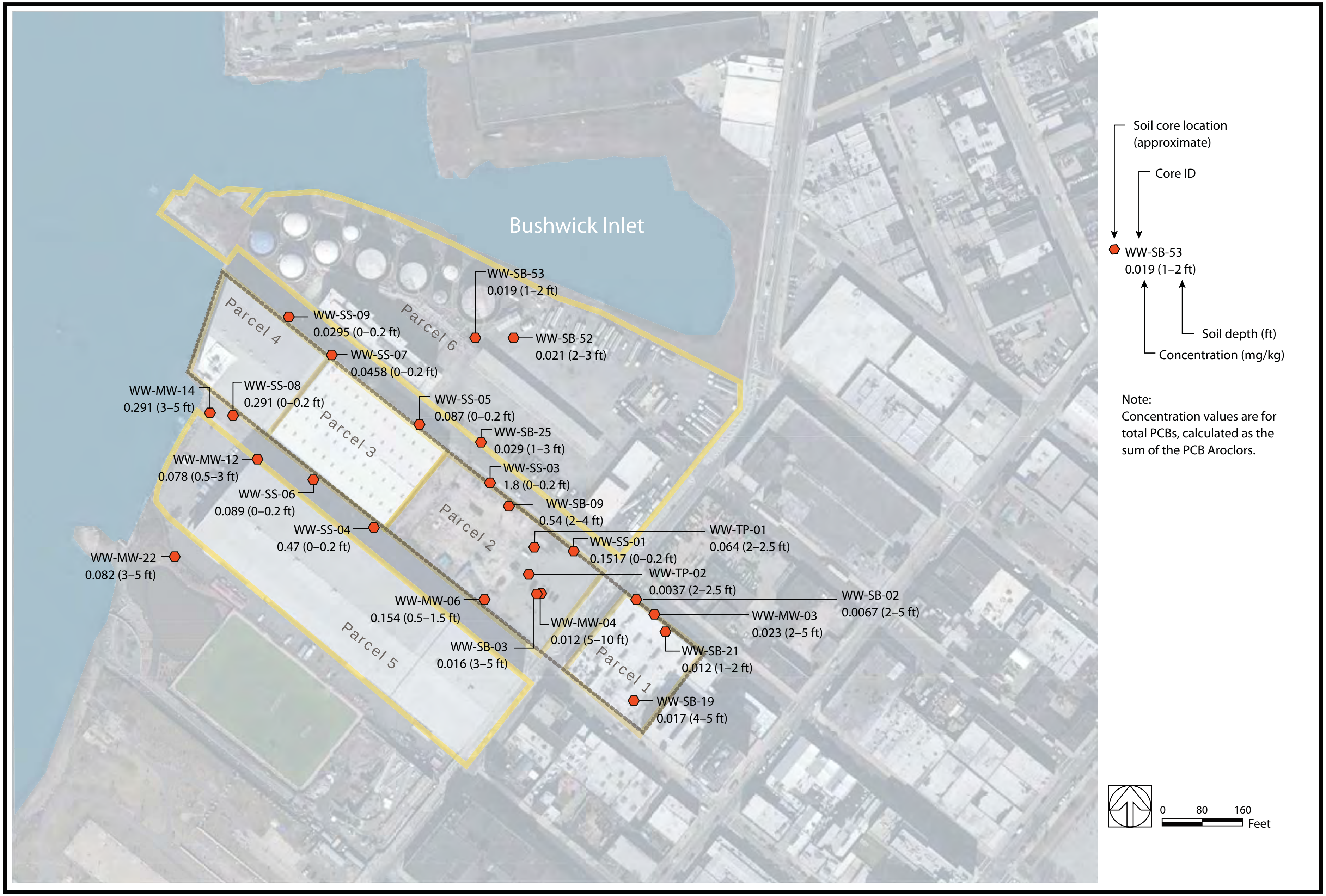


Note:
Concentration values are for total PCBs, calculated as the sum of the PCB Aroclors.

Figure 5.2.1 PCBs spatial distribution and concentrations in the sampled areas.

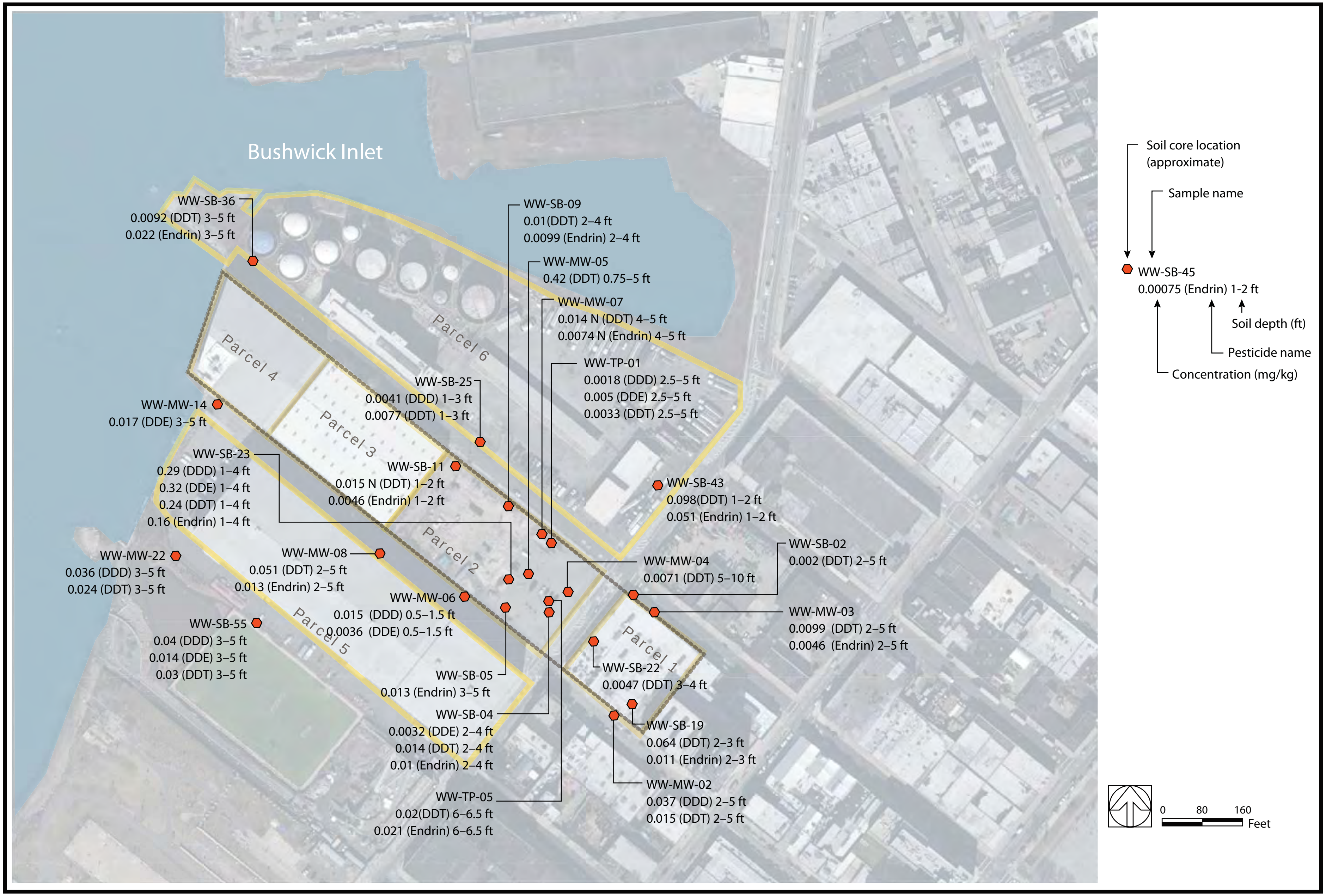


Figure 5.2.2 Spatial distribution and concentrations of selected pesticides in sampled areas.

