
FINAL IRA COMPLETION REPORT

**FIRE TRAINING PIT
FORT LEE, VIRGINIA**



PREPARED FOR:

**U.S. ARMY ENVIRONMENTAL COMMAND
ABERDEEN PROVING GROUND, MARYLAND
CONTRACT No. W91ZLK-05-D-0009**



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This Interim Removal Action (IRA) Completion Report describes field activities completed to address soils impacted as the result of historical activities conducted at the inactive Fire Training Pit (Site) and to summarize the results of the IRA that was completed at the Site. The field work and data evaluation followed U.S. Environmental Protection Agency (USEPA) guidance documents developed for activities performed under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). Furthermore, procedures were performed in accordance with Virginia Department of Environment Quality (VDEQ), where applicable.

1.1 PURPOSE OF REPORT

Field activities completed as part of this IRA were conducted under the requirements of the Department of Defense (DOD) Installation Restoration Program (IRP), which are consistent with the U.S. Environmental Protection Agency (EPA), and Virginia Department of Environmental Quality (VDEQ) guidelines. The USEPA guidelines followed during the Interim Removal Action are set forth in *Guidance for Remedial Investigations and Feasibility Studies under CERCLA*, (EPA, 1988).

All work was conducted in accordance with the field investigation procedures developed in the Final IRA Work Plan, dated February 2009 approved by the U.S. Army, USEPA, Region III and the Virginia Department of Environmental Quality (VDEQ). The activities in the IRA were geared towards collecting the information necessary to evaluate the type and magnitude of contamination, transport mechanisms and impacts of contamination on various media such as groundwater and soil. This report also documents site activities completed as part of the IRA. The specific objectives of this investigation and removal action were:

1. Characterize soils and groundwater within and surrounding the Site through a pre-excavation investigation;
2. Establish the limits of impacted soils associated with historical use of the Site;
3. Remove site soils impacted as the result of historical activities conducted at the Site; and
4. Update the nature and extent of contamination in soils, groundwater, and sediment associated with the Site;
5. Assess the risk to human health and ecological receptors.

1.2 BACKGROUND

1.2.1 FACILITY DESCRIPTION AND HISTORY

Fort Lee is located in Prince George County, Virginia, south of the City of Hopewell and northeast of Petersburg, as shown in **Figure 1-1**. Geographically, Fort Lee is sited in east central Virginia in the

Atlantic Coastal Plan physiographic province. The total area encompassed by Fort Lee is approximately 5,407 acres about half of which has been developed. Remaining portions are forested.

Just 18 days after a state of war with Germany was declared, the first Camp Lee was selected as a state mobilization camp and later became a division training camp. In June 1917, building began and within sixty days, 14,000 men swarmed over the newly designed military installation. When construction work ended, there were accommodations for 60,335 men. On July 15, 1917, the War Department announced that the camp would be named in honor of General Robert E. Lee (1807-1870), the most famous of the Confederate Civil War commanders.

After World War I, Camp Lee was taken over by the Commonwealth of Virginia and designated a game preserve. Later, portions of the land were incorporated into the National Military Park of Petersburg.

In October 1940, the War Department ordered the construction of another Camp Lee on the site of the earlier installation. Built as rapidly as the first, construction was still ongoing when the Quartermaster Replacement Training Center (QMRTC) started operation in February 1941. Camp Lee was also the home of a Medical Replacement Training Center, but as the Quartermaster training increased, it was decided to relocate the QMRTC at Camp Pickett. Later, the QMRTC was redesignated as an Army Services Forces Training Center, but it retained its basic mission of training Quartermaster personnel.

While the QMRTC was getting underway, the Quartermaster School was transferred to Camp Lee. A full program of courses was conducted, including Officer Candidate School. By the end of 1941, Camp Lee was the center of both basic and advanced training of Quartermaster personnel and held this position throughout the war.

When World War II ended, the fate of Camp Lee was in question. In 1946, the War Department announced that Camp Lee would be retained as a center for Quartermaster training. Official recognition of its permanent status was obtained in 1950 and the post was redesignated as Fort Lee.

Immediately thereafter troops began Quartermaster training for the Korean War and continued for the next three years. After the Korean War, progress was made on an ambitious permanent building program. Under the twenty year program, Fort Lee changed from an installation of temporary wooden structures to a modern Army post with permanent brick and cinder block buildings. The Quartermaster Training Center, created to supervise the training of Quartermaster personnel and troop units, brought an intensification of training activity within the Quartermaster Corps. As a result, the courses formerly taught at other locations were incorporated in the curriculum of the Quartermaster School.

Profound changes were evident at Fort Lee during 1962. The post became a Class 1 military installation under Second United States Army. The Quartermaster School became a part of the Continental Army Command service school system and was also selected to serve as the home of the Quartermaster Corps and Corps Historian. In July 1973, Fort Lee came under the control of the U.S. Army Training and

Doctrine Command.

1.2.2 SITE DESCRIPTION AND HISTORY

The site is located near the southern installation boundary (shown in **Figure 1-2**) near the intersection of H Avenue and 38th Street. The Fire Training Pit area consists of two (one active and one inactive) training pits. Waste oil has reportedly been used for fire training at the Site since the 1960s. The inactive pit, which is the focus of this Interim Removal Action Completion Report, is located at the eastern portion of the site and was reportedly closed in the early 1980s. The active pit is located approximately 100 yards west of the inactive pit and was constructed of an earthen dike with a metal burn pad in the center of the pit. A metal pipe with a valve was also installed through the dike for drainage. It is assumed that the inactive pit was similarly constructed. Drainage from the active pit is to the southeast and the soils in the active pit and in the drainage area were observed to be stained, during a 1997 Preliminary Assessment/Site Inspection (Fluor Daniel, 1997). No records exist that define the materials that were burned in the pits, but Fort Lee personnel reported that waste fuels and possibly solvents were burned in the pits during the 1970s. Additional analytical results were collected for the inactive Fire Training Pit site in November-December 2007. The results are presented and discussed in Section 1.2.3.

1.2.3 PREVIOUS INVESTIGATIONS

Previous investigations and findings at the site include the following:

Flour Daniel Preliminary Assessment/Site Investigation (PA/SI)

Flour Daniel conducted a Preliminary Assessment/Site Investigation (PA/SI) on six Fort Lee sites in 1997. One of the sites included in the report was the Petroleum Laboratory, which included concrete storage pads and storage buildings, the active fire training pit, and the inactive fire training pit. Soil sampling and groundwater monitoring wells were completed as part of the study. During the PA/SI, Fluor Daniel collected 12 surface soil/sediment samples, advanced a total of 18 direct push borings from which they collected 12 soil samples and 18 groundwater samples. Of these samples, three of the sediment samples and three borings were advanced in the immediate vicinity of the inactive fire pit. Analytical results indicated the following were detected in the three site soil borings:

- TPH-H concentrations ranged from 43 mg/Kg to 1,063 mg/Kg with samples from borings DPS-10 and DPS-11 exhibiting the highest concentrations.
- Concentrations of BTEX ranged from 0.013 mg/Kg to 5.74 mg/Kg.

Analytical results indicated the following detections in the four groundwater samples obtained from the immediate vicinity of the inactive fire pit:

- BTEX was not detected.
- TPH-L was detected in one groundwater sample at a concentration of 413 ug/L.
- Halogenated VOCs were detected in one sample at a concentration of 4.7 ug/L.

Fluor Daniel recommended no further action regarding the Petroleum Laboratory and the associated concrete storage pad and storage buildings; however, the areas of concern should be the inactive and active fire training pits. Fluor Daniel recommended that a confirmatory investigation be conducted in the area of the fire training pits.

PHYSICAL CHARACTERISTICS

Section 2.1 discusses the physical characteristics for Fort Lee including data on topography, climate, hydrology, geology, hydrogeology, and ecology. Detailed descriptions of physical characteristics for the Fire Training Pit are provided in Section 2.2.

2.1 FORT LEE CHARACTERISTICS

This section provides a summary of the physical characteristics of Fort Lee including topography, hydrology, climate, geology, and hydrogeology. The data provided for the Fort Lee facility was obtained from the Fluor Daniel *Chemical Data Acquisition Plan*, dated July 1994.

2.1.1 TOPOGRAPHY AND HYDROLOGY

Fort Lee terrain is gently rolling with an average elevation of 95 feet above mean sea level (MSL). The highest elevations, between 150 and 160 feet MSL, are found in the family housing area east of Saratoga Drive, and near the reservation boundary south of the U.S. Army Logistics Management Center. The lowest elevations, between 30 and 50 feet MSL, are found along Bailey and Cabin Creeks that flow through the central portion of the installation.

Significant surface water bodies within Fort Lee's boundary are Bailey Creek and the Blackwater Swamp. Bailey Creek is the main natural drainage channel extending through the center portion of Fort Lee from its headwaters near the southwest boundary of the post to the northeast boundary, and then to the James River which is approximately 7 miles from the post. Blackwater Swamp meanders across the southeast part of Fort Lee and receives a relatively small segment of the total runoff. Harrison Creek, which flows northward across the Park Service property, also drains a small area of Fort Lee.

2.1.2 CLIMATE

Climatic conditions in east central Virginia are moderate with an average annual temperature for the region of 60°F. The area experiences moderately cool summers with average July temperatures of 79°F, and mild winters with average January temperatures of 41°F. Precipitation in the area averages 42 inches per year with the heaviest rainfall occurring in the summer months of June, July, and August. Snowfall averages 15 inches per year and generally occurs in light falls that melt within 24 hours.

2.1.3 GEOLOGY

Fort Lee is located on the western edge of the Atlantic Coastal Plain Geologic Province. The Coastal Plain Province extends from the transitional zone of the Piedmont, or Fall Line, to the Continental Shelf and is comprised of a sediment wedge of unconsolidated clay, sand, and gravel with occasional bituminous shale, limestone, and sandstone lenses which increases in thickness from west to east.

The sediments in the vicinity of Fort Lee extend from the land surface to an approximate depth of 700 feet below land surface (bls) and are underlain by basement rocks of Precambrian and Paleozoic age. The maximum depth of investigation to date at Fort Lee is approximately 300 feet bls. The lithologic log of the test wellbore drilled to 300 feet bls indicates that the unconsolidated sediments in this section of the sediment wedge consist of three stratigraphic units. The upper unit is comprised of mixtures of clay, silt,

PHYSICAL CHARACTERISTICS

sand, and gravel and extends from land surface to a depth of approximately 75 feet bls. The intermediate unit is comprised of sand and gravel and extends from 75 feet to a depth of approximately 230 feet bls. The third unit is comprised of gravel and clay and extends from 230 feet to a depth of approximately 300 feet bls.

The upper stratigraphic units at Fort Lee, from land surface to approximately 300 feet bls, are representative of fluvial sediments deposited during the Pleistocene and Pliocene Epochs. The fluvial nature of the deposits is characterized by the intertonguing of clay, silt, and sand facies observed in local trenches and wellbores and by the presence of aggrading stream deposits observed in fill cuttings.

2.1.4 HYDROGEOLOGY

Fort Lee is underlain by approximately 700 feet of Coastal Plain sediments comprised primarily of unconsolidated sand, silt, and clay with occasional shale, limestone, and sandstone lenses. These sediments include up to 10 aquifers of varying permeability and water quality, between land surface and the crystalline basement rocks located at 700 feet bls. Confining units of varying thicknesses separate the sand and gravel aquifers within the sediment wedge.

The water table aquifer, called the Yorktown-Eastover Aquifer, uppermost of 10 aquifers and present in the shallow soils at the site, is comprised of moderately permeable sand, silt, and clay. Lenticular clay and silt beds have been documented as randomly distributed throughout the shallow aquifer. These clay and silt lenses may cause a locally perched water table in the shallow sediments, a condition that is indicated by historical depth-to-water measurements taken in shallow wells at the site.

The regional direction of groundwater flow at Fort Lee is toward the east; however, locally the direction of flow in the water table aquifer is toward topographically low areas such as Blackwater Swamp and Bailey Creek. Depth-to-water measurements in the water table aquifer range from land surface in low areas to as much as 30 feet bgs in the northwestern section of Fort Lee.

2.2 SITE CHARACTERISTICS

This section provides a detailed description of the Fire Training Pit including a discussion of topography, surface water hydrology, geology, hydrogeology, and ecology.

2.2.1 TOPOGRAPHY

The topography of the Fire Training Pit is generally flat with a gentle slope to the northwest and southwest which develops a surface water drainage divide across the site. As reported in the 1997 Final PA/SI, Fluor Daniels stated that “this topographic feature may also suggest that a shallow groundwater divide may occur along a northwest-southeast line extending though the middle of the site. The limited ECPT (Electronic Cone Penetration Testing) data suggests that this may be possible.”

2.2.2 SURFACE WATER HYDROLOGY

The surface water pathway can be significant due to the silty clay soils that are found throughout the Fort Lee installation which inhibit infiltration of precipitation and results in more surface runoff than infiltration

PHYSICAL CHARACTERISTICS

into the ground surface. Surface drainage at the site would move in two directions. Runoff from the concrete pad, parking lot and site building would drain towards the north-northwest. This surface water pathway eventually drains into Bailey Creek head waters. The remaining site runoff is to the south-southeast towards the Blackwater swamp, which is approximately 500 yards to the south.

2.2.3 GEOLOGY / HYDROGEOLOGY

As reported in the 1997 Final PA/SI, site topography may indicate "...that a shallow groundwater divide may occur along a northwest-southeast line extending though the middle of the site. The limited ECPT [*Electronic Cone Penetration Testing*] data suggests that this may be possible." The surface water pathway can be significant due to the silty clay soils that are found throughout the Fort Lee installation which inhibit infiltration of precipitation and results in more surface runoff that infiltration into the ground surface. Surface drainage at the site would move in two directions. Runoff from the concrete pad, parking lot and site building would drain towards the north-northwest. This surface water pathway eventually drains into Bailey Creek head waters. The remaining site runoff is to the south-southeast towards the Blackwater swamp, which is approximately 500 yards to the south.

The site is located within the Coastal Plain Physiographic Province. The Coastal Plan of Virginia has been characterized to weakly consolidated, stratified sediments. These sediments were deposited during the Cretaceous to the Quaternary periods and overlie older crystalline basement rocks. These deposits consist primarily of marine and terrigenous clastic sediments including sand, silt, clays, and gravels. The 1997 PA/SI provided limited site specific interpretation of site soils. The PA/SI reported that "the soils at the Petroleum Lab site consist of a thin layer (1 to 2 feet thick) of sand to silty sand underlain by clays, silty sands, and clayey silts." Similar conditions were identified during site activities completed in November-December 2007.