Exponent

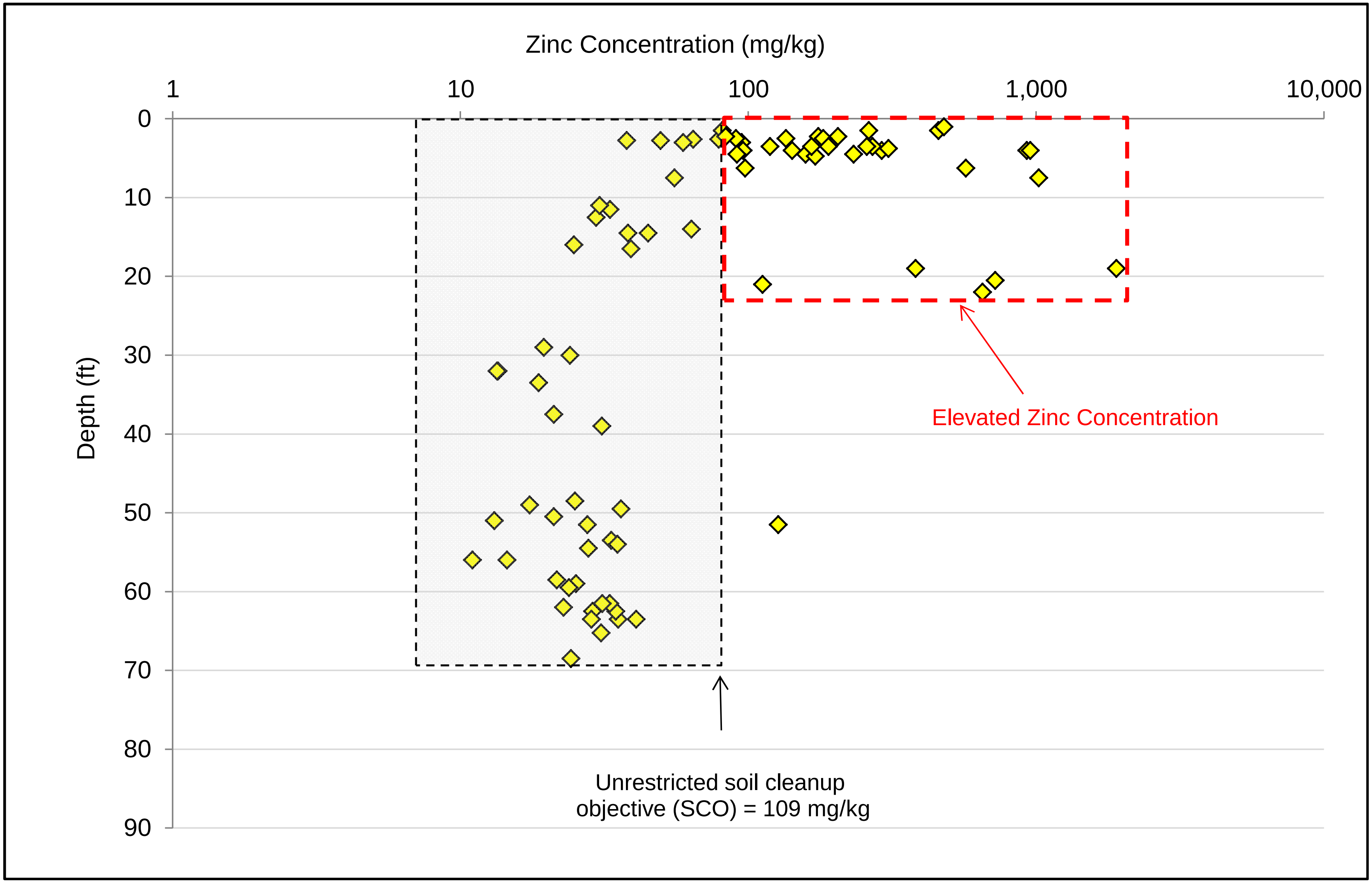


Figure 5.3.1 Zinc concentrations were elevated in the top 20 feet of soil/fill in Parcels 1 and 2.

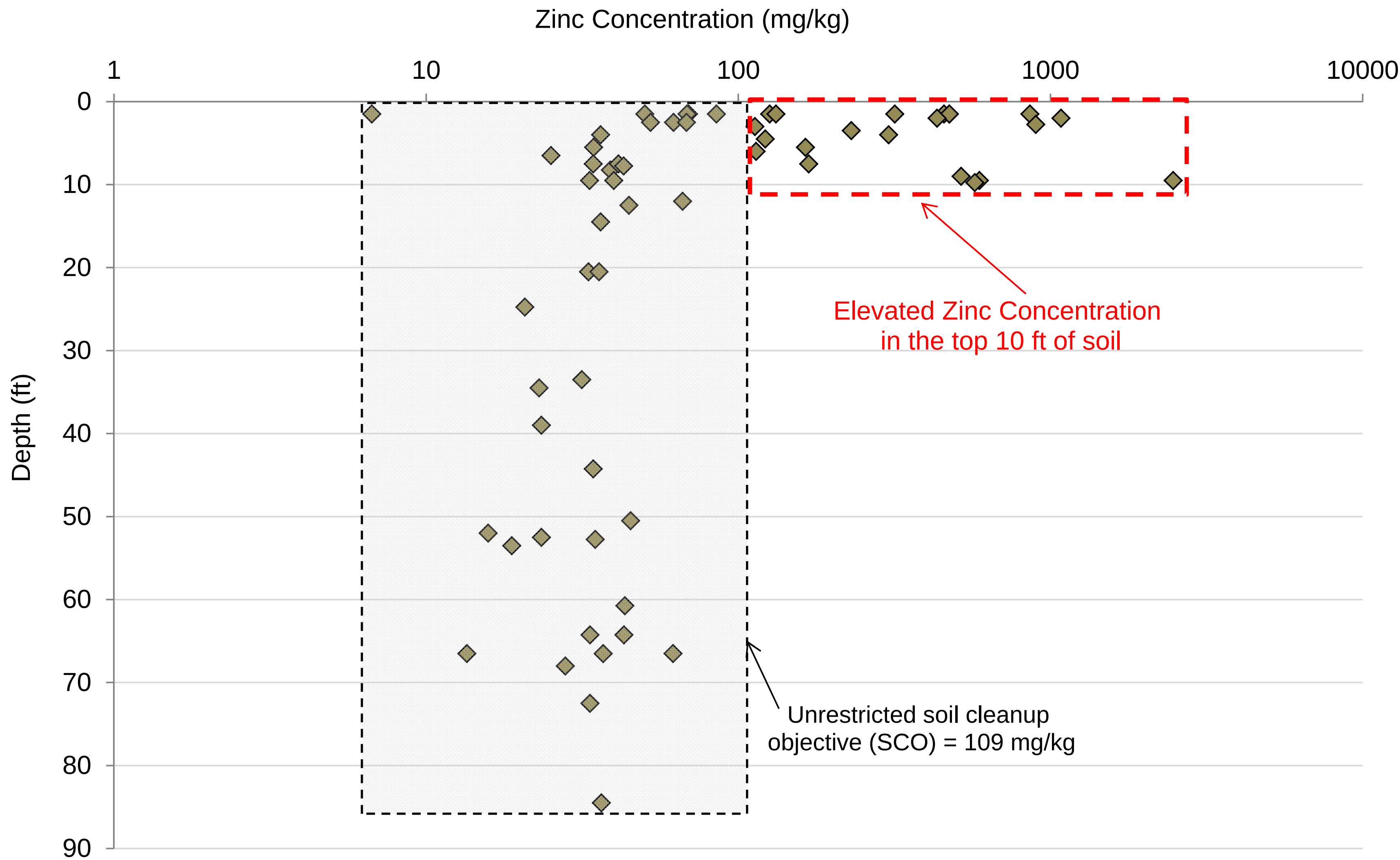


Figure 5.3.2 Zinc concentrations were elevated in the top 10 feet of soil/fill in Parcel 6.

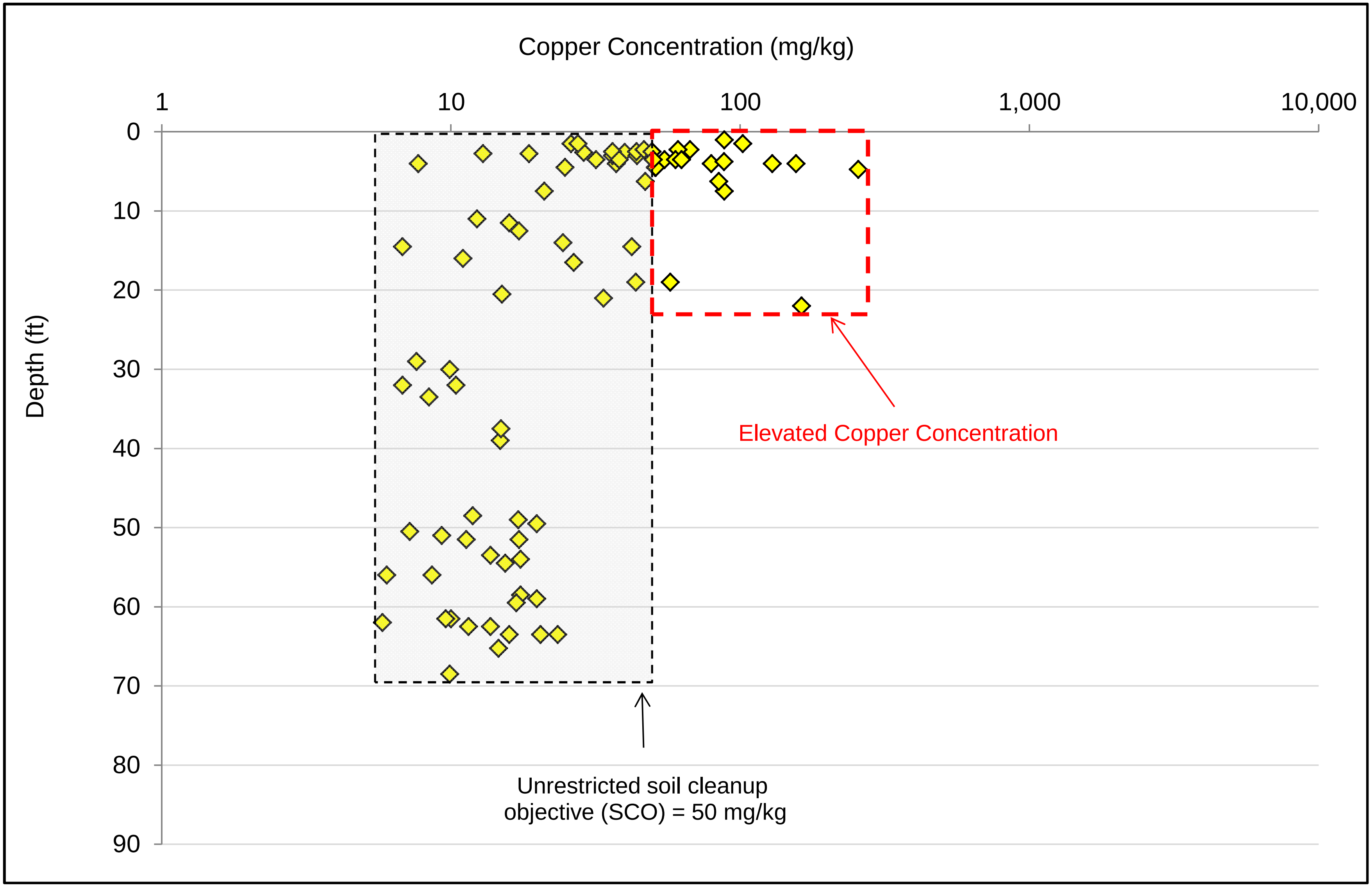


Figure 5.3.3 Copper concentrations were elevated in the top 20 feet of soil/fill in Parcels 1 and 2.

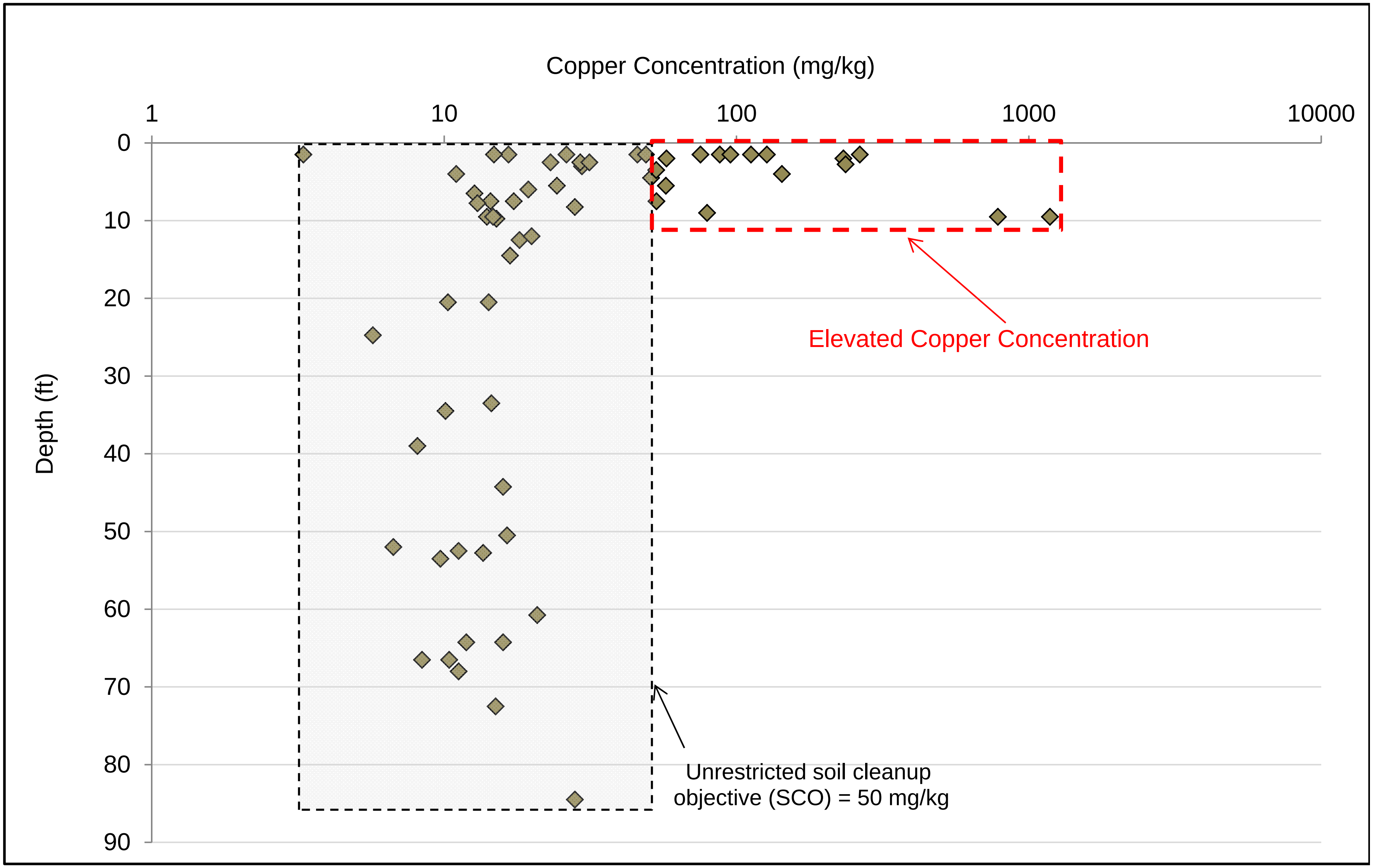
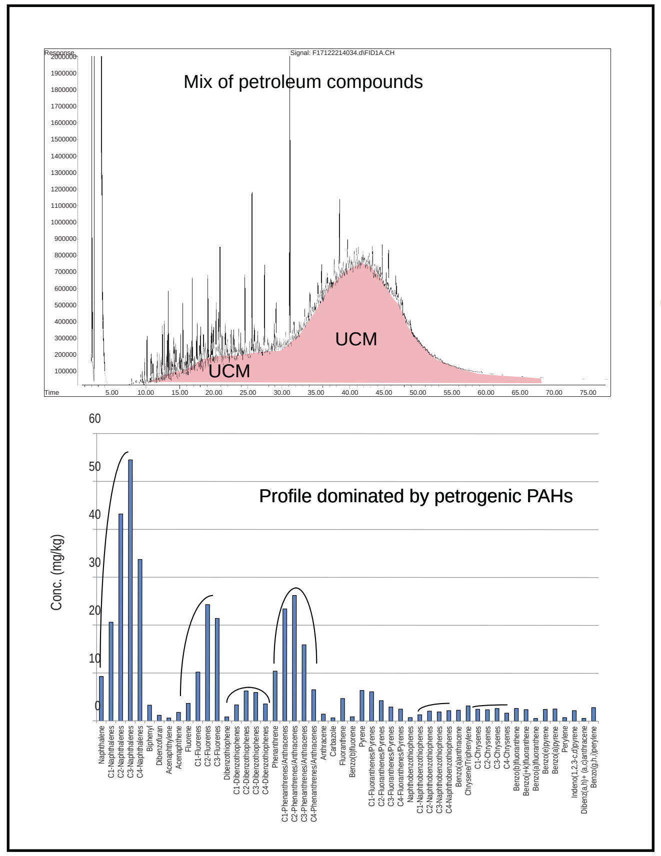