2.2.4 ECOLOGY

Information on wildlife common to the area was obtained from the Virginia Fish and Wildlife Information Service species lists for the Prince William, VA 7.5 minute USGS quadrangle. Fire Training Pit consists of a vegetated area with a dirt road. Vegetation on the site is primarily pine trees. The area surrounding Fire Training Pit includes a wooded area to the south and improved area to the north, east and west. This area is visible on **Figure 1-2**.

FIELD INVESTIGATION PROGRAM IRA SUMMARY

A field investigation was conducted to characterize soils and groundwater within and surrounding the inactive Fire Training Pit site in November-December 2007, prior to excavation activities. Soil and/or groundwater samples were analyzed for target compound list volatile organic compounds (TCL VOCs), TCL Polynuclear Aromatic Hydrocarbons (PAHs), TAL Metals and Total Organic Carbon (TOC). TCL VOCs were analyzed using SW-846 Method 8260B; TCL PAHs were analyzed using SW-846 Method 8270C, and TAL metals were analyzed using SW-846 Methods 6010/7471. The data was validated by TLI Solutions in January 2008. **Figure 3-1** provides the boring and monitoring well locations.

3.1 SOIL

As shown on **Figure 3-1**, a total of 14 soil borings were advanced to 20-24 feet below ground surface (bgs) using direct push technology. Soils removed from each boring location were visually examined and field screened with a photoionization detector (PID). A total of 24 soil samples were collected from the soil borings and the sample depths were chosen based on visual evidence of contamination (such as discolored or stained soils) and/or the depths at which the highest readings with the PID were detected. The Work Plan indicated that two soil samples would be collected from each boring location. However, during field activities a number of borings showed elevated PID readings and visual evidence of contamination at more than two depths. At these locations, soil samples were collected from three intervals rather than two. At other locations there was either no visual evidence of contamination and/or no elevated PID readings, or only one depth interval showed any evidence of contamination. At these locations, a soil sample was collected from only one interval.

Five surface soil samples were collected from the site at borings DPT-6, DPT-7, DPT-10, DPT-12, and DPT-14. These were composite soil samples. Surface soil samples were collected from 0-1 foot bgs.

3.1.1 SOIL RESULTS

In general, the site stratigraphy consists of light brown fine sand and silt overlying clayey and silty soils. A red, brown silt and clay mixture becomes prominent at a depth of approximately 4 feet bgs across the site. The soil transitions from a fine sand mixture to a brown, red brown silt and clay. During drilling efforts, a strong petroleum odor was detected in soil removed from DPT-1, DPT-6, DPT-7, DPT-8, DPT-9, and DPT-10. There was also free product visible in DPT-5, DPT-6, DPT-7 and DPT-10. Soil descriptions for soils removed from each of the borings are included in the Interim Removal Action Work Plan, February 2009. Soil analytical data are presented in **Table 3-1** and compared to the USEPA RSLs for residential and industrial soils and Fort Lee background values.

SURFACE SOIL

Numerous VOCs were detected above the method detection limits in each of the surface soil samples analyzed. However, none of the constituent concentrations were above the USEPA RSLs for residential or industrial soils. One or more SVOCs and numerous inorganics were detected at concentrations greater than the method detection limits in one or more samples collected at the ground surface from the various sample locations. Concentrations which exceed one or more of the regulatory criteria are shown spatially

FIELD INVESTIGATION PROGRAM IRA SUMMARY

on **Figure 3-1**. Additionally, results which exceed one of the regulatory criteria and, where appropriate, site specific background values are summarized below:

- Benzo(a)anthracene was detected in surface soils above the USEPA RSLs for residential soils in samples collected at DPT-6 and DPT-7 at concentrations of 310 ug/kg and 140 ug/kg, respectively.
- Naphthalene was detected in surface soil above the USEPA RSL for residential soils at DPT-6 and DPT-7 with concentrations varying from 6,300 ug/kg in shallow soils at DPT-6 to 4,500 ug/kg at DPT-7.
- Antimony was detected in surface soils above the USEPA RSL for residential soils and background values for Fort Lee surface soils in the sample collected at DPT-6 at a concentration of 35 mg/kg.
- Lead was detected in surface soils above the USEPA RSL for residential and industrial soils and site specific background values for Fort Lee surface soils at boring locations DPT-6 and DPT-7 with concentrations varying from 333 mg/kg to 1,240 mg/kg.

SUBSURFACE SOIL

Subsurface soil samples were collected from each of the boring locations at either one or two depth ranges depending on the results of the visual inspection and PID screening as described above. No VOCs were detected in concentrations which exceeded any of the applicable screening criteria within subsurface samples. Various SVOCs were detected above the USEPA RSL for residential and, locally, industrial soils. SVOC exceedances are summarized below. Various inorganic constituents in subsurface soil samples were detected above the USEPA RSLs for residential and industrial soils. However, only antimony concentrations exceeded the site specific background values. Concentrations which exceed one or more of the regulatory criteria and, where applicable, are above the background values, are shown on **Figure 3-1**.

- Naphthalene was detected in subsurface soils above the USEPA RSLs for residential soils at DPT-6, DPT-10, and DPT-11. Naphthalene was detected in subsurface soils above the industrial criteria at DPT-1, DPT-5, and DPT-7. Naphthalene concentrations in samples that exceeded one or more of the regulatory criteria varied from 8,100 ug/kg and 69,000 ug/kg, respectively.
- Antimony concentrations in subsurface soils exceeded the USEPA RSLs for residential soil at a number of locations. However, only one location showed antimony concentrations above the site specific background levels. Antimony was present at DPT-11 (4 to 8 feet bgs) at a concentration of 13.1 mg/kg which is above the USEPA RSLs for residential soil and the site specific background value for subsurface soil.

3.2 GROUNDWATER

Groundwater samples were collected from the monitoring well locations shown on **Figure 3-2** on December 17, 2007. Wells were sampled using a peristaltic pump and clean disposable tubing. Prior to removing any water from a well, depths to groundwater were measured. After collecting depth to groundwater data, the field team began evacuating water from the well. While evacuating groundwater from the wells, the team collected and recorded water quality data at regular intervals. Water quality data is included as Interim Removal Action Work Plan. When the difference between readings for each of the

FIELD INVESTIGATION PROGRAM IRA SUMMARY

parameters being measured stabilized to within 10% of the total variation for three successive readings, the field crew began collecting the groundwater sample. VOCs were collected first, in a manner which prevented any headspace from forming within the sample vials after which jars for the remaining parameters were filled.

3.2.1 GROUNDWATER RESULTS

One or more VOCs, SVOCs, and inorganics (total and dissolved) were detected at concentrations greater than the method detection limits in samples collected from the monitoring wells. Groundwater analytical results are summarized in **Table 3-2** and shown in **Figure 3-2**. A summary of groundwater analytical results (exceedances) is included below.

- 1,1-Dichloroethene was detected above the USEPA RSL for Tap Water in the groundwater sample collected at MW-5 at a concentration of 8.8 ug/L.
- 4-Methyl-2-pentanone was detected above the USEPA RSL for Tap Water in the groundwater sample collected at MW-5 at a concentration of 250 ug/L
- Benzene was detected above the USEPA RSL for Tap Water and/or the Maximum Contaminant Level (MCL) in samples collected from each of the sample locations at concentrations that range from 0.67 ug/L (estimated) to 180 ug/L.
- Ethylbenzene was detected above the USEPA RSL for Tap Water in samples collected from each of the sample locations at concentrations that range from 13 ug/L to 47 ug/L.
- m/p-Xylene was detected above the USEPA RSL for Tap Water in samples collected from MW-2 and MW-5 at concentrations of 95 ug/L and 48 ug/L, respectively.
- Naphthalene was detected above the USEPA RSL for Tap Water in the samples collected from each of the sample locations at concentrations that range from 52 ug/L to 240 ug/L.

Numerous inorganics (total and dissolved) were also detected above one or more of the applicable criteria at MW-1, MW-2, MW-4, and MW-5. Antimony, Cobalt, Iron, Manganese, and Thallium (both total and dissolved) were detected above the USEPA RSL for Tap Water and/or MCL at one or more locations. Refer to **Table 3-2** for a tabulated summary of groundwater data and groundwater exceedances for the various analytes.

A groundwater elevation map is included in **Figure 3-3**. As shown in **Figure 3-3**, groundwater at the site appeared to flow to the north during December 2007. It should be noted that during the timeframe in which site activities were completed the Fort Lee area was in the midst of an extensive drought. Groundwater elevation varied across the site by less than 0.2 feet and the groundwater flow direction during the sampling event was different than that previously reported for the site (groundwater was reported to flow to the southeast) by site personnel familiar with previous investigations completed in the area.

FIELD INVESTIGATION PROGRAM IRA SUMMARY**3.3 DATA GAPS**

Based on a review of the existing data, recommendations provided by Fluor Daniel, an initial site visit, and communications with Fort Lee, the data gaps identified for the field investigation were summarized as follows:

- Determining the Extent of Contamination in Environmental Media. The nature and extent of contamination had not been fully assessed in groundwater at the site based on a review of the existing data. However, as indicated in the Interim Removal Action Work Plan, the extent of the groundwater impacting the Fire Training Pit is a result of contamination off-site and is not covered in this report.

3.4 PATH FORWARD

Based upon the results of the 2007 investigation of the site, an interim removal action was designed for the site as detailed in the *Final Interim Removal Action Work Plan*, dated February 2009. Section 4 of this report details activities completed as part of the interim removal action.

INTERIM REMOVAL ACTION SUMMARY

4.1 IRA SUMMARY

On 23 January 2009, ECC mobilized to the Site upon receiving approval of the Final Interim Removal Action Work Plan. During mobilization activities, the Site Superintendent coordinated with the USAEC's Contracting Officer's Representative (COR) at Fort Lee and received approval to construct the temporary access road staging areas, and approval to cut trees larger than 6-inches in diameter.

Tree clearing and chipping activities were performed at the site to allow construction of the temporary access road, create sufficient space around the perimeter of the excavation area to perform the work, and to create space for stockpiling impacted soil prior to off-site removal and disposal.

Initially, soil was to be excavated from predefined limits (as specified in the IRA Work Plan) within the inactive FTP as shown on **Figure 4-1**. However, during the removal activities, the Army decided to over-excavate impacted soils to their limits based upon field data and observations. The final exaction area was expanded to approximately 40 feet wide by 60 feet across (2,400 square feet) and extended to the depth of groundwater (approximately 16 feet deep). Soil that could be determined to be impacted per visual or olfactory observation was transported to the impacted stockpile or was loaded directly onto a truck and transported to a local RCRA Subtitle D disposal facility. If there was no visual or olfactory evidence, soil samples were screened in accordance with the Work Plan (ECC and Malcolm Pirnie 2009) using PetroFLAG™ field test kits to determine TPH concentration. However, by visual/olfactory evidence or by the field test kits, all excavated soil was determined to be petroleum impacted. A total of 2,081 tons of non-hazardous contaminated soil was transported and disposed at the East End Landfill located in Richmond VA. Appendix F contains the manifest and weight tickets.

Following the soil excavation and removal, an amendment was applied to the base of the excavation as a supplemental/tertiary treatment to assist in the degradation of any residual contamination that is possibly present in the smear zone and groundwater. The amendment (Regenesis's Oxygen Release Compound Advanced™) was used in accordance with manufacturer's recommendations. Forty pounds of the dry powder form was mixed thoroughly with clean backfill material. The mixture was backfilled within the depth interval where the groundwater table and smear zone occur as identified during excavation and through previous investigations. The amendment will slowly release oxygen over time to enhance biological degradation of residual contaminants by microorganisms under aerobic conditions.

An acceptable source for backfill material was identified on the installation. Two soil samples were collected from the source area and the source was deemed acceptable clean fill consistent with native soils and similar to existing soils at the site. The excavation area was backfilled, graded, and compacted with the excavator bucket. Backfill was utilized from the "borrow pit" on Fort Lee.

Following the backfill activities, the temporary access road was removed. Previous grass-covered areas disturbed during project activities were topped with topsoil and seeded. Non-grass covered areas that were disturbed were graded to match the surrounding area. The ECC field team and subcontractors demobilized from the site on 21 February 2009.

INTERIM REMOVAL ACTION SUMMARY

4.2 SAMPLING

Confirmation samples were collected from the excavation walls and samples were analyzed for target compound list (TCL) volatile organic compounds (VOCs), TCL Polynuclear Aromatic Hydrocarbons (PAHs), Target analyte list (TAL) Metals and Total Organic Carbon (TOC), and dioxin/furans. TCL VOCs were analyzed using SW-846 Method 8260B; TCL PAHs were analyzed using SW-846 Method 8270C, and TAL metals were analyzed using SW-846 Methods 6010/7471. During the excavation, 15 soil samples and one groundwater sample were collected. Twelve soil samples were laboratory analyzed for volatile organic compounds (VOCs), PAHs, and metals, 2 soil samples were analyzed for dioxins, and one soil sample was analyzed for diesel and gasoline range organics. One groundwater sample was analyzed for dioxins. The data was validated by TLI Solutions in June 2009. **Figure 4-1** provides the soil sample and monitoring well locations.

4.2.1 SOIL

One sample was collected from the walls of the excavation at a depth of 3.5 feet (ft) below ground surface (bgs), 10 samples were collected from the walls of the excavation at a depth of approximately 9 to 10 feet bgs (at the primary depth where stained soils were noted in the boring logs), 2 samples were collected from a depth of 14 ft bgs, just above the water table in an area laterally equivalent to the smear zone, and 1 sample (BOTT) was collected at the base of the excavation at a depth of 16 ft bgs.

4.2.1.1 Soil RESULTS

Subsurface soil samples were collected from 15 sample locations within the excavation area. One or more VOC and SVOCs were detected at concentrations greater than the method detection limits in one sample collected at 14 feet below the ground surface. Soil analytical data and the USEPA RSLs and Fort Lee background values are presented in **Table 4-1** and are shown spatially on **Figure 4-2**. VOC and SVOC detections above RSLs are summarized below:

- Ethylbenzene was detected above the USEPA RSL for residential soil in the sample collected at C2 (14 feet bgs) at a concentration of 6,200 ug/kg.
- Naphthalene was detected above the USEPA RSL for residential soil in samples collected at C2 (14 feet bgs) and BOTT (16 feet bgs) at concentrations of 11,000 ug/kg and 5,400 ug/kg, respectively.
- 2-Methylnaphthalene was detected above the USEPA RSL for residential soil in the sample collected at C2 (14 feet bgs) at a concentration of 45,000 ug/kg.