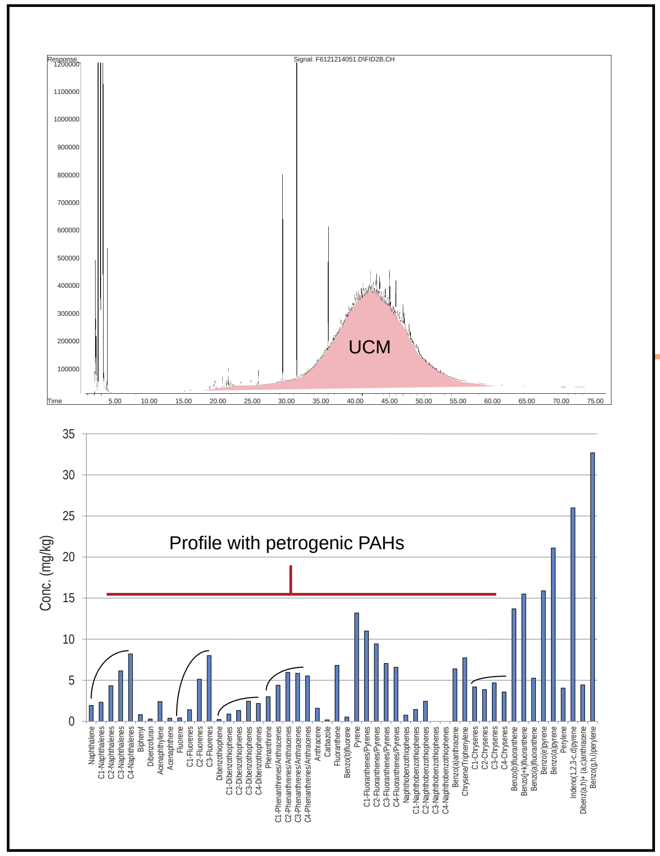
Figure 5.3.4 Copper concentrations were elevated in the top 10 feet of soil/fill in Parcel 6.

UCM: Unresolved Complex Mixture.

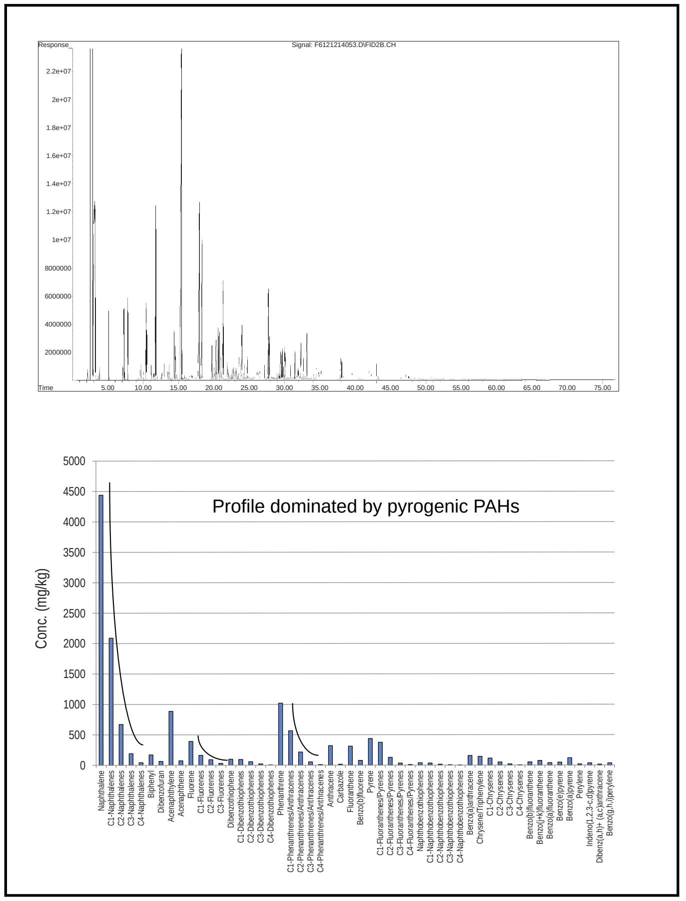
Figure 5.4.1
Gas chromatograms from the former MGP parcels indicate the presence of various petroleum products in the shallow soil/fill.

Shallow Soil Samples





Deep Soil Sample



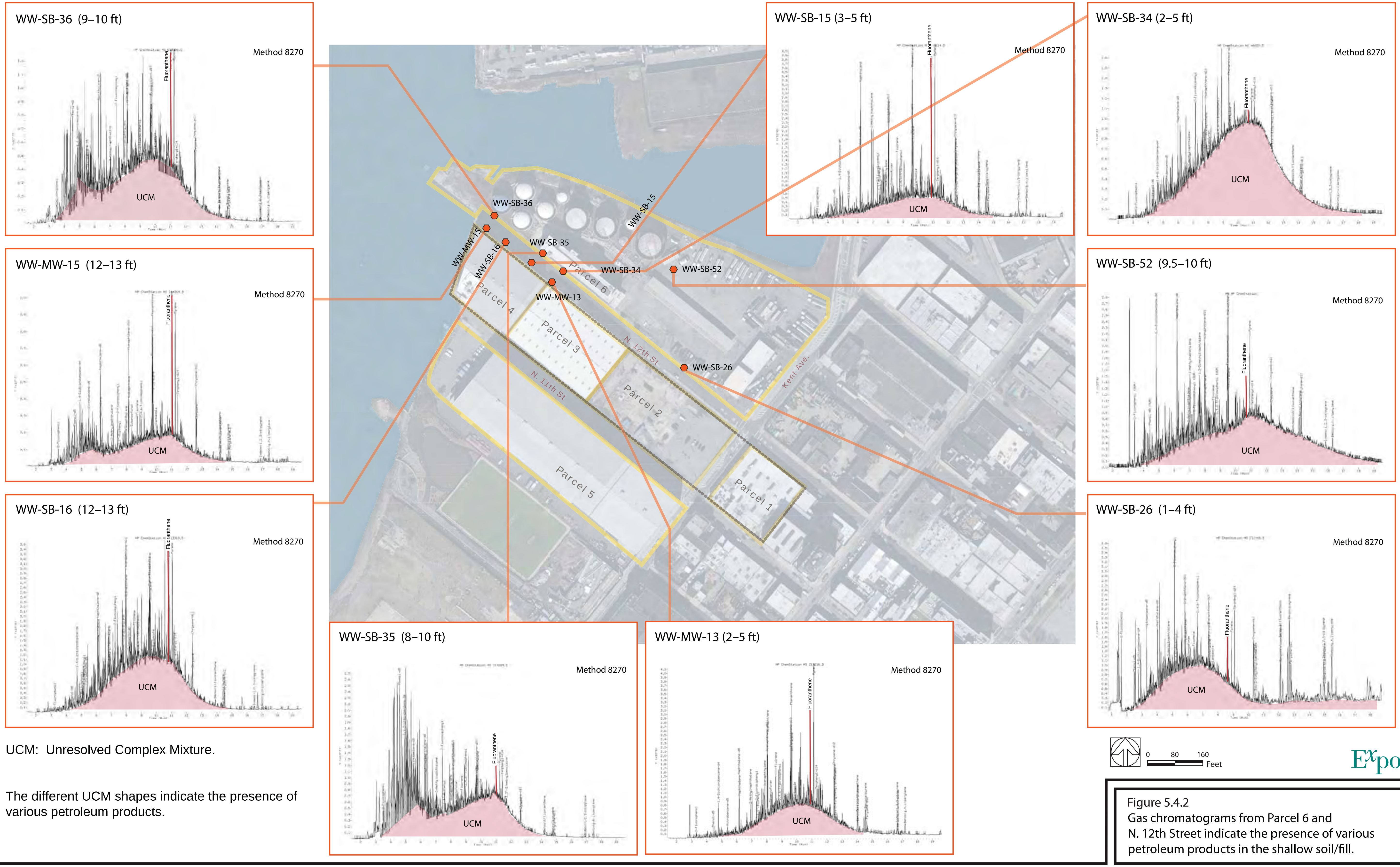
Sample locations are approximate.

UCM: Unresolved Complex Mixture.

0 80 160
Feet

Exponent®

Figure 5.4.1.1 Fingerprinting analysis showed the presence of a mix of petroleum products in Parcel 2 shallow soil, inconsistent with impacts from the former MGP. The deep soil sample from Parcel 2 was impacted by tar.

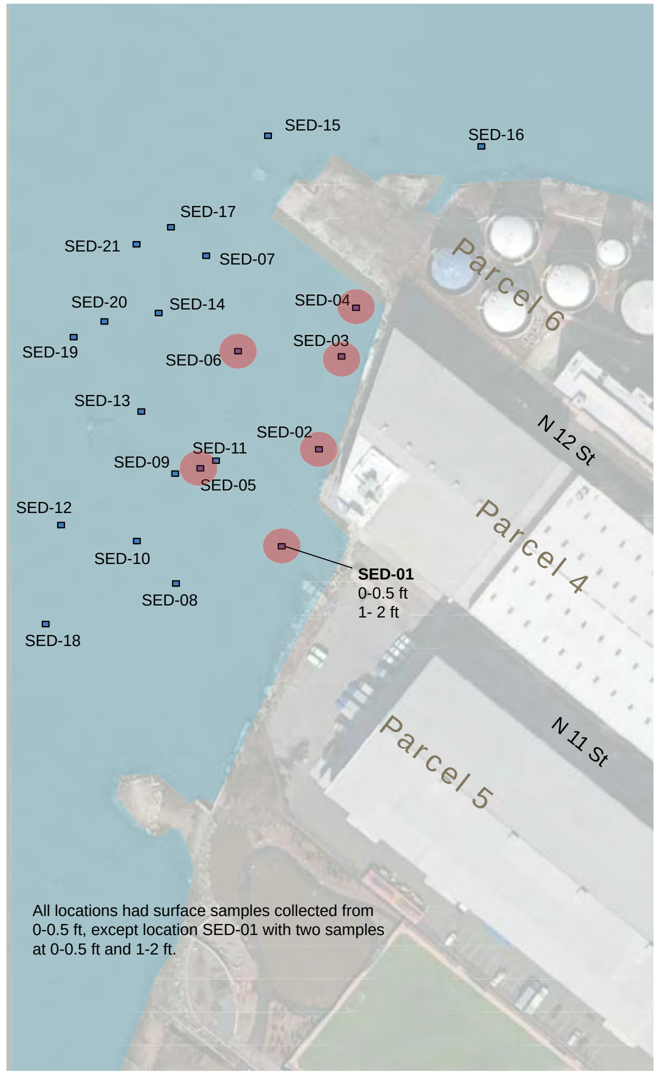


UCM: Unresolved Complex Mixture.

The different UCM shapes indicate the presence of various petroleum products.

Figure 5.4.2
Gas chromatograms from Parcel 6 and N. 12th Street indicate the presence of various petroleum products in the shallow soil/fill.

0-2 FT

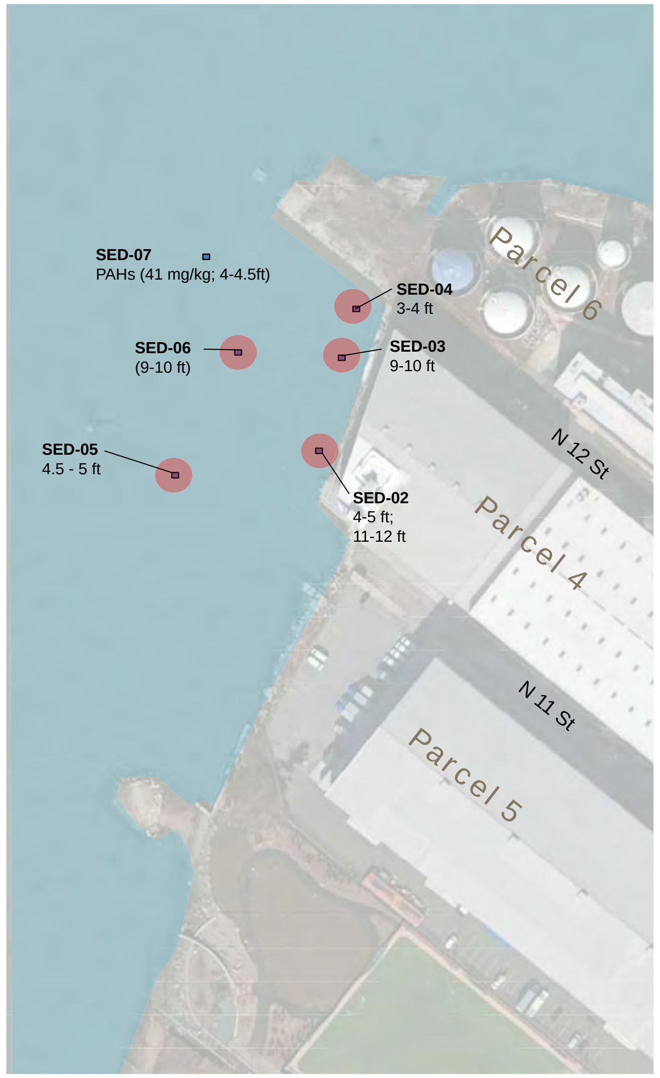


● PAHs 769 - 18,536 mg/kg (remainder of samples ranged from 0.6 - 27.7 mg/kg)

PCBs detected in 11 out of 22 samples, including duplicates (detections from 0.037 - 5.2 mg/kg).