Numerous inorganics were also detected above one or more of the applicable criteria at each of the locations sampled. However, only barium was detected above the applicable regulatory criteria (both the USEPA RSL for residential and industrial soils) and site specific background values. Refer to **Table 4-1** for a tabulated summary of soil data and soil exceedances for the various analytes. Soil exceedances are shown spatially on **Figure 4-2**.

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4.3.1 GROUNDWATER

One groundwater sample was collected from MW-5 on February 12, 2009 prior to removal of the monitoring well. The well location is shown on **Figure 4-1**. The groundwater sample was analyzed for dioxins only. The well was sampled using a peristaltic pump and clean disposable tubing. While obtaining groundwater from the well, the team collected and recorded water quality data at regular intervals. When the difference between readings for each of the parameters being measured stabilized to within 10% of the total variation for three successive readings, the field crew began collecting the groundwater sample.

4.3.2 GROUNDWATER RESULTS

One or more dioxins/furans were detected at concentrations greater than the method detection limits in samples collected from the monitoring well; however only the 2,3,7,8-TCDD Toxic Equivalents (TEQ) are presented. Dioxin/furan analytical results are summarized in **Table 4-2** and provided below.

- 2,3,7,8-TCDD TEQ was calculated in MW-5 at a concentration of .000000244 ug/L.

Organics

Additional sampling was conducted in May 2009, and one or more VOCs, SVOCs, and inorganics (total and dissolved) were detected in samples collected from the monitoring wells. Groundwater analytical results are summarized in **Table 4-3** and shown in **Figure 4-3**. A summary of groundwater analytical results is also included below.

- Benzene was detected above the USEPA RSL for tap water in 2 samples collected at MW-2 and MW-3 at concentrations of 2.8 ug/L and 17 ug/L, respectively. The concentration at MW-3 also exceeded the MCL.
- Ethylbenzene was detected above the USEPA RSL for tap water in 3 samples collected at MW-1, MW-2, and MW-3 at concentrations that range from 5 ug/L to 13 ug/L.
- m,p-xylene was detected above the USEPA RSL for tap water in MW-2 at a concentration of 160 ug/L.
- o-xylene was detected in MW-2 above the USEPA RSL for tap water at a concentration of 150 ug/L.
- Xylene was detected above the USEPA RSL for tap water in MW-2 at concentration of 310 ug/L.
- 2-methylnaphthalene was detected above the USEPA RSL for tap water in 2 samples collected at MW-1, and MW-2 at concentrations that of 22 ug/L and 26 ug/L, respectively.
- 1-methylnaphthalene was detected above the USEPA RSL for tap water in 3 samples collected at MW-1, MW-2, and MW-3 at concentrations that range from 6.2 ug/L to 17 ug/L.
- Naphthalene was detected above the USEPA RSL for tap water in 4 samples collected at MW-1, MW-2, MW-3, and MW-4 at concentrations that range from 2.4 ug/L to 25 ug/L.

Inorganics

The May 2009 sampling results indicated one or more inorganics (total) were detected in samples collected from each of the monitoring wells. Numerous metals were detected above the USEPA RSLs for tap water and MCLs for drinking water; however, all of these values were below the Fort Lee

INTERIM REMOVAL ACTION SUMMARY

groundwater background values except for iron concentrations. Inorganic data for samples collected in May 2009 are presented in **Table 4-3**, and exceedances are shown spatially on **Figure 4-3**. Groundwater results for constituents which exceeded regulatory criteria and Fort Lee groundwater background values are summarized below.

- Iron was detected above the USEPA RSL for tap water and site specific background in MW-1 at a concentration of 12,700 ug/L.

NATURE AND EXTENT OF CONTAMINATION

This section discusses the nature and extent of contamination at the site. The PA/SI was limited in scope and concluded that the nature of contamination at the inactive fire pit is likely due to waste fuels. Groundwater samples were collected to define the nature and extent of contamination at the Site. As previously detailed, the 2007 investigation was used to delineate the approximate limits of impacted soils and groundwater in order to outline the scope of this IRA, as discussed in Section 2 of this report. Additional characterization of subsurface soils was completed during excavation of impacted soils (January 2009), as detailed in Section 4 of this report. An additional round of confirmation groundwater samples was collected in May 2009 and is described in more detail later in this section.

5.1 NATURE AND EXTENT OF CONTAMINATION (PRE-REMOVAL ACTION, 2007)

5.1.1 SURFACE SOILS

As detailed in Section 3, five surface soil samples were collected in November-December 2007. Although these samples contained numerous VOCs typically associated with fuels (benzene, xylene, toluene), none of the VOC constituents exceeded USEPA RSLs for residential soil, SVOCs including benzo(a)anthracene and naphthalene were detected above USEPA RSLs for residential soil in two samples (DPT6 and DPT7).

5.1.2 SUBSURFACE SOILS

As detailed in Section 3, 24 soil samples and 3 duplicates were collected from the excavation area in November-December 2007. The sample locations are shown on **Figure 3-1**. These samples were collected after completion of removal of impacted soils (as previously discussed) from the walls of the excavation. The resulting data were used in the subsequent risk assessment. Refer to Section 3 for a summary of analytical results. SVOC and inorganic constituents were detected above USEPA RSL for residential soil. Although VOCs were detected in subsurface soil, detections were below screening criteria. As shown on **Figure 3-1**, the majority of detections occurred in the center of the fire training pit and with the exception of DPT-1, subsurface samples located upgradient and downgradient of the inactive pit did contain screening criteria exceedances.

5.1.3 GROUNDWATER

As discussed in Section 4 and shown on **Figure 3-2**, concentrations of VOCs, SVOCs, and inorganics (total and dissolved) were detected at concentrations greater than USEPA RSLs for tap water and/or MCLs at one or more locations. In general, the highest concentrations were observed in the center of the Site near MW-5 and were consistent among the remaining wells located upgradient and downgradient of MW-5.

5.2 NATURE AND EXTENT OF CONTAMINATION IN REMOVED SOILS (2009)

As detailed in Section 4, two samples were obtained from the center of the excavated area in February 2009 and contained numerous VOC and SVOC constituents such as ethylbenzene, naphthalene, and 2-methylnaphthalene. These are consistent with the likely contaminant source (possibly waste fuels and solvents). As discussed in Section 4, removal activities extended to the limits shown on **Figure 4-1** where VOC and SVOC constituents were detected in soil samples but at concentrations less than screening criteria.

NATURE AND EXTENT OF CONTAMINATION

5.3 NATURE AND EXTENT OF CONTAMINATION (POST-REMOVAL ACTION, 2009)

5.3.1 SURFACE SOILS

As the excavated area encompassed 2007 sample locations where VOCs and SVOCs exceeded USEPA RSLs for residential soil (DPT6 and DPT7), VOC and SVOC exceedances in surface soil have likely been removed. As shown on **Table 3-1**, certain inorganic constituents may remain in surface soil outside of the limits of remedial action which exceed USEPA RSLs (DPT10, DPT12, and DPT14). However these inorganic concentrations are within one order of magnitude of Fort Lee background values.

5.3.2 SUBSURFACE SOILS

As detailed in Section 4, 15 soil samples and 2 duplicates were collected from the excavation area in February 2009. The sample locations are shown on **Figure 4-1**. These samples were collected after completing the removal of impacted soils (as previously discussed) from the walls of the excavation. The resulting data were used in the subsequent risk assessment. Refer to Section 4 for a summary of analytical results.

Consistent with the likely contaminant source (possibly waste fuels and solvents), concentrations of ethylbenzene, naphthalene, and 2-methylnaphthalene were found in samples C2 and BOTT at concentrations exceeding Region III RSLs for residential soil. Both of these samples were collected from within the smear zone in the center of the fire training pit. As previously discussed in the February 2009 Interim Removal Action Work Plan, it should be noted that groundwater impacted from off-site up-gradient source areas reportedly flows on site from west to east. Constituents contained in groundwater have and will continue to impact site soils within the smear zone.

All 12 samples analyzed for TAL metals contained one or more metals at concentrations exceeding the USEPA RSLs for residential soil. However, only arsenic was detected above site-specific background levels and only at one location. Arsenic was detected at a concentration of 2.0 mg/kg at SSW3 (9 to 10 feet bgs). This exceeds the USEPA RSLs for residential (0.39 mg/kg) and industrial (1.6 mg/kg) soils, as well as the site specific background value for subsurface soils (1.6 mg/kg).

5.3.3 GROUNDWATER

As discussed in Section 4, one groundwater sample was collected from MW-5 (located within the limits of the excavation area) during IRA activities conducted in February 2009 to assess the dioxin/furan levels in groundwater and for use in the subsequent risk assessment. MW-5 was removed after collection of the sample during excavation activities. **Table 4-2** provides the analytical results for the groundwater sample collected from MW-5. Four groundwater samples were collected from the monitoring wells remaining in place after completion of the IRA site activities (MW-1 through MW-4) in May 2009. Monitoring well locations are shown on **Figure 4-3**. As previously discussed, dioxin/furan values did not exceed the USEPA RSLs for tap water or USEPA MCLs. Groundwater samples collected from MW-1 through MW-4 were collected in order to compare concentrations of constituents in groundwater after completion of IRA activities to data from the December 2007 sampling event. Data for groundwater samples collected in May 2009 are presented in **Table 4-3**.

NATURE AND EXTENT OF CONTAMINATION

Organics

VOCs and SVOCs were detected at concentrations greater than the method detection limits in samples collected from the monitoring wells. Groundwater analytical results are summarized in **Table 4-3** and shown in **Figure 4-3**. A summary of exceedances in groundwater collected in May 2009 is presented below.

- Benzene was detected above the USEPA RSL for tap water in 2 samples collected at MW-2 and MW-3 at concentrations of 2.8 ug/L and 17 ug/L, respectively. The concentration at MW-3 also exceeded the MCL.
- Ethylbenzene was detected above the USEPA RSL for tap water in MW-1, MW-2, and MW-3 at concentrations that range from 5 ug/L to 13 ug/L.
- m,p-xylene was detected above the USEPA RSL for tap water in MW-2 at a concentration of 160 ug/L.
- o-xylene was detected above the RSL in MW-2 above the USEPA RSL for tap water at a concentration of 150 ug/L.
- Xylene was detected above the USEPA RSL for tap water in MW-2 at concentration of 310 ug/L.
- 2-methylnaphthalene was detected above the USEPA RSL for tap water in MW-1, and MW-2 at concentrations of 22 ug/L and 26 ug/L, respectively.
- 1-methylnaphthalene was detected above the USEPA RSL for tap water in MW-1, MW-2, and MW-3 at concentrations that range from 6.2 ug/L to 17 ug/L.
- Naphthalene was detected above the USEPA RSL for tap water in MW-1, MW-2, MW-3, and MW-4 at concentrations that range from 2.4 ug/L to 25 ug/L.

Inorganics

The May 2009 sampling results indicated one or more inorganics (total) were detected in samples collected from each of the monitoring wells. Numerous metals were detected above the USEPA RSLs for tap water and MCLs for drinking water; however, all of these values were below the Fort Lee groundwater background values except for iron concentrations. Inorganic data for samples collected in May 2009 are presented in **Table 4-3**, and are shown spatially on **Figure 4-3**. Groundwater results for constituents which exceeded regulatory criteria and Fort Lee groundwater background values are summarized below.

- Iron was detected above the USEPA RSL for tap water and site-specific background concentration in MW-1 at a concentration of 12,700 ug/L.

The 2009 groundwater sampling event is compared to the 2007 sampling event in **Table 5-1**. Overall the SVOC concentrations in the May 2009 sampling event decreased. There were a number of fluctuations within the VOC results from December 2007 and May 2009. A discussion of the VOC fluctuations is provided below.

- m,p-xylene was detected in MW-2 at a concentration of 160 ug/L in May 2009. m,p-xylene was detected in MW-2 at a concentration of 95 ug/L in December 2007. m,p-xylene was detected in MW-1 at a concentration of 10 ug/L in May 2009. m,p-xylene was detected in MW-1 at a concentration of 2.8 ug/L in December 2007.
- o-xylene was detected in MW-2 at a concentration of 150 ug/L in May 2009. o-xylene was

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detected in MW-2 at a concentration of 110 ug/L in December 2007. o-xylene was detected in MW-3 at a concentration of 6 ug/L in May 2009. o-xylene was detected in MW-3 at a concentration of 11 ug/L in December 2007.

- Isopropyl benzene was detected in MW-2 at a concentration of 7.4 ug/L in May 2009. Isopropyl benzene was detected in MW-2 at a concentration of 4.1 ug/L in December 2007. Isopropyl benzene was detected in MW-3 at a concentration of 3.8 ug/L in May 2009. Isopropyl benzene was detected in MW-3 at a concentration of 3.6 ug/L in December 2007.
- Methyl-tert-butyl ether was detected in MW-2 at a concentration of 3.0 ug/L in May 2009. Methyl-tert-butyl ether was detected in MW-2 at a concentration of 1.3 ug/L in December 2007.
- Acetone was detected in MW-1 at a concentration of 13 ug/L in May 2009. Acetone was not detected in MW-1 in December 2007.
- Benzene was detected in MW-2 at a concentration of 2.8 ug/L in May 2009. Benzene was detected in MW-2 at a concentration of 0.67ug/L in December 2007. Benzene was detected in MW-3 at a concentration of 17 ug/L in May 2009. Benzene was detected in MW-3 at a concentration of 30 ug/L in December 2007.

FATE AND TRANSPORT

This section provides a qualitative evaluation of contaminant fate and transport at the Fire Training Pit site. Known and potential contaminant sources, site physical characteristics, physical and chemical properties of the contaminants, and the nature and extent of contamination are discussed.

6.1 TRANSPORT MECHANISMS AND CONTAMINANT PROPERTIES

The fate and transport of contaminants in the environment is influenced by the following mechanisms:

- **Adsorption/Desorption.** The process by which contaminant transport is retarded due to adsorption of contaminants to soil particles. Desorption is the reverse process of adsorption.
- **Advection.** The physical process by which contaminants are transported in solution at the average linear velocity of groundwater in the direction of groundwater flow.
- **Complexation.** The chemical process by which dissolved species are formed from two or more simpler dissolved species, each of which can exist in an aqueous solution.
- **Diffusion.** The chemical process that results in the movement of contaminants in response to concentration gradients.
- **Dispersion.** The mechanical process of mixing that results from local variations in the average velocity of groundwater.
- **Dissolution/Precipitation.** The chemical process by which a material is dissolved in a liquid solvent such as water. Precipitation is the reverse process of dissolution.
- **Ion Exchange.** The chemical process involving the reversible exchange of ions between a liquid and a solid.
- **Reduction/Oxidation.** A chemical reaction (redox reaction) involving changes in the oxidation states of elements.
- **Transformation.** The loss or degradation of contaminants from the environment as a result of chemical reactions of microbial activity.
- **Volatilization.** The transfer of contaminants from the liquid phase to the vapor phase (i.e., soil gas in unsaturated environments or the atmosphere).

6.1.1 ORGANIC COMPOUNDS

The primary organic compounds that have been detected at the site are select VOCs, SVOCs and Dioxins. Below is a summary of the number of detects for each analyte in each media (number of detects/number of samples):

Parameter	Subsurface Soil	Groundwater
Volatile Organics		
Carbon disulfide	0/12	2/4
Acetone	12/12	1/4
Methyl-tert-butyl ether	0/12	1/4
1,1-dichloroethane	0/12	1/4
Methylene Chloride	7/12	0/4
2-Butanone	5/12	0/4
1,1,1-Trichloroethane	1/12	0/4

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Benzene	1/12	2/4
Toluene	6/12	1/4
Ethylbenzene	7/12	3/4
Isopropyl Benzene	8/12	2/4
1,2,4-Trichlorobenzene	1/12	0/4
Xylenes (total)	12/12	3/4
Cyclohexane	0/12	1/4
Methylcyclohexane	8/12	2/4
Semivolatile Organics		
Naphthalene	9/12	4/4
2-Methylnaphthalene	11/12	4/4
1-Methylnaphthalene	11/12	4/4
Acenaphthene	7/12	3/4
Fluorene	8/12	4/4
Phenanthrene	11/12	4/4
Anthracene	0/12	2/4
Fluoranthene	0/12	3/4
Pyrene	2/12	3/4
Dioxin/Furans		
2,3,7,8-TCDD TEQ ¹	2/2	1/1

VOCs

Numerous VOCs were detected including (but not limited to) acetone, methylene chloride, toluene, isopropyl benzene, and xylenes in the soil at the site; however, only one constituent (ethylbenzene) was detected above the USEPA RSL for residential soils. The constituent was detected within the smear zone.

The major fate process for VOCs in soil is biodegradation. VOCs under normal environmental conditions are not expected to undergo hydrolysis, and are not susceptible to oxidation or reduction reactions in the subsurface environment. As part of the interim removal action, an oxidizer was added to the soil to increase the rate of oxidation reactions.

SVOCs

Most PAHs are reported to be readily susceptible to aerobic biodegradation. However, the rate of biodegradation is dependent upon each PAH and the environmental conditions. Numerous PAHs including acenaphthene, anthracene, fluoranthene, fluorene, naphthalene, phenanthrene, pyrene, and 1-methylnaphthalene, 2-methylnaphthalene were detected in site soils; however, only two constituents (naphthalene, and 2-methylnaphthalene) were detected above the USEPA RSL for residential soil. The two constituents were detected above the residential RSL within the smear zone (14-16 feet bgs).

The major fate process for PAHs in soil is biodegradation. PAHs under normal environmental conditions

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are not expected to undergo hydrolysis, and are not susceptible to oxidation or reduction reactions in the subsurface environment. Most PAHs are reported to be readily susceptible to aerobic biodegradation. However, the rate of biodegradation is dependent upon each PAH and the environmental conditions. As part of the interim removal action, an oxidizer was added to the soil to increase the rate of oxidation reactions.

Dioxins/Furans

Dioxins/furans are persistent and immobile contaminants in environmental media. Typically, Dioxins/furans are insoluble in water so, whether they are sprayed, dusted, or applied directly to soil, Dioxins/furans ultimately accumulate in soil. Dioxins/furans travel at various rates through soil, primarily due to their affinity for soil/sediment particles.

6.1.2 INORGANIC COMPOUNDS

The reactions and processes that are expected to govern the fate and transport of the inorganic contaminants detected at the Fire Training Pit site are:

- Dissolution/precipitation
- Adsorption/desorption
- Ion exchange
- Reduction-oxidation (redox) reactions
- Complexation

These processes are interrelated, and complicate the fate and transport of inorganic species. Furthermore, some inorganic species that influence the reactions occur naturally and are present in background concentrations, while other inorganic species are derived from anthropogenic sources.

6.2 POTENTIAL PATHWAYS OF CONTAMINANT TRANSPORT

This section discusses the potential transport pathways by which groups of contaminants can migrate between and within environmental media (i.e. air, soil and groundwater) at the site. Only the media present on-site are discussed.

6.2.1 ON-SITE DEPOSITION OF WINDBLOWN DUST

Wind can act as a contaminant transport agent by eroding soil and exposed sediment and blowing it off-site. The net transport is influenced by: wind velocity, the grain size/density of the soil/sediment particles and the amount of vegetative cover over the site. The site has a moderate amount of underbrush and field area. There is also extensive ground cover (fallen leaves and pine needles) which would effectively restrict windblown transport. There appears to be sufficient ground cover on the site to effectively limit this transport mechanism.

6.2.2 SOIL TRANSPORT BY STORM WATER RUNOFF

Water can erode exposed soil particles during precipitation events. This is influenced by site topography, amount and rate of precipitation, soil particle size/density, cohesion of soil, and vegetative cover. Similar to windblown transport, vegetative cover at the site limits the surface area of soil subject to erosion by storm water runoff. Also, the high permeability of the soil present at the surface of the site effectively

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reduces the volume of storm water runoff. Based on the factors that influence transport by storm water runoff, transport by this mechanism would be limited. Furthermore, following removal activities, the area immediately surrounding the excavation area was graded to be relatively flat with no observable drainage features. Backfilling of the excavation area has likely resulted in higher infiltration rates due to increased porosity and homogeneity of the soils.

6.2.3 SOIL/SURFACE WATER TO AIR TRANSPORT

The primary mechanism of contaminant transport from soil and surface water to air is volatilization. Volatile soil contaminants can migrate up through soil pore spaces and diffuse into the atmosphere. Nonvolatile contaminants such as metals can be transported to air only if adhered to airborne particulate matter. No surface water is present on the site.

6.2.4 SOIL/VADOSE ZONE TO GROUNDWATER TRANSPORT

The primary mechanism of contaminant transport from the soil/vadose zone to groundwater is through dissolution and transport of constituents via infiltration of rainwater. This mechanism can effectively transport soluble contaminants. Because of the high annual precipitation (42 inches per year) in the Fort Lee area infiltration rates can be very high.

6.2.5 GROUNDWATER TO SOIL/VADOSE ZONE TRANSPORT

There are several mechanisms of contaminant transport from groundwater to the vadose zone. VOCs in groundwater can volatilize into the unsaturated pore space in the vadose zone. At the capillary fringe, groundwater contaminants can be transported to unsaturated soil via precipitation, adsorption, and ion exchange.

6.3 FATE AND TRANSPORT CONCEPTUAL MODEL

The conceptual fate and transport model presented in this section provides a qualitative analysis of the environmental mechanisms, site characteristics, and physical/chemical properties of contaminants that have influenced, or currently influence, contaminant fate and transport at the site. Evaluating the site conditions and contaminant properties resulted in identification of the potential contaminant pathways.

Migration of the majority of the site contaminants (primarily select PAHs, select dioxins/furans, and metals) is more likely to occur by transport from soil into the vadose zone and/or groundwater than by storm water. This is based on the physical and chemical properties of the identified compounds, the identified concentrations, and the established groundwater flow regime, it is anticipated that contaminants likely to have leached from the waste mass would have done so.

6.4 SITE FATE AND TRANSPORT

This section discusses the fate and transport for the site, as well as the transport mechanisms applicable to the general types of chemicals present at the site.

The possible transport pathways identified for the site which are considered to be minor pathways due to mitigating site conditions or contaminant properties include the following:

- Volatilization of chlorinated hydrocarbons (e.g., volatile organics and dioxins/furans) from shallow

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groundwater to shallow soils. Tetrachloroethene was detected in surficial soil but not in groundwater or subsurface soils. Dioxins/furans strongly adsorb to soils and have low aqueous solubility.

- Migration enhanced by infiltrating rainwater, of dioxins/furans through the vadose zone to groundwater. Dioxins/furans strongly adsorb to soil/sediments and are not readily leached to groundwater due to their low aqueous solubility. This is evident on the site by the lack of dioxins/furan detections in groundwater.
- Migration of VOCs, dioxins/furans, SVOCs, and metals adsorbed to soil and transported along with windblown dust. Ground cover at the site limits the amount of transport by wind.

The major transport pathways identified for the site include:

- Lateral migration of VOCs (tetrachloroethene), PAHs, and dioxins/furans dissolved in groundwater.

Soils

Shallow surface soil samples results for the site indicate that VOCs, SVOCs, dioxins/furans, and inorganics were present.

Organics

- The VOC and SVOC concentrations in the soil at depths 9-10 feet bgs were below the associated USEPA risk screening criteria, while concentrations were greatest in the soil samples taken within the smear zone (14-16 feet bgs). As VOC and SVOC concentrations were higher in the smear zone than the vadose zone, the presence of contaminants in the smear zone are likely the result of a fluctuating groundwater table in combination with horizontal movement of contaminated groundwater. Ethylbenzene concentrations exceeded the USEPA RSL for residential soils in 1 of 12 samples, which collected 14 feet bgs.
- Naphthalene concentrations exceeded the USEPA RSL for residential soils in 2 of 12 samples, which were collected 14-16 feet bgs.
- 2-methylnaphthalene concentrations exceeded the USEPA RSL for residential soils in 2 of 12 samples, which were collected 14-16 feet bgs.

Inorganics

Numerous metals were detected on-site. A discussion of the lateral and vertical extent of inorganic contamination is provided as follows:

- Numerous metals including aluminum, arsenic, barium, beryllium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, vanadium and zinc were detected in most surface and subsurface soil samples collected at the site. Metals concentrations on the site are relatively evenly distributed.
- No specific vertical distribution of inorganics was noted. In some soil borings, inorganic concentrations decrease with depth while others increase with depth.

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Groundwater

Dioxins/Furans

Dioxins/furans were detected at low concentrations in MW-5. 2,3,7,8-TCDD TEQ were calculated at .000000244 ug/L.

Organics and Inorganics

As previously detailed, numerous organic (VOCs and SVOCs) and inorganic constituents are present at concentrations which exceed one or more of the applicable criteria. The distribution of these constituents in groundwater indicates historical activities conducted at the Inactive Fire Training Pit site may have impacted groundwater at the site, but that impacted groundwater also flows onto the site from an up-gradient source.

This risk assessment evaluates the potential for adverse health effects from human and ecological exposure to residual chemicals at the Inactive Fire Training Pit (Site). The Site is one of two pits in the immediate area (the other is active) that have been used for fire training purposes since the 1960s. Soil and groundwater investigations conducted in November-December 2007 indicated potential environmental impacts at the Site. In January 2008, an interim removal action (IRA) was performed, during which approximately 2,081 tons of non-hazardous contaminated soils were removed from the Site. The excavation area was approximately 40 feet wide by 60 feet across (2,400 square feet) and was 16 feet deep, which is the approximate depth to groundwater at the Site. In February 2009, post-excavation samples were collected from the walls of the excavation to determine residual chemical concentrations in soil. Groundwater samples were collected in May 2009 to evaluate the lateral and vertical extent of chemicals in groundwater. This risk assessment is based on the results of the post-excavation soil and groundwater samples.

The risk assessment is composed of a human health risk assessment (HHRA) and screening-level ecological risk assessment (SLERA), presented in Sections 7.1 and 7.2, respectively. The HHRA and SLERA were conducted in accordance with relevant USEPA and USEPA Region 3 guidance. While the HHRA provides quantitative estimates of human exposure and associated health risks at the Site, the SLERA is a qualitative evaluation of the potential for adverse ecological health effects, based solely on the identification of chemicals of potential ecological concern (COPEC). The SLERA process is truncated, because no potentially complete exposure pathways from COPECs to ecological receptors exist under the current and foreseeable future use of the Site.

7.1 HUMAN HEALTH RISK ASSESSMENT

The HHRA follows guidance outlined in *Risk Assessment Guidance for Superfund (RAGS): Volume I, Human Health Evaluation Manual, Part A* (USEPA, 1989) and other relevant USEPA guidance cited throughout the assessment. Accordingly, the HHRA is presented in a series of tables in RAGS, Part D format (USEPA, 2001) and consists of the following four components: hazard identification, exposure assessment, toxicity assessment, and risk characterization.

In the Hazard Identification, relevant data are compiled and chemicals of potential concern (COPC) are identified. In the Exposure Assessment, actual or potential chemical release and transport mechanisms are identified; potentially exposed human populations and possible exposure pathways and routes are described; COPC concentrations at points of potential human contact are determined; and human exposures to the COPCs are estimated. In the Toxicity Assessment, quantitative and qualitative toxicity data used to characterize the potential for adverse health effects are identified. In the Risk Characterization, the likelihood and magnitude of adverse health effects are estimated, in the form of incremental lifetime cancer risks and non-cancer hazards, for each applicable exposure scenario shown in **Appendix E, Table E-1**. Sources of uncertainty in the HHRA are then noted and discussed.

7.1.1 HAZARD IDENTIFICATION

This section describes the environmental data used to characterize post-IRA conditions at the Site and presents the COPCs that, if exposed to, may cause adverse human health effects.

The decision process for the selection of COPCs in sampled environmental media is dictated by relevant

USEPA (1989) and USEPA Region 3 (1993) guidance. The following risk-based screening of detected chemical concentrations was implemented, using the USEPA (2009a) RSLs as screening toxicity values:

- All detected chemicals designated by the USEPA as Class A or known human carcinogens were identified as COPCs, regardless of the other selection criteria.
- Detected chemicals with maximum concentrations greater than chemical-specific RSLs were identified as COPCs. RSLs based on adverse, non-cancer health effects were reduced by a factor of 10, to represent a target hazard quotient of 0.1, to address potential non-cancer health effects from exposure to multiple chemicals.
- The essential nutrients (i.e., calcium, magnesium, potassium, and sodium) were categorically eliminated as COPCs.
- A few of the detected chemicals did not have RSLs available. These chemicals were identified as COPCs but were qualitatively evaluated in the Uncertainty Analysis.