DDT detected in 12 out of 22 samples (detections from 0.018 - 1.3 mg/kg)

3-12 FT

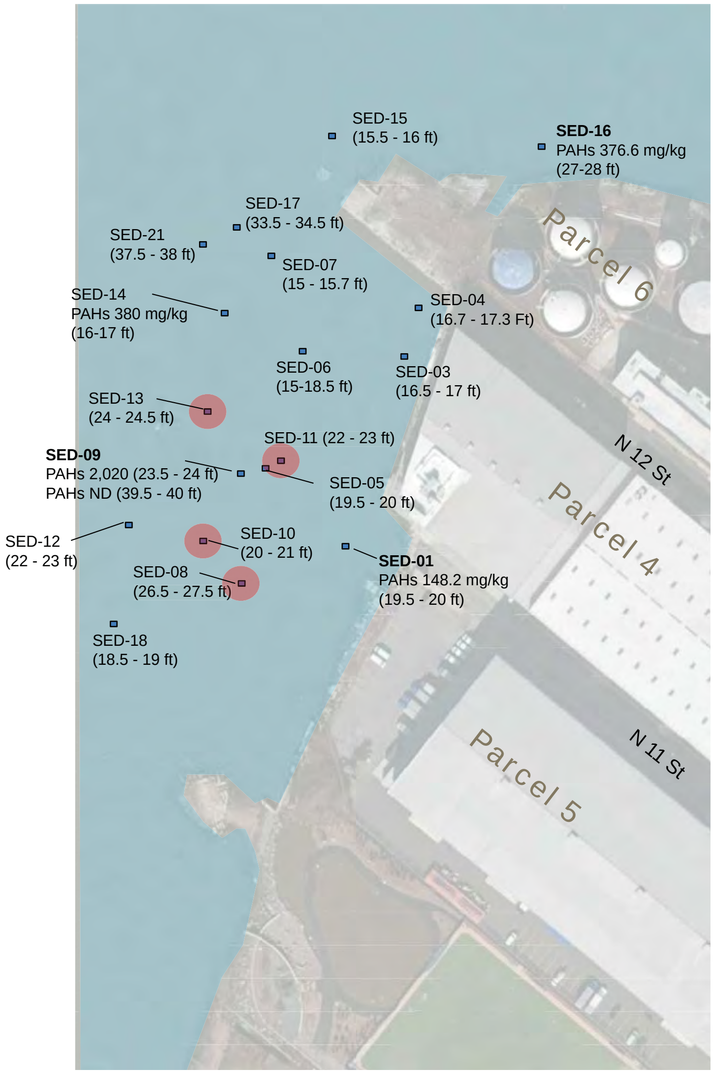


● PAHs 2,801 - 19,905 mg/kg

PCBs detected in 5 out of 7 samples (detections from 0.056 - 3.15 mg/kg).

DDT detected in all samples (detections from 0.12 - 3.8 mg/kg)

15-40 FT

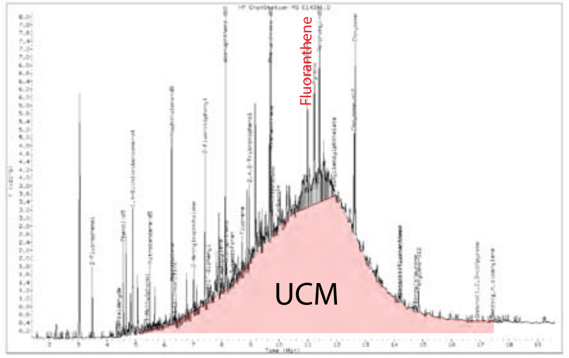


● PAHs 800 - 2,525 mg/kg (remainder of samples ranged from 1.43 - 380 mg/kg)

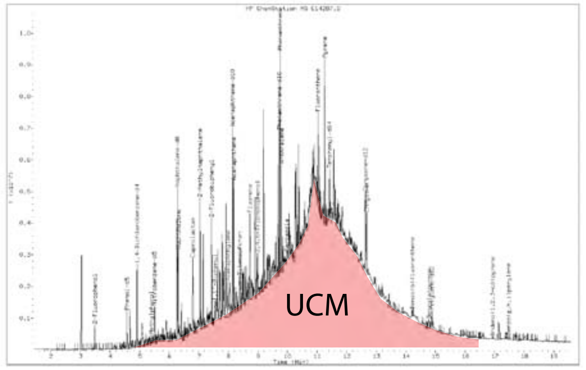
PCBs detected in all 6 analyzed samples (detections from 0.226 - 3.21 mg/kg; samples SED-01, 03, 04, 05, 06, 07)

DDT detected in all 4 of 6 analyzed samples (detections from 0.024 - 0.28 mg/kg; samples SED-01, 03, 04, 05, 06, 07)

SED-07 (0-0.5 ft)



SED-01 (19.5-20 ft)



0 80 160
Feet

Figure 6.2 East River sediment sample locations and results.

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LEGEND

▬	APPROXIMATE CURRENT PROPERTY BOUNDARY
┅	APPROXIMATE BOUNDARY OF FORMER MGP PROPERTY

OTHER INVESTIGATION SAMPLE LOCATIONS

A NRW-2	RECOVERY WELL[3]

0 100 200

SCALE, FEET

SOURCE:

1. AERIAL PHOTOGRAPH 2011 ESRI WORLD IMAGERY AND ITS DATA SUPPLIERS ACCESSED VIA ARCGISONLINE.COM

2. NEW YORK CITY OPEN ACCESSIBLE SPACE INFORMATION SYSTEM HTTP://WWW.OASISNYC.NET ACCESSED JANUARY 2008.

3. URS CORPORATION, NAPL RECOVERY WELLS, CONSTRUCTION COMPLETION REPORT, NOVEMBER 2014.

Draft Interim Remedial Investigation Report
Williamsburg Works Former MGP Site
Borough of Brooklyn, New York

nationalgrid

GEI Consultants

Figure 7.1 Recovery well locations.