The following describes the post-excavation soil and groundwater data and lists the COPCs identified in each data set.

7.1.1.1 Subsurface Soil

Fifteen soil samples were collected from the walls of the excavation to characterize residual chemical contamination at the Site. Sample locations are shown on **Figure 4-1**. All samples were collected from depths greater than 3 feet below ground surface (bgs) and are therefore considered representative of subsurface soil. Individual sample depths and analytical results are noted in **Table 4-1**. As shown, twelve samples were analyzed for TCL VOCs, TCL PAHs, and TAL metals; two samples were analyzed for dioxins/furans¹, and one sample was analyzed for diesel and gasoline range organics².

A subsurface soil data summary, with the frequency of detection and range of detected chemical concentrations, is presented in **Appendix E, Table E-2.1**. The table also presents the RSLs for residential soil and documents the COPC screening process for subsurface soil. The RSLs for residential soil were used to select a conservative list of COPCs.

As shown in **Table E-2.1**, the following chemicals were identified as COPCs in subsurface soil:

- VOCs – benzene, ethylbenzene, and due to the lack of an RSL, methycyclohexane
- SVOCs – naphthalene, 2-methylnaphthalene, and due to the lack of an RSL, phenanthrene
- Metals – aluminum, arsenic, iron, and vanadium

No risk-based screening toxicity values were available for methylcyclohexane and phenanthrene, therefore, the potential for adverse human health effects from exposure to these COPCs was qualitatively evaluated in the Uncertainty Analysis.

1 The dioxin/furan data were reduced to 2,3,7,8-tetrachlordibenzo-p-dioxin (2,3,7,8-TCDD) toxic equivalents (TEQ) using the 2005 World Health Organization (WHO) toxic equivalency factor (TEF) scheme (Van den Berg et al., 2006), as shown in Table 5-3, and evaluated as 2,3,7,8-TCDD.

2 For the purposes of this HHRA, the diesel and gasoline range organics data were not used.

7.1.1.2 Groundwater

Five groundwater samples were collected from monitoring wells MW-1 through MW-5 to evaluate the lateral and vertical extent of potential impacts to groundwater. Sample locations are shown on **Figures 3-2**. Monitoring wells MW-1 and MW-2 are located up-gradient of the Site and monitoring wells MW-3, MW-4 and MW-5 are in and around the excavation area. All wells are screened at depths greater than 13 feet bgs. The groundwater analytical results are noted in **Tables 3-2**.

As shown in **Table 4-3**, four groundwater samples were collected in May 2009 from MW-1 through MW-4 and analyzed for TCL VOCs, TCL PAHs, and TAL metals. The groundwater sample from MW-5 was collected during the IRA in February 2009 and was analyzed for dioxins/furans³ (as shown in **Table 4-2**). MW-5 was destroyed during completion of the IRA; therefore, there are no May 2009 groundwater data from this well, and the February 2009 data were used in this HHRA instead.

A groundwater data summary, with the frequency of detection and range of detected chemical concentrations, is presented in **Appendix E, Table E-2.2**. The table also presents the RSLs for tap water and documents the COPC screening process for groundwater.

As shown in **Table E-2.2**, the following chemicals were identified as COPCs in groundwater:

- VOCs – benzene, ethylbenzene, xylenes, and due to the lack of an RSL, methylcyclohexane
- SVOCs – naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, and due to the lack of an RSL, phenanthrene
- Metals – cobalt, iron, and manganese
- Dioxins/Furans – 2,3,7,8-TCDD TEQ

No risk-based screening toxicity values were available for methylcyclohexane and phenanthrene, therefore, the potential for adverse human health effects from exposure to these COPCs was qualitatively evaluated in the Uncertainty Analysis.

7.1.2 EXPOSURE ASSESSMENT

The objective of the exposure assessment is to estimate the type and magnitude of human exposure to COPCs at the Site. Assumptions regarding the potential for human exposure (e.g., exposed populations, exposure frequency) are presented. Representative exposure point concentrations (EPC) for each COPC are calculated and used to model human exposure.

In accordance with USEPA (1989, 1997a) guidance, estimates of chemical intake were developed to portray the reasonable maximum exposure (RME) that might be expected to occur under each exposure scenario. That is, the highest exposure that might reasonably be expected to occur at the Site, one that is well above the average case of exposure but within the range of possibility, was evaluated.

³ As with soil, the dioxin/furan data were reduced to 2,3,7,8-TCDD TEQ using the 2005 WHO TEF scheme (Van den Berg et al., 2006) and evaluated as 2,3,7,8-TCDD.

7.1.2.1 Conceptual Site Model

Appendix E, Table E-1 presents the conceptual site model (CSM), based on the current understanding of the potential for human exposure to residual chemicals at the Site. The CSM presents the exposure media of concern, potential human receptor populations, and the pathways and routes through which humans may be exposed to COPCs.

Soil is an environmental medium of concern, because it is or may become available for human contact. Generally, affected surface soil was removed during the IRA, and post-excavation soil samples were collected from depths greater than 3 feet bgs. Therefore, the exposure medium of concern in this HHRA is subsurface soil and not surface soil. Groundwater is also an environmental medium of concern. However, it is only evaluated in this HHRA under a hypothetical, future exposure scenario. Due to the depth to groundwater across the Site (approximately 16 feet bgs), human exposure to groundwater is not likely to occur. In addition, exposure to COPCs in groundwater via ingestion of drinking water is not considered a potential exposure pathway, because there are currently no potable groundwater wells on Fort Lee or in the immediate vicinity. Additionally, potable groundwater wells are restricted from areas on Fort Lee that are serviced by municipal water providers. Therefore, it is not expected that potable groundwater wells would be installed on or near the Site in the future.

No personnel or visitors/trespassers are allowed on the Site without permission. Site access is controlled by a security gate and regulated by Range Control and the USAEC's Contracting Officer's representative at Fort Lee. Based on the depth to COPCs at the Site and the current land use of the Site as a fire training area, there are no potential human receptors identified under a current exposure scenario. In addition, the Site is likely to remain a fire training area into the foreseeable future. The Site is not likely to be redeveloped for future residential use following the 2005 Defense Base Closure and Realignment Commission (BRAC) Report recommendations. These recommendations identified Fort Lee as an important training installation for the foreseeable future. In addition, the installation Master Planner has identified a shortage of suitable training areas at Fort Lee; therefore, the only potential human receptors who may be exposed to COPCs at the Site under a future exposure scenario are construction/utility workers. In order to prevent potential future residential use, land use controls will be established at the Site.

Construction/utility worker exposure was evaluated in this HHRA based on the following potential exposure pathways and routes:

- Subsurface Soil – incidental ingestion of and dermal contact with subsurface soil during construction/utility work; inhalation of volatile COPCs and respirable particulates released from subsurface soil to outdoor air during soil excavation and/or during construction/utility work.
- Groundwater – dermal contact with groundwater that infiltrates and pools in the bottom of a trench excavated for construction/utility work; inhalation of volatile COPCs released from groundwater that infiltrates and pools in the bottom of the excavation.

7.1.2.2 Exposure Point Concentrations

In order to determine the COPC concentrations to which an individual might be exposed, representative EPCs were calculated from the available data sets. Data assigned a qualifier indicating the numerical

value is an estimated quantity, or that the identity and quantity are based on presumptive evidence, were treated the same way as data without such qualifiers. In addition, in utilizing the analytical data to select COPCs and derive representative EPCs, analytical results of duplicate samples were averaged with those of the corresponding originals.

The EPCs for the COPCs in soil and groundwater are presented in **Appendix E, Tables E-3.1 and E-3.2**, respectively. The following describes the various approaches used to calculate EPCs for COPCs in the different exposure media.

Subsurface Soil

For COPCs in subsurface soil, the 95% upper confidence limits (UCL) of the arithmetic average concentrations were used as the EPCs (USEPA, 2002a, 1992, 1989). The 95% UCL concentrations provide reasonable confidence that the true average concentrations will not be underestimated. The ProUCL, Version 4.0 computer software, developed by the USEPA's Technology Support Center for Monitoring and Site Characterization, was used to test the distributional assumptions and calculate 95% UCL concentrations. When entering the data into ProUCL, if a COPC was not detected in a sample, it was assumed to be present at a concentration equivalent to the sample reporting limit. The ProUCL output sheets for the individual COPCs in subsurface soil are provided in **Appendix E**.

The EPCs for the volatile and non-volatile COPCs in outdoor air following migration or emission from soil were based on the EPCs calculated for subsurface soil. Emissions of the non-volatile COPCs in soil were estimated by assuming that COPCs associated with respirable particulates are released to outdoor air during the digging of an excavation, for example, for underground utility installation, maintenance, or repair. Emissions of the volatile COPCs in soil were estimated under the assumption that chemicals are released from the soil pore space during the digging of the excavation and diffuse through the sidewalls and bottom of the excavation once completed. Details on the equations and atmospheric dispersion models used to estimate COPC migration/emission, dispersion, and concentrations in outdoor air are presented in **Appendix E**.

Groundwater

For COPCs in groundwater, where only five samples were collected, the maximum detected concentrations were used as the EPCs.

The EPCs for the volatile COPCs in outdoor air following emission from groundwater were based on the EPCs calculated for groundwater. Emissions of the volatile COPCs in groundwater were estimated by assuming that groundwater infiltrates a subsurface excavation and volatile COPCs are released from pooled water at the bottom of the excavation⁴. Details on the equations and atmospheric dispersion models used to estimate COPC migration/emission, dispersion, and concentrations in outdoor air are presented in **Appendix E**.

⁴ Considering that depth to groundwater across the Site is approximately 16 feet bgs, groundwater would not realistically infiltrate an approximately 10-foot deep trench; this scenario therefore constitutes a conservative, hypothetical evaluation of construction/utility worker exposure to groundwater at the Site.

7.1.2.3 Estimates of Human Exposure

The equations and receptor-specific parameter values used to model human exposure are presented in **Appendix E, RAGS Part D Tables E-4.1.RME to E-4.4.RME**.

Oral and Dermal Exposure

Application of the exposure equations results in daily intake (DI) for oral exposure or dermally absorbed dose (DAD) for dermal contact exposure, both of which are expressed in milligrams per kilogram of body weight per day (mg/kg-day). The DI is the amount of chemical at the exchange boundary. A fundamental assumption in the estimate of the DAD is that absorption continues after the exposure has ended (USEPA, 2004). Thus, the dermal absorbed dose per event (DA_{event}) is the total dose dissolved in the skin at the end of the exposure.

Several receptor-specific exposure parameters are needed to estimate COPC intakes and DADs. For the construction/utility worker, a soil ingestion rate of 330 milligrams per day (mg/day) and a fraction ingested of 1 were used. A skin surface area of 3,300 square centimeters (cm^2) and a soil-to-skin adherence factor of 0.3 mg/cm^2 per event ($\text{mg}/\text{cm}^2\text{-event}$) were assumed (USEPA, 2002b). An exposure frequency (EF) of 60 days/year (5 days/week for 4 weeks/month and 3 months/year), and an exposure duration (ED) of 1 year were used, as construction/utility work is limited in duration. A standard adult body weight (BW) of 70 kg was used (USEPA, 2002b, 1991).

Chemical-specific parameter values needed to calculate DA_{event} for COPCs in soil are dermal absorption fractions (USEPA, 2004, 2003a, 1995a). Chemical-specific parameter values needed to calculate DA_{event} for COPCs in groundwater include the dermal permeability coefficient (K_p) and lag time per event (τ_{event}). The K_p reflects movement across the skin to the underlying skin layers and into the bloodstream. The chemical-specific parameter for the ratio of the K_p of a chemical through the stratum corneum relative to its permeability coefficient across the viable epidermis (B) does not appear in the equation for DA_{event} for short exposure times because DA_{event} is not a function of B at short exposure times. For short exposure times, the amount of chemical absorbed depends only on K_p . Chemical-specific values used in the calculation of DA_{event} appear in the dermal worksheets presented in **Appendix E** (See **Tables E-13** and **E-14**).

The averaging time depends on the type of toxic effect being assessed. When evaluating exposures for potential long-term, non-cancer health effects, intakes are calculated by averaging over the period of exposure. This is equal to the ED multiplied by 365 days/year (i.e., 365 days for construction/utility workers). When evaluating potential incremental lifetime cancer risks, intakes are calculated by prorating the total cumulative intake over a lifetime (i.e., lifetime average daily intake). For calculation purposes, this is equal to 70 years multiplied by 365 days/year or 25,550 days. This distinction is consistent with the hypothesis that the mechanism of action for each of these health effects endpoints is different. The approach for carcinogens is based on the assumption that a high dose received over a short period of time is equivalent to a corresponding low dose spread over a lifetime.

Inhalation Exposure

The estimate of inhalation exposure is an exposure concentration (EC), which is based on the EPC for

each COPC in air. The EPCs were modified to account for receptor-specific exposure parameters [e.g., EF, ED, and exposure time (ET)] but do not consider receptor-specific BW or inhalation rate. This approach is consistent with RAGS Part F guidance (USEPA, 2009c) and is believed to result in more realistic risk estimates, as the amount of chemical that reaches a target organ may not depend on body weight or inhalation rate.

A receptor-specific EF of 5 days/week and ED of 12 weeks/year (equivalent to 60 days/year) were used to estimate ECs. An exposure time of 8 hours/day was assumed. The period over which the exposure is averaged is expressed in hours; therefore, for evaluating potential incremental lifetime cancer risks, the AT equals 613,200 hours (25,550 days x 24 hours/day). The AT for non-cancer health effects is 2,016 hours, which is equivalent to 12 weeks multiplied by 7 days/week and 24 hours/day.

7.1.3 TOXICITY ASSESSMENT

The toxicity assessment, also termed the dose-response assessment, serves to characterize the relationship between the magnitude of human exposure and the potential that an adverse health effect will occur. It involves determining whether exposure to a chemical can cause an increase in the incidence of a particular adverse health effect and characterizing the nature and strength of the evidence of causation.

The USEPA and other regulatory agencies have performed toxicity assessments for numerous chemicals, and the guidance they provide was used in this HHRA. These include cancer potency slope factors or unit risk factors for the evaluation of incremental cancer risk from exposure prorated over a lifetime and reference doses (RfD) or reference concentrations (RfC) for the evaluation of non-cancer health effects from chronic and subchronic exposure to chemicals. The following hierarchy of sources of toxicological information and toxicity values was used in this HHRA and is consistent with USEPA (2003b) guidance:

- Integrated Risk Information System (IRIS) (USEPA, 2009b). IRIS is an internet database containing current information on human health effects that may result from exposure to chemicals in the environment and is subject to internal and external scientific review.
- Provisional Peer-Reviewed Toxicity Values (PPRTV). PPRTVs were developed by the USEPA Office of Research and Development/National Center for Environmental Assessment/Superfund Health Risk Technical Support Center and are presented in a series of chemical-specific issue papers.
- Additional USEPA and non-USEPA sources of toxicity information, including but not limited to the California Environmental Protection Agency (CalEPA), the Agency for Toxic Substances and Disease Registry (ATSDR), and USEPA Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997b).

7.1.3.1 Noncarcinogenic Effects from Chronic Exposure

The USEPA (1990) indicates that acceptable exposure levels for chemicals with non-cancer health effects should represent concentration levels to which the human population, including sensitive subpopulations (e.g., the elderly, young children, etc.), may be exposed without adverse health effects during a lifetime or part of a lifetime, incorporating an adequate margin of safety. The potential for non-cancer health effects associated with oral and dermal exposures is evaluated by comparing an estimate

of chemical exposure over a specified time period (i.e., the intake or DAD) with an RfD derived for a similar exposure period. The RfD is an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime. Therefore, the ratio of the exposure estimate to the RfD, termed the hazard quotient (HQ), assumes that there is a level of exposure (i.e., the RfD) below which it is unlikely for even sensitive subpopulations to experience adverse health effects.

Similar to the approach for assessing cancer risks from inhalation exposures, RfCs that relate the COPC concentration in air to the incidence of a particular adverse health effect were used to evaluate inhalation exposures to noncarcinogens. The HQ was estimated by calculating the ratio of the EC to the RfC.

The oral RfDs and inhalation RfCs used in this HHRA are presented, respectively, in **Appendix E, Tables E-5.1** and **E-5.2**. The tables also present the primary target organ, the combined uncertainty and modifying factors used in the derivation of the RfD and RfC, and the source of the RfD and RfC. Similar to the cancer slope factors, RfDs were not available for dermal exposure. In their absence, oral RfDs were adjusted to reflect absorbed dose and were used, per USEPA (2004) guidance. The oral-to-dermal adjustment factors and adjusted RfDs are also presented in **Appendix E, Table E-5.1**.

The USEPA has indicated that RfDs and RfCs are based on the assumption that thresholds exist for certain toxic effects and that they often have an uncertainty spanning perhaps an order of magnitude. Chronic RfDs and RfCs were specifically developed to be protective of long-term exposure to a chemical. However, for construction/utility workers whose exposure was assumed to have occurred over a one-year period, subchronic RfDs and RfCs were used, where available. For some chemicals, subchronic RfDs and RfCs were estimated from chronic RfDs and RfCs by removal of the uncertainty factor applied where a chronic RfD or RfC was extrapolated from a subchronic study. Chronic RfDs and RfCs were used as conservative approximations where subchronic values were not available or could not be estimated.

7.1.3.2 Carcinogenic Effects from Lifetime Exposure

Conventional risk evaluation methods employed by the USEPA generally derive from the hypothesis that, regardless of the mechanism of effect, thresholds for cancer induction by carcinogens do not exist and that the dose-response relationship is linear at low doses. Based on this hypothesis, the USEPA has derived estimates of incremental cancer risk from lifetime exposure to potential carcinogens. This is accomplished by establishing the carcinogenic potency of the chemical through critical evaluation of the various test data and by fitting dose-response data to a low-dose extrapolation model. The slope factor, which describes the dose-response relationship at low doses, is expressed as a function of intake [i.e., (mg/kg-day)⁻¹]. Slope factors were used in this HHRA to evaluate oral and dermal exposures. Incremental lifetime cancer risks were estimated by multiplying an estimated daily COPC intake, prorated over 70 years, by the chemical-specific slope factor.

The oral slope factors used in this HHRA are presented in **Appendix E, Table E-6.1**. The table also presents the USEPA weight-of-evidence classification under the USEPA's 1986 guidelines for carcinogen risk assessment or cancer guideline description under USEPA's revised carcinogen risk assessment guidelines (USEPA, 2005). The USEPA has not derived dermal slope factors. In their absence, oral slope

factors were adjusted to reflect absorbed dose and were used, per USEPA (2004) guidance. This allows for risk estimation based on exposures estimated as absorbed doses and slope factors expressed as absorbed doses. The oral-to-dermal adjustment factors and the adjusted slope factors are also presented in **Appendix E, Table E-6.1**.

To evaluate inhalation exposures, inhalation unit risk factors that relate cancer potency to a chemical concentration in air were used instead of slope factors (USEPA, 2009c). Both are presented, where available, for each COPC in **Appendix E, Table E-6.2**. Incremental lifetime cancer risks were estimated by multiplying an estimated EC by the chemical-specific inhalation unit risk factor.

7.1.3.3 Chemical Mixtures

USEPA guidance was also used to account for the overall potential for cancer risks and non-cancer health effects from exposure to multiple chemicals.

For the evaluation of cancer risks, USEPA guidance indicates that the individual risks associated with exposure to each COPC can be summed. This approach assumes independence of action by the chemicals involved (i.e., that there are no synergistic or antagonistic chemical interactions and that all chemicals produce the same effect: cancer).

For the evaluation of non-cancer health effects, USEPA guidance assumes that sub-threshold exposures to several chemicals at the same time could result in an adverse health effect. The sum of the non-cancer HQs (for individual chemicals, exposure routes, exposure pathways, or potentially-exposed populations) is the hazard index (HI). Generally, HIs are only used in the evaluation of a mixture of chemicals that induce the same effect by the same mechanism of action. In this HHRA, the HIs of a mixture of chemicals that can have different effects were used as a screening-level approach, as recommended by the USEPA (1989). This approach may overestimate the likelihood of adverse, non-cancer health effects. Therefore, for HIs greater than 1E+00, toxic endpoint-specific HIs were calculated based on the toxicological endpoints used to derive the RfDs and RfCs.

7.1.4 RISK CHARACTERIZATION

Risk characterization involves combining exposure estimates with toxicity information to generate incremental lifetime cancer risks and non-cancer hazards for each human exposure scenario evaluated in the HHRA. In this section, the cancer risks and non-cancer hazards are presented and discussed. Lastly, sources of uncertainty in this HHRA are noted.

7.1.4.1 Incremental Lifetime Cancer Risks

Incremental lifetime cancer risks are expressed as unitless probabilities (e.g., 2×10^{-5} or 2 in 100,000) of an individual developing cancer. The unitless probability represents the incremental (or increased) lifetime cancer risk associated with the estimated exposure above the background risk of developing cancer. The total individual (i.e., COPC-specific) cancer risks are summed for each exposure pathway and scenario to arrive at an estimate of the potential for cancer risk from cumulative exposure.

For known or suspected carcinogens, the National Oil and Hazardous Substances Pollution Contingency

Plan (NCP) established that acceptable exposure levels are generally concentration levels that represent an incremental upper-bound lifetime cancer risk in the range from 10^{-4} (i.e., 1E-04 or 1 in 10,000) to 10^{-6} (i.e., 1E-06 or 1 in 1,000,000) or less (USEPA, 1990). The cancer risks estimated for the construction/utility worker were therefore compared to this risk range established by the NCP.

The individual incremental lifetime cancer risks for the construction/utility worker are presented in **Appendix E, Tables E-7.1.RME and E-7.2.RME** for subsurface soil and groundwater, respectively. The total COPC-specific incremental lifetime cancer risks from all exposure routes are presented in **Appendix E, Table E-9.1.RME**. As shown, the total incremental lifetime cancer risk for the construction/utility worker is 3E-05, which is within the cancer risk range established by the NCP.

7.1.4.2 Non-Cancer Hazards

As described in Section 7.4.2, the potential for adverse, non-cancer health effects is expressed as an HQ, which for oral and dermal exposures is the ratio of an estimated DI or DAD over a specified time period to a chemical-specific RfD derived for a similar exposure period. For inhalation exposures, the HQ is the ratio of the EC to the RfC. The total individual HQs were summed for each exposure pathway and scenario to yield HIs representative of the potential for adverse, non-cancer health effects from cumulative exposure. For the non-cancer assessment, exposure scenarios with an HI greater than 1E+00 are of concern.

Appendix E, RAGS Part D Tables E-7.1.RME and E-7.2.RME present the individual non-cancer HQs for the construction/utility worker for, respectively, subsurface soil and groundwater. The COPC-specific non-cancer HIs from all exposure routes are presented in **Appendix E, RAGS Part D Table E-9.1.RME**. As shown, the total non-cancer HI for the construction/utility worker is 2E+00. The predominant contributors to this non-cancer hazard are aluminum in subsurface soil and 2,3,7,8-TCDD TEQ in groundwater, as both of these chemicals have HQs equal to 8E-01 for all exposure routes. No individual HQ shown in **Appendix E, Table E-9.1.RME** is greater than 1E+00; nor are any of the toxic endpoint-specific HQs greater than 1E+00.

7.1.4.3 Qualitative Assessment of COPCs without Screening Levels

Chemical-specific USEPA RSLs or published toxicity values were not available to quantitatively assess the potential for human health effects from exposure to two COPCs: methylcyclohexane and phenanthrene. The following describes possible human health implications associated with exposure to these chemicals.

Methylcyclohexane

Methylcyclohexane is a low-molecular weight hydrocarbon that has the chemical structure of a cycloalkane. Alkanes are aliphatic hydrocarbons that are flammable and burn readily in air (Lewis, 1998). They are neurotoxic, cytotoxic, and irritants that affect the skin and central nervous system (CNS) (Lewis, 1998). Alkanes with five to eight carbon atoms, such as methylcyclohexane, are used in gasoline and other petroleum products. Exposure to these volatile chemicals is mainly through inhalation. CNS depression and loss of coordination have been observed following human exposure (Lewis, 1998).

Phenanthrene

Phenanthrene is one of the chemicals among the seventeen PAHs typically analyzed for and evaluated at hazardous waste sites. Phenanthrene can be derived from coal tar and, along with the other PAHs, is a product of incomplete combustion of fossil fuels and wood; therefore, it has been detected throughout the environment (ORNL, 1993). The seventeen PAHs often occur together in the environment and many have similar environmental fate and toxicological characteristics (ATSDR, 1995). However, reliable environmental fate and toxicological information is available for only a few of the seventeen PAHs, and the potential health effects of the less studied PAHs must be inferred from this information (ATSDR, 1995).

Seven of the 17 PAHs (not including phenanthrene) are listed by the USEPA as “probable human carcinogens” (i.e., the USEPA has assigned these chemicals a weight-of-evidence characterization of B2). Inhalation of PAHs has been linked with respiratory and immunological effects in human beings, as well as with lung cancer. The USEPA regards phenanthrene, however, as “not classifiable as to human carcinogenicity” (the weight-of-evidence characterization is D) (USEPA, 2009b). Phenanthrene is absorbed following oral and dermal exposure (ORNL, 1993). Evidence of slight hepatotoxicity following bodily injections in rats exists (ORNL, 1993). Phenanthrene acted as a tumor initiator in only one of multiple animal studies reviewed (ORNL, 1993).

7.1.4.4 Uncertainty Analysis

Risk assessment entails the integration of complex analyses of chemical concentrations in the environment, the fate and transport of chemicals in the environment, the potential for human exposure, and the chemical’s carcinogenic potency or toxicity. Some uncertainties are associated with each component of this process. Uncertainty in a HHRA is typically addressed by identifying the sources of uncertainty and characterizing whether the risk estimates may be over-predicted or under-predicted. The aim of most risk assessments, including this HHRA, is to err on the side of conservatism, so the potential for risks is over- rather than under-predicted.

Environmental Sampling and Analysis

Uncertainty associated with environmental sampling is generally related to limitations in terms of the number and distribution of samples, while uncertainty associated with sample analysis is generally associated with systematic or random errors (i.e., false positive or negative results). Thus, exposure may be over-estimated or under-estimated depending on how well the environmental medium was characterized.

The soil samples collected at the Site represent a biased sample group. Post-excavation samples were collected from the walls of the excavated pit. Therefore, the samples are biased towards locations that are more likely to contain residual chemical contamination. As a result, this HHRA over-estimates COPC concentrations across that Site.

Fate and Transport Modeling

EPCs for volatile and non-volatile COPCs in outdoor air were estimated from screening-level emission/release calculations and atmospheric dispersion modeling. Due to their relative simplicity, these

calculations and models tend to overestimate these processes. For example, source depletion over time (e.g., through COPC release or environmental degradation) was not accounted for. Uncertainty associated with such modeling is related to the accuracy with which environmental conditions and processes are simulated. Overall, the potential inhalation exposure scenarios were modeled in ways that likely overestimate exposure and risk.

Human Exposure Modeling

The exposure assessment relies on a series of assumptions regarding the potential for human exposure, outlined in the CSM and approximated in the calculation of COPC intakes by parameters such as the EPC and receptor-specific exposure duration, frequency, and time. Some of this uncertainty is addressed by conservatively evaluating the risk to individuals under RME conditions. Accordingly, this HHRA primarily relied on the USEPA's standard default exposure assumptions which are used at Superfund sites across the country with appropriate modifications to reflect site-specific conditions.

The EPCs for COPCs at the Site were estimated without consideration of environmental migration, transformation, degradation, or loss. EPCs for the soil COPCs were estimated by calculating the 95% UCL on the arithmetic average concentrations. This method ensures that the true arithmetic average concentrations are not under-estimated. EPCs for the groundwater COPCs were set equal to maximum detected concentrations. Because of these practices, the EPCs likely over-estimate exposure to COPC concentrations across the Site.

Potential exposure of construction/utility workers to groundwater COPCs via dermal contact and inhalation is likely overstated, because groundwater at the Site was observed at approximately 16 feet bgs. Regular construction/utility work at that depth is not expected, such that the scenario in which groundwater infiltrates the bottom of an excavated trench is hypothetical. Nonetheless, it was included in this HHRA as a conservative evaluation.