Project 093060

December 2014

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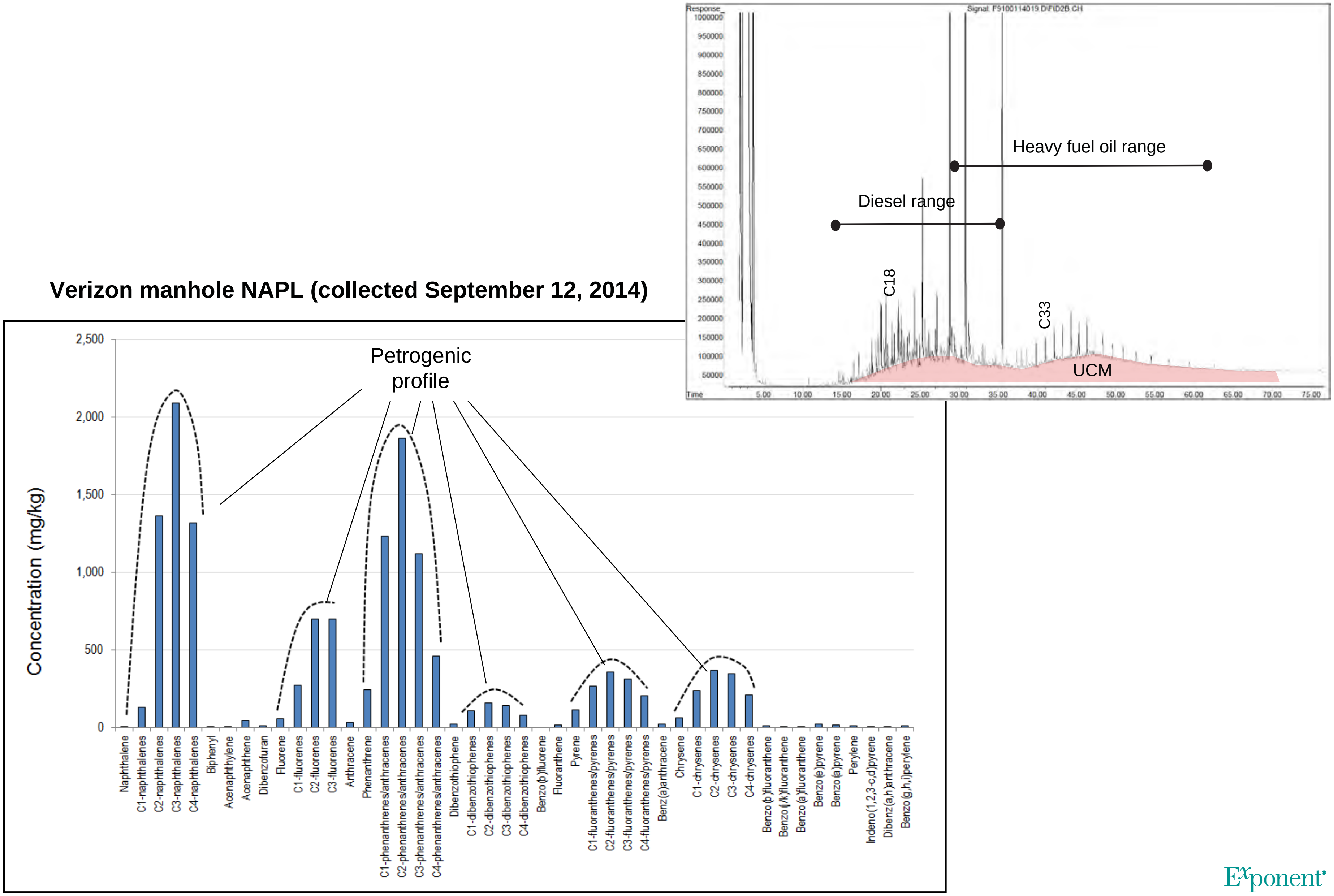
Verizon manhole NAPL (collected September 12, 2014)

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Figure 7.2 PAHs in the Verizon manhole NAPL is from petrogenic origins. The gas chromatogram indicates the presence of a mixture of petroleum products, inconsistent with impacts from the former MGP.

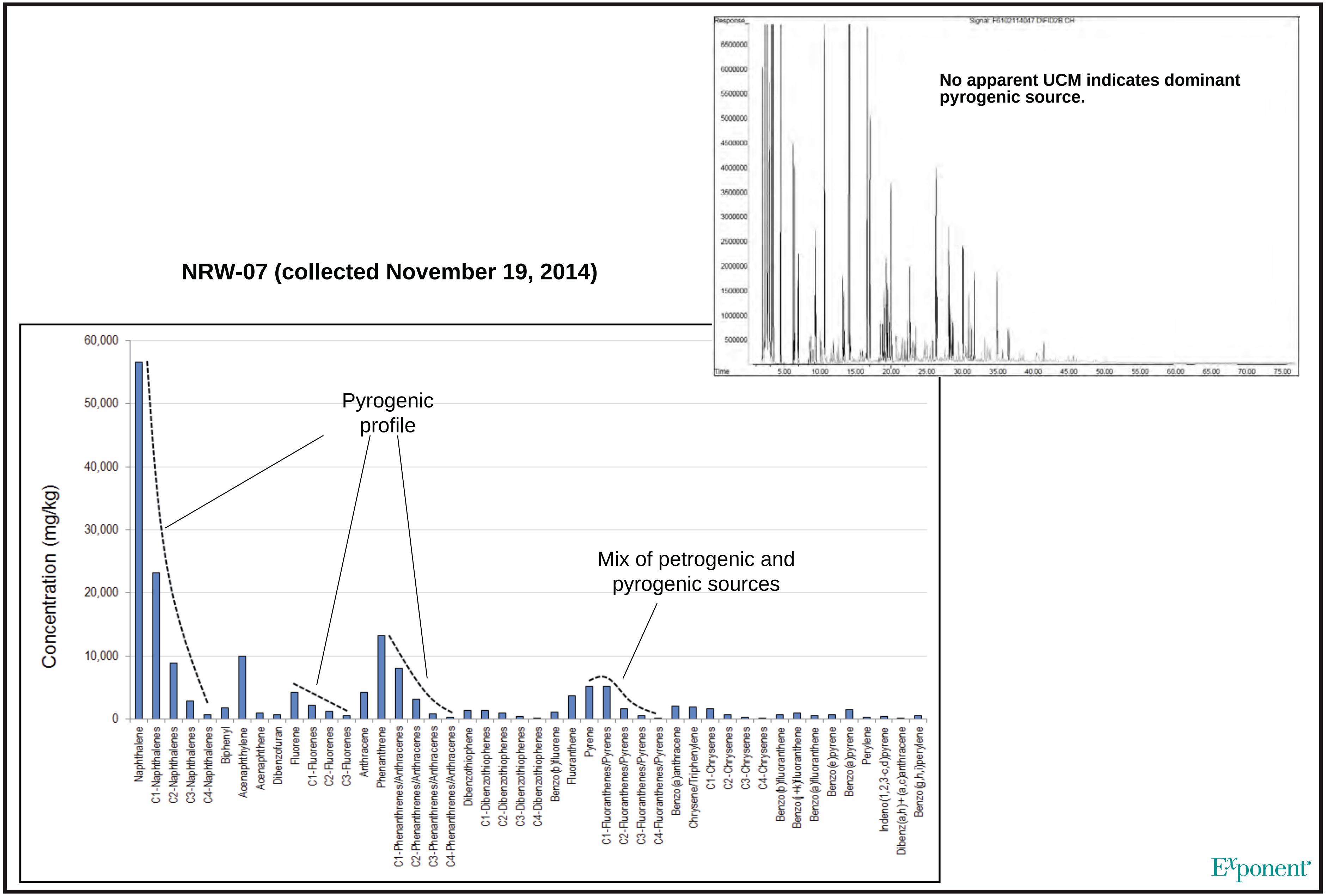

Figure 7.3 PAH profile for the NRW-07 NAPL sample indicates dominant pyrogenic PAHs, with a trace petrogenic source.