Toxicity Values

The derivation of the toxicity values that form the basis of the risk characterization can result in overestimates or underestimates of the potential for adverse health effects. In most cases, the toxicity values are derived from extrapolation from laboratory animal data to humans. As indicated in **Tables E-5.1 and E-5.2**, the oral and inhalation RfDs contain modifying and/or uncertainty factors that range as high as 10,000.

RfDs and cancer slope factors for oral exposure were adjusted and used to assess risks from dermal absorption. While this adjustment follows USEPA guidance, oral absorption for the organic COPCs was assumed to be 100%, which may underestimate dermal contact exposure for some chemicals. For those chemicals with specific oral absorption factors, consideration was not given to the absorption efficiency of the exposure vehicle used in the studies on which the factors are based. This may overestimate or underestimate dermal contact risks for some chemicals.

For benzene, where the USEPA provides a range of cancer potency, the more conservative (i.e., health protective) toxicity values were used.

Finally, for some chemicals, health criteria are insufficient to determine RfDs or slope factors for oral and/or inhalation exposure. As a result, the risk estimates may be underestimated. Toxicity values (i.e., RfDs, RfCs, slope factors, and unit risk factors) were not available for select COPCs as indicated on **Tables E-5.1, E-5.2, E-6.1, and E-6.2**. In the absence of toxicity values, the cancer risks and non-cancer HIs may be underestimated.

7.2 SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT

The SLERA follows guidance outlined in *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997c). The SLERA constitutes a Step 1 screening assessment and encompasses problem formulation and ecological effects evaluation. Problem formulation establishes the goals, breadth, and focus of the SLERA (USEPA, 1997c). The ecological effects evaluation entails hazard identification and dose-response assessment. While COPECs in subsurface soil samples from the Site are identified, the SLERA process is truncated, because no potentially complete exposure pathways to ecological receptors exist under the current or foreseeable future use of the Site.

7.2.1 PROBLEM FORMULATION

Problem formulation consists of site characterization, ecological receptor identification, and a description of potentially complete ecological exposure pathways. The problem formulation typically ends with the identification of relevant assessment endpoints and appropriate measurement endpoints, upon which the ecological effects assessment is based.

7.2.1.1 Environmental Setting

The Site is approximately 2.5 acres and is located near the southern installation boundary in an area that can generally be considered upland forest habitat. The predominant vegetation on the Site is pine trees. There are no buildings, concrete structures, or surface water bodies on the Site. Unpaved driveways and parking areas consist of hard-packed, aggregate stone ranging in size from sand to gravel. A wooded area is south of the Site, and improved areas are located to the north, east, and west.

7.2.1.2 Potentially Complete Exposure Pathways

For an exposure pathway to be complete, a chemical must be able to travel from the source medium to ecological receptors and be available for contact by receptors via one or more exposure routes. The following describes the source media and potentially complete exposure pathways at the Site.

The exposure medium of potential concern is subsurface soil. Surface soil that may have been impacted by historic Site activities was removed and replaced with clean fill during the IRA. Post-excavation soil samples were collected from the walls of the excavation, from (with the exception of one sample collected at 3.5 feet bgs) depths greater than 9 feet bgs. It is not expected that ecological receptors would contact chemicals in soil at these depths. Therefore, no potentially complete exposure pathways from soil to ecological receptors exist.

Post-excavation groundwater samples were also collected from the Site. However, the depth to

groundwater across the Site is approximately 16 feet bgs and groundwater does not surface near the Site. It is not expected that ecological receptors would contact chemicals detected in groundwater at or originating from the Site. Therefore, no potentially complete exposure pathways from groundwater to ecological receptors exist.

7.2.1.3 Assessment and Measurement Endpoints

Due to the lack of potentially complete exposure pathways, Site-specific assessment and measurement endpoints were not developed. However, more generally, assessment endpoints are any adverse effects (e.g., reduced vigor or population decline) on ecological receptors (i.e., plant and animal populations and communities) that may be present and measurement endpoints can be detected chemical concentrations in exposure media of concern, which are compared to ecological screening values (ESV) indicative of the potential for adverse health effects in ecological receptors.

7.2.2 ECOLOGICAL EFFECTS EVALUATION

The ecological effects evaluation consists of data evaluation and the identification of COPECs, based on the comparison of detected chemical concentrations in exposure media of concern to ESVs that are based on generic assessment endpoints and are assumed to be widely applicable to sites around the United States (USEPA, 1997c). Although there are no potentially complete exposure pathways, post-IRA subsurface soil data are nevertheless evaluated to determine whether residual chemical concentrations exceed ESVs.

7.2.2.1 Data Evaluation

The subsurface soil data evaluated in this SLERA are from the same fifteen post-excavation soil samples described in the HHRA. Sample locations are shown on **Figure 4-1**. Individual sample depths and analytical results are noted in **Table 4-1**. Twelve samples were analyzed for TCL VOCs, TCL PAHs, and TAL metals; two samples were analyzed for dioxins/furans⁵, and one sample was analyzed for diesel and gasoline range organics⁶. The subsurface soil data summary for the SLERA, with the frequency of detection and range of detected chemical concentrations, is presented in **Appendix E, Table E-15**.

7.2.2.2 Identification of COPECs

Table E-15 also presents the chemical-specific ESVs and documents the COPEC identification process. Chemicals with maximum detected concentrations greater than the ESVs were identified as COPECs. With the exception of the essential nutrients (i.e., calcium, magnesium, potassium, and sodium), chemicals for which ESVs were not available were also identified as COPECs.

ESVs were obtained from the following hierarchy of sources:

- USEPA (2009d) Ecological Soil Screening Levels (EcoSSL)
- USEPA Region 3 (1995b) BTAG Screening Levels for Soil, Draft
- USEPA Region 5 (2003c) Ecological Screening Levels for Soil

⁵ The dioxin/furan data were reduced to 2,3,7,8-TCDD TEQ using the 2005 WHO TEF scheme for mammals (Van den Berg et al., 2006) and evaluated as 2,3,7,8-TCDD. While a 1998 WHO TEF scheme for birds also exists (Van den Berg et al., 1998), the ESV used in this SLERA for 2,3,7,8-TCDD is the USEPA EcoSSL for mammals.

⁶ For the purposes of this SLERA, the diesel and gasoline range organics data were not used.

As shown in **Table E-15**, the following chemicals were identified as COPECs in subsurface soil:

- VOCs – benzene, ethylbenzene, toluene, xylenes, and due to the lack of ESVs, isopropylbenzene and methylcyclohexane
- SVOCs – 2-methylnaphthalene
- Metals – aluminum, antimony, cadmium, chromium, iron, lead, selenium, and vanadium

The organic COPECs are all components of petroleum and petroleum products, have a propensity to biodegrade in the environment over time, and are unlikely to represent a long-term threat to ecological receptors. Of the metals selected as COPECs, the detected antimony, cadmium, lead, and selenium concentrations are indistinguishable from background concentrations in surface soil at the installation, as evident in **Table E-15**. Of the remaining metals, chromium and lead are the only ones considered by the USEPA to be bioaccumulative (USEPA, 2000). However, bioaccumulative potential is dependent on physical parameters and soil chemistry (e.g., soil pH), which may not be conducive to bioaccumulation at the Site.

7.3 SUMMARY

This risk assessment evaluated the potential for adverse health effects from human and ecological exposure to residual chemicals following implementation of the IRA at the Site in January 2008.

The HHRA was based on the results of fifteen post-excavation subsurface soil samples collected from the walls of the excavation and five groundwater samples collected from monitoring wells located in and around the excavation area. The HHRA provides quantitative estimates of human exposure and associated health risks. The SLERA is a qualitative evaluation of the potential for adverse ecological health effects, because no potentially complete exposure pathways for ecological receptors exist under the current and foreseeable future use of the Site.

The following presents summaries of the HHRA and SLERA and their relevant findings.

7.3.1 HUMAN HEALTH RISK ASSESSMENT

The HHRA characterized the potential for adverse health effects by combining estimates of human exposure with chemical-specific toxicity information to generate incremental lifetime cancer risks and non-cancer hazard indices. COPCs in subsurface soil and groundwater were identified through a screening process, using the USEPA (2009a) RSLs as screening toxicity values. Using this approach, the following chemicals were identified as COPCs at the Site:

Subsurface Soil

- VOCs – benzene, ethylbenzene, and, due to the lack of an RSL, methylcyclohexane
- SVOCs – naphthalene, 2-methylnaphthalene, and, due to the lack of an RSL, phenanthrene
- Metals – aluminum, arsenic, iron, and vanadium
-

Groundwater

- VOCs – benzene, ethylbenzene, xylenes, and due to the lack of an RSL, methylcyclohexane

- SVOCs – naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, and due to the lack of an RSL, phenanthrene
- Metals – cobalt, iron, and manganese
- Dioxins/Furans – 2,3,7,8-TCDD TEQ

The HHRA considered potential human exposure scenarios under the current and most likely future land uses of the Site. Considering the depth to residual chemicals and the current land use of the Site as a training area, no potential human receptors were identified for the current exposure scenario. As the Site will likely remain a training area into the foreseeable future, the only potential human receptor identified for the future exposure scenario was a construction/utility worker. As residential risk was not calculated in the HHRA, land use controls will be established at the Site to prevent future residential land use. The relevant exposure pathways and routes evaluated in this HHRA were dermal contact with and incidental ingestion of COPCs in subsurface soil and inhalation of particulates and volatile COPCs released from subsurface soil while excavating a trench and/or performing construction/utility work. In addition, the potential for construction/utility workers to be exposed via dermal contact with COPCs in groundwater and inhalation of volatile COPCs released from groundwater that infiltrates the bottom of an excavated trench was evaluated. This latter exposure scenario was included as a conservative, hypothetical evaluation, as the depth to groundwater across the Site is approximately 16 feet bgs.

The HHRA relied on RME parameter values recommended by the USEPA to evaluate the highest exposure that might reasonably be expected to occur at the Site, one that is well above the average case of exposure but within the range of possibility. The EPCs for COPCs in soil and groundwater were estimated using statistical approaches and assumptions regarding chemical fate and transport that likely resulted in overestimates of COPC concentrations across the Site.

The incremental lifetime cancer risk estimated for the construction/utility worker in this HHRA was 3E-05, which is within the cancer risk range of 1E-04 to 1E-06 established by the NCP (USEPA, 1990). The non-cancer HI was 2E+00, which is greater than the target HI of 1E+00. The predominant contributors to this non-cancer hazard were aluminum in subsurface soil and 2,3,7,8-TCDD TEQ in groundwater. However, no individual HQ or toxic endpoint-specific HQ was greater than 1E+00.

7.3.2 SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT

The SLERA consisted of problem formulation and an ecological effects evaluation. The problem formulation contained a description of the Site and established that, under the current and foreseeable future land uses, there are no potentially complete exposure pathways from chemicals detected in soil and groundwater to potential ecological receptors at the Site.

Nonetheless, an ecological effects evaluation, consisting of a subsurface soil data evaluation and the identification of COPECs, was conducted. COPECs were identified based on the comparison of maximum detected chemical concentrations to ESVs indicative of the potential for adverse ecological health effects. The following COPECs were identified in subsurface soil:

- VOCs – benzene, ethylbenzene, toluene, xylenes, and due to the lack of ESVs, isopropylbenzene and methylcyclohexane
- SVOCs –2-methylnaphthalene

- Metals – aluminum, antimony, cadmium, chromium, iron, lead, selenium, and vanadium

All of the organic COPECs are components of petroleum and petroleum products, have a propensity to biodegrade in the environment over time, and are unlikely to represent a long-term threat to ecological receptors. Of the metals selected as COPECs, the detected antimony, cadmium, lead, and selenium concentrations are indistinguishable from background concentrations in surface soil at Fort Lee. Of the remaining metals, chromium and lead are considered bioaccumulative. However, bioaccumulative potential is dependent on physical parameters and soil chemistry (e.g., soil pH), which may not be conducive to bioaccumulation at the Site.

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UPDATED HISTORICAL GROUNDWATER MONITORING RESULTS

In order to determine the effect of soil excavation activities on groundwater contaminant concentrations, additional groundwater samples were collected from the monitoring wells on May 25, 2010. Prior to purging wells, depths to groundwater were measured. Wells were then purged and sampled using a peristaltic pump and clean disposable tubing. Water quality parameters were measured during purging until parameters stabilized to within 10% of the total variation for three successive readings. Water quality data is included as Interim Removal Action Work Plan. After parameters stabilized, groundwater samples were collected. VOCs were collected first, in a manner which prevented any headspace from forming within the sample vials after which jars for the remaining parameters were filled.

8.1 GROUNDWATER RESULTS

May 25, 2010 groundwater analytical results are summarized in **Table 8-1**. Historical groundwater concentrations are also shown on this table and indicate that the following exceedances and trends may be occurring:

VOCs

- Benzene was detected above the USEPA RSL for Tap Water (0.41 ug/L) in all four samples with a maximum concentration of 12 ug/L in MW-3. Overall, benzene concentrations have significantly decreased (MW-1, MW-3, and MW-4).
- Ethylbenzene was detected above the USEPA RSL for Tap Water (1.5 ug/L) in all four samples with a maximum concentration of 9.4 ug/L in MW-1. Overall, ethylbenzene concentrations have significantly decreased (MW-1, MW-2, MW-4).
- Xylene was detected above the USEPA RSL for Tap Water (20 ug/L) in one sample (MW-2) at a concentration of 41 ug/L. Overall, xylene concentrations have significantly decreased (MW-1, MW-2, MW-4).

SVOCs

- 2-Methylnaphthalene was detected above the USEPA RSL for Tap Water (15 ug/L) in one sample (MW-1) at a concentration of 56 ug/L. Overall, 2-methylnaphthalene concentrations have not shown a noticeable trend.
- Naphthalene was detected above the USEPA RSL for Tap Water (0.14 ug/L) in all four samples with a maximum concentration of 39 ug/L in MW-1. Overall, naphthalene concentrations have not shown a noticeable trend.

Numerous inorganics (total and dissolved) were also detected above one or more of the applicable criteria. Antimony, arsenic, cobalt, iron, manganese, and thallium (both total and dissolved) were detected above the USEPA RSL for Tap Water and/or MCL at one or more locations. Inorganic constituents appear to be detected at relatively consistent concentrations and are typically below published Fort Lee background concentrations.