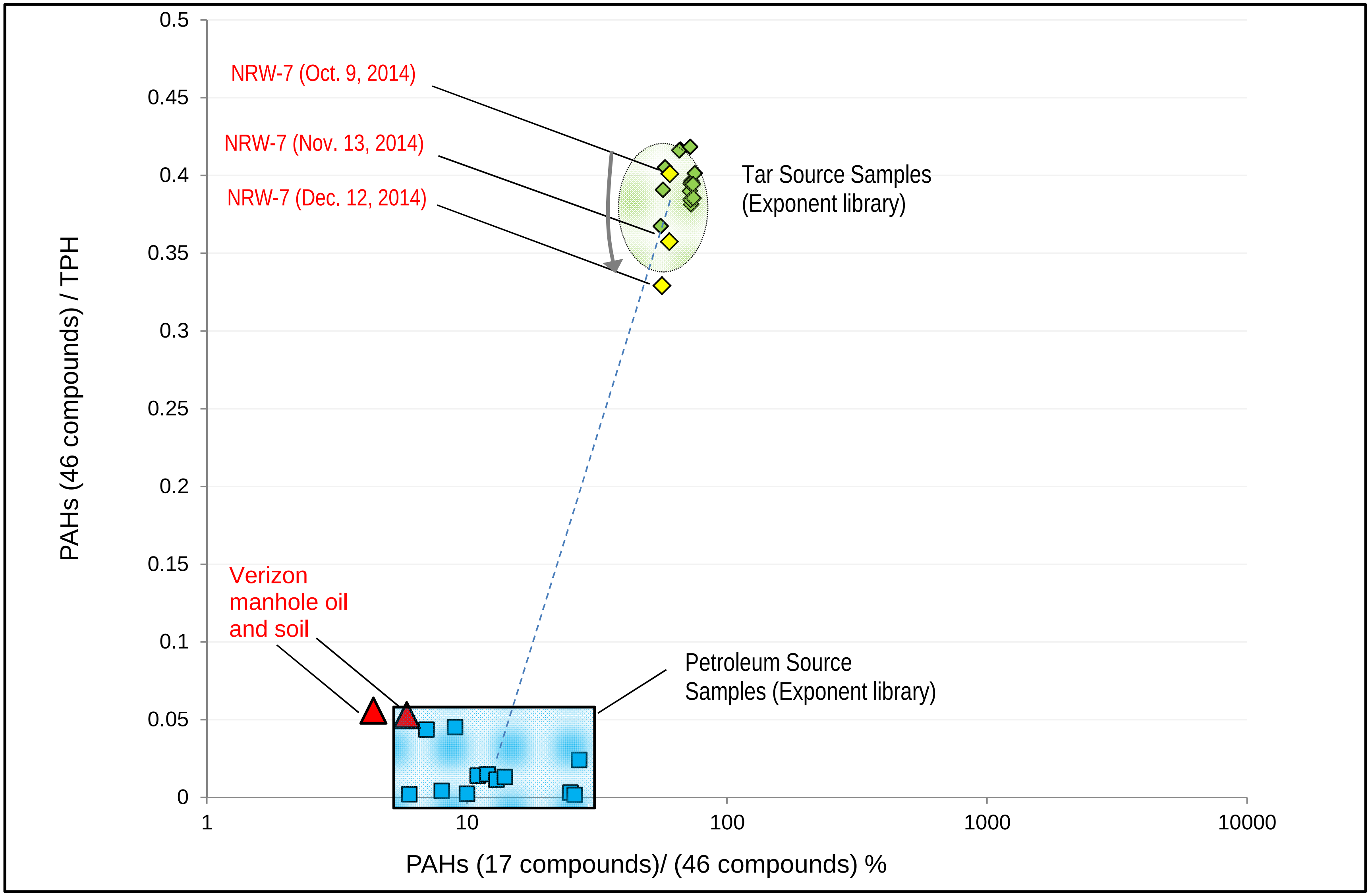

Figure 7.4. NRW-7 NAPL samples results with time.

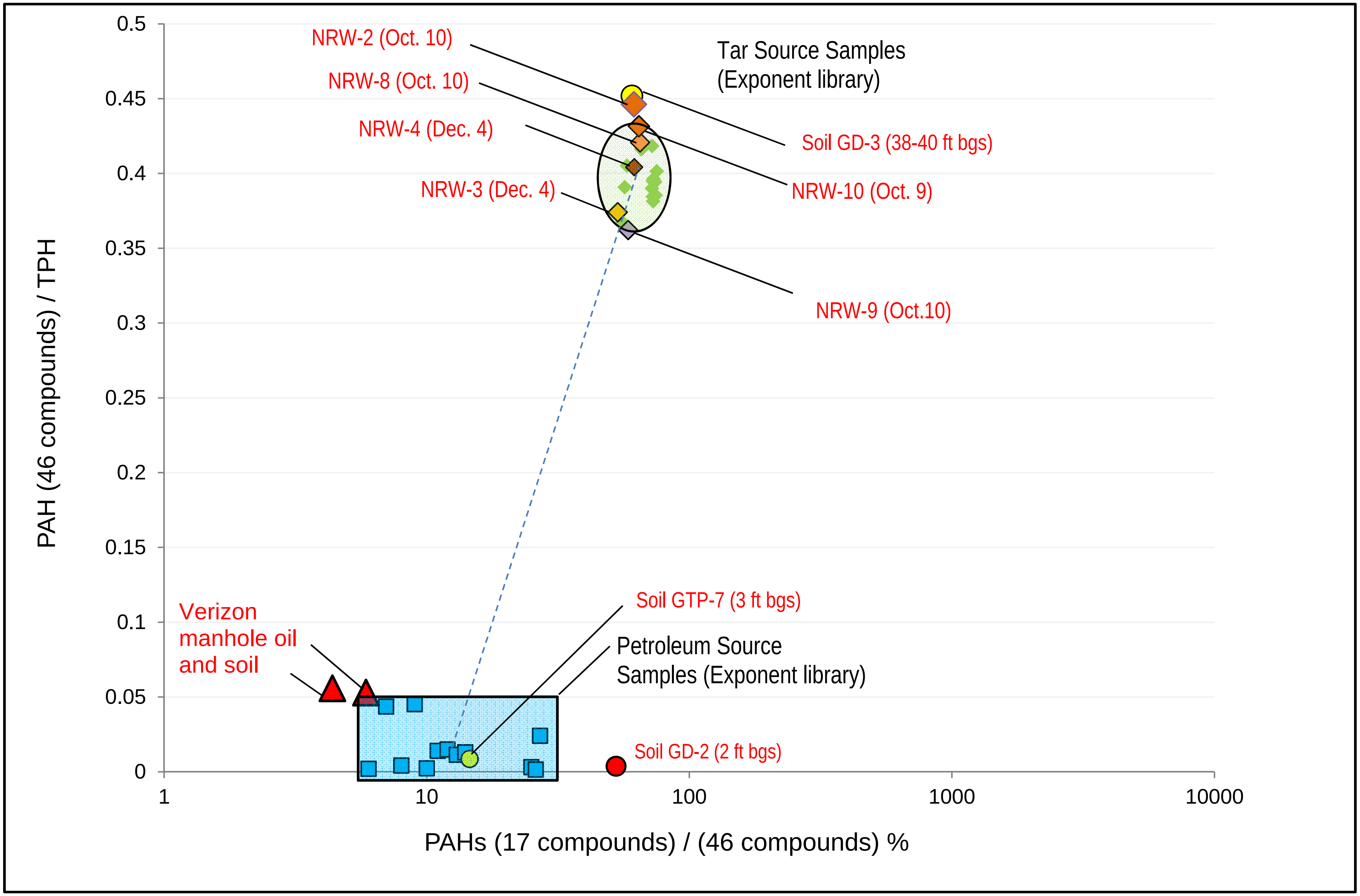

Figure 7.5. NAPL from the recovery wells contained PAHs from a pyrogenic dominant source. Verizon manhole NAPL and solid sample, and shallow soils from Parcel 2 were dominated by PAHs from a petrogenic source.