CONCLUSIONS AND RECOMMENDATIONS

9.1 NATURE AND EXTENT OF CONTAMINATION

The extent of contamination has been impacted by the soil removal activities, and therefore, only post-removal data is used to determine the existing nature and extent of contamination.

Subsurface Soil

Soil removal activities encompassed the area containing constituent exceedances of USEPA RSLs for VOCs and SVOCs, and post-removal data indicates that no constituent concentrations in subsurface soil remaining at the Site exceed screening criteria. Although VOCs and SVOCs were detected in samples obtained from the outer wall of the excavation pit, the detections were below applicable screening criteria. Although numerous inorganic constituents were detected from samples along the outer wall of the excavation pit, they were below site-specific background levels and vertical distribution of inorganics was not noted.

Groundwater

Using 2009 groundwater data (data used for the risk assessment), four VOCs and two SVOCs were detected above USEPA screening criteria. These detections are highest in MW-3, located in closest proximity to the excavated area. Although numerous inorganic constituents were detected above USEPA screening criteria, only iron detected in MW-1 was above Fort Lee background values.

9.2 FATE AND TRANSPORT

A summary of the fate and transport for the site contaminants is provided in the following sections.

9.2.1 TRANSPORT PATHWAYS

The possible transport pathways identified for the site that are considered to be minor pathways due to mitigating site conditions or contaminant properties include the following:

- Volatilization of chlorinated hydrocarbons (e.g., volatile organics and dioxins/furans) from shallow groundwater to shallow soils is not considered as no VOCs were detected in site groundwater.
- Migration enhanced by infiltrating rainwater of dioxins/furans through the vadose zone to groundwater is not likely as dioxins/furans strongly adsorb to soil and are not readily leached to groundwater due to their low aqueous solubility.
- Migration of VOCs, dioxins/furans, SVOCs, and metals adsorbed to soil and transported along with windblown dust would be limited due to ground cover at the site.
- Leaching of soil contaminants to surface water is not considered due to the lack of surface water on the site.

The major transport pathways identified for the site include:

- Migration of PAHs, dioxins/furans, VOCs, SVOCs, and metals adsorbed to soil by storm runoff into site trenches, bunkers and gulleys.
- Lateral migration of metals dissolved in groundwater.

CONCLUSIONS AND RECOMMENDATIONS

9.3 RISK ASSESSMENT

9.3.1 Human Health Risk Assessment

The Human Health Risk Assessment included in **Section 7** determined that cancer risks and non-cancer hazards to potential receptors (excluding residential use) was within the allowable ranges as established by the NCP.

9.3.2 Ecological Risk Assessment

The Ecological Risk Assessment included in **Section 7** concluded there was not significant hazard to ecological receptors.

9.4 SUBSEQUENT GROUNDWATER MONITORING EVENTS

Results of groundwater sampling results obtained in 2010 indicate decreasing trends are occurring for VOCs (benzene, ethylbenzene, and xylene) and SVOCs (2-methylnaphthalene and naphthalene).

9.5 RECOMMENDATIONS

The recommendations for the site are based on the nature and extent of contamination, fate and transport characteristics and the results of the human health and ecological risk assessments. Typically, the results of the risk assessment are the triggers for performance for further action. No further action is recommended for the Fire Training Pit based on the results of the risk assessment which indicates no or minimal potential risks for the identified potentially exposed human and ecological populations. However, as residential use of the Site was not included in the risk assessment (not anticipated in the foreseeable future), land use controls will be established in the Fort Lee Master Plan. The land use controls will prohibit residential development of the site, as well as groundwater withdrawal from the Site. In addition, the most recent groundwater monitoring activities demonstrate significantly decreasing VOC and SVOC groundwater concentrations. This is evidence that the removal activities have removed a significant contributing groundwater contaminant source. However, two more LTM events (Spring 2011 and 2012) will be conducted to demonstrate the continued decreasing trends in VOC and SVOC constituents. A monitoring well will be installed at the location identified on **Figure 4-4** and the monitoring well will be included in future LTM events.

**IRA Completion Report
Fire Training Pit
Fort Lee, Virginia**

**Table 3-1
November - December 2007 Soil Investigation Results
Fire Training Pit**

Boring Location	EPA Region III SL ¹		Background Values		DPT1	DPT2	DPT3	DPT4	DUP1	DPT5	DPT6			DPT7			DPT8		DPT9	DUP2	DPT10	
	Residential Soils	Industrial Soils	Surface Soil	Subsurface Soil	16 to 20 (feet bgs)	4 to 8 (feet bgs)	16 to 20 (feet bgs)	16 to 20 (feet bgs)		12 to 16 (feet bgs)	0 to 1 (feet bgs) ²	4 to 8 (feet bgs)	12 to 16 (feet bgs)	0 to 1 (feet bgs) ²	4 to 8 (feet bgs)	12 to 16 (feet bgs)	4 to 8 (feet bgs)	8 to 12 (feet bgs)	8 to 12 (feet bgs)		0 to 1 (feet bgs)	8 to 12 (feet bgs)
Volatile Organic Analysis (ug/kg)																						
1,1-Dichloroethane	3,400 C	17,000 C	NA	NA	32 U	33 U	33 U	31 U	30 U	32 U	29 U	30 U	21 J	28 U	30 U	31 U	30 U	30 U	33 U	31 U	29 U	31 U
Acetone	6,100,000 N	61,000,000 N	NA	NA	110 J	160 U	170 U	150 U	150 U	160 U	150 U	120 J	160 U	350	260	170 U	120 J	150 U	170 U	170 U	140 U	150 U
Methyl tert-butyl Ether	39,000 C	190,000 C	NA	NA	32 U	33 U	33 U	31 U	30 U	32 U	29 U	30 U	31 U	28 U	30 U	31 U	30 U	30 U	33 U	31 U	29 U	31 U
Methyl Acetate	7,800,000 NS	100,000,000 NS	NA	NA	32 U	33 U	33 U	31 U	30 U	32 U	27 J	30 U	31 U	28 U	30 U	31 U	30 U	30 U	33 U	31 U	29 U	31 U
Methylene Chloride	11,000 C	54,000 C	NA	NA	29 JB	28 JB	26 JB	26 JB	22 JB	31 JB	41	19 J	31 U	32	19 J	31 U	21 J	31 B	33 B	28 JB	19 J	24 JB
Cyclohexane	720,000 NS	3,000,000 NS	NA	NA	80 U	33 U	33 U	31 U	30 U	180	360	30 U	390	260	30 U	590 JD	30 U	40	33 U	31 U	29 U	99
1,1,1-Trichloroethane	900,000 NS	3,900,000 NS	NA	NA	32 U	33 U	33 U	31 U	30 U	27 JB	29 U	30 U	490	28 U	30 U	31 U	30 U	30 U	33 U	31 U	29 U	25 J
Methylcyclohexane	---	---	NA	NA	1600 D	33 U	33 U	31 U	30 U	2300 D	280	30 U	1200 D	530	72	3200 D	30 U	150	33 U	31 U	29 U	560
Benzene	1,100 C	5,600 C	NA	NA	32 U	33 U	33 U	31 U	30 U	90	46	30 U	390	28 U	30 U	180	30 U	30 U	33 U	31 U	29 U	25 J
Toluene	500,000 NS	4,600,000 NS	NA	NA	32 U	33 U	33 U	31 U	30 U	410 JD	810	30 U	150	160	30 U	5000 D	72	130	33 U	31 U	29 U	54
Tetrachloroethene	570 C	2,700 C	NA	NA	32 U	33 U	33 U	31 U	30 U	23 JB	29 U	30 U	31 U	17	30 U	150	30 U	30 U	33 U	31 U	29 U	31 U
Ethyl Benzene	5,700 C	29,000 C	NA	NA	630 JD	33 U	33 U	31 U	30 U	1600 D	280	30 U	940 D	300	58	2600 D	150	140	33 U	31 U	29 U	130 JD
m/p-Xylenes	60,000 NS	260,000 NS	NA	NA	2400 D	65 U	67 U	61 U	60 U	6700 D	1100	59 U	3500 D	1100	59 U	9600 D	430	580	66 U	62 U	58 U	530 JD
o-Xylene	530,000 NS	2,300,000 NS	NA	NA	54	33 U	33 U	31 U	30 U	3100 D	470	30 U	1600 D	340	30 U	1700 D	360	260	33 U	31 U	29 U	240 JD
Isopropylbenzene	220,000 NS	1,100,000 NS	NA	NA	210	33 U	33 U	31 U	30 U	710 D	86	30 U	410 JD	130	30 U	1000 D	77	71	33 U	31 U	29 U	250
Semi-Volatile Organic Analysis (ug/kg)																						
Naphthalene	3,900 C	20,000 C	NA	NA	20000	4.2 U	19	13	4.0 U	69000 D	6300	920	16000	4500	320	34000 D	2600	90	73	12000	8.9	6800
Acenaphthylene	340,000 N	3,300,000 N	NA	NA	1100	4.2 U	4.5 U	4.2 U	4.0 U	3900 D	98 U	4.0 U	670	790	26	2700 D	770	4.0 U	4.4 U	520	3.8 U	450
Acenaphthene	340,000 N	3,300,000 N	NA	NA	43 U	4.2 U	4.5 U	4.2 U	4.0 U	19000 D	98 U	4.0 U	42 U	19 U	4.0 U	10000	4.0 U	4.0 U	4.4 U	40 U	3.8 U	40 U
Fluorene	230,000 N	2,200,000 N	NA	NA	5700	4.2 U	4.5 U	10	4.0 U	22000 D	18000	580	4000	5400	180	16000 D	780	41	38	2600	3.8 U	2700
Phenanthrene	---	---	NA	NA	12000	200	37	19	14	40000 D	29000	1200	9900	8800	300	30000 D	1700	84	75	4500	14	3800
Anthracene	1,700,000 N	17,000,000 NM	NA	NA	1100	32	3.6 J	2.1 J	1.2 J	3700 D	2800	88	810	430	38	2800 D	130	4.0 U	4.4 U	350	1.2 J	310
Fluoranthene	230,000 N	2,200,000 N	NA	NA	150	9.8	2.7 J	1.7 J	0.800 J	870 D	98 U	25	170	710	4	720 D	34	4.0 U	1.3 J	73	1.9 J	85
Pyrene	170,000 N	1,700,000 N	NA	NA	560	81	4 J	3 J	1.6 J	2000 D	4600	120	560	2000	16	1800 D	150	4.0 U	4.9	230	1.9 J	200
Benzo(a)anthracene	150 C	2,100 C	NA	NA	43 U	4.2 U	4.5 U	4.2 U	4.0 U	42 U	310	4.0 U	42 U	140	4.0 U	46 U	4.0 U	4.0 U	4.4 U	40 U	3.8 U	40 U
Chrysene	15,000 C	210,000 C	NA	NA	43 U	4.2 U	4.5 U	4.2 U	4.0 U	42 U	1300	15	42 U	290	4.0 U	46 U	14	4.0 U	4.4 U	40 U	3.8 U	40 U
Benzo(b)fluoranthene	150 C	2,100 C	NA	NA	43 U	4.2 U	2.2 J	1.3 J	4.0 U	42 U	98 U	4.0 U	42 U	19 U	4.0 U	46 U	4.0 U	0.81 J	4.4 U	40 U	1.9 J	40 U
Benzo(k)fluoranthene	1,500 C	21,000 C	NA	NA	43 U	4.2 U	1.8 J	0.84 J	4.0 U	42 U	98 U	4.0 U	42 U	19 U	4.0 U	46 U	4.0 U	4.0 U	4.4 U	40 U	0.770 J	40 U
Benzo(a)pyrene	15 C	210 C	NA	NA	43 U	4.2 U	1.8 J	0.84 J	4.0 U	42 U	98 U	4.0 U	42 U	19 U	4.0 U	46 U	4.0 U	4.0 U	4.4 U	40 U	1.2 J	40 U
Indeno(1,2,3-cd)pyrene	150 C	2,100 C	NA	NA	43 U	4.2 U	2.2 J	4.2 U	4.0 U	42 U	98 U	0.81 J	42 U	19 U	4.0 U	46 U	4.0 U	4.0 U	4.4 U	40 U	3.8 U	40 U
Dibenz(a,h)anthracene	15 C	210 C	NA	NA	43 U	4.2 U	2.2 J	4.2 U	4.0 U	42 U	98 U		42 U	19 U	4.0 U	46 U	4.0 U	4.0 U	4.4 U	40 U	3.8 U	40 U
Benzo(g,h,i)perylene	---	---	NA	NA	43 U	4.2 U	2.2 J	4.2 U	4.0 U	42 U	110	2 J	42 U	19 U	4.0 U	46 U	4.0 U	4.0 U	4.4 U	40 U	3.8 U	40 U

Notes:
 1.) EPA Region III - Regional Screening Levels (May 19, 2009). RSLs adjusted for a Hazard Quotient of 0.1 for noncancer compounds (i.e., divided by 10) to account for additive effects.
 2.) DPT6 (0-1) and DPT7 (0-1) were re-analyzed due to laboratory internal control criteria. Results from the re-analyzed sample are reported.
 NA - Not Applicable or Not Analyzed
 - Analyte was not detected
 N - Non-carcinogen
 C - Carcinogen

Columns with a gray header contain data for surface soils
 1.750 U Indicates the reporting limit is above the screening level for residential and/or industrial soils.
 550 Bolded text indicates analyte was detected
 550 Underlined text indicates analyte detected above site background values
 200 Yellow shaded box indicates analyte detected above EPA RBC for residential soils only
 800 Pink shaded box indicates analyte detected above EPA RBC for both residential a industrial soils

Data Qualifiers:
 U Not detected
 J Analyte present. Reported value between detection a quantitation limits
 D Sample diluted due to exceedance of calibration range in original sample
 B Analyte present in associated method blank
 E Exceeded calibration range of instrument

Table 3-1
November - December 2007 Soil Investigation Results
Fire Training Pit

Boring Location	EPA Region III SL ¹		Background Values		DPT1	DPT2	DPT3	DPT4	DUP1	DPT5	DPT6			DPT7			DPT8		DPT9	DUP2	DPT10	
	Residential Soils	Industrial Soils	Surface Soil	Subsurface Soil	16 to 20 (feet bgs)	4 to 8 (feet bgs)	16 to 20 (feet bgs)	16 to 20 (feet bgs)		12 to 16 (feet bgs)	0 to 1 (feet bgs) ²	4 to 8 (feet bgs)	12 to 16 (feet bgs)	0 to 1 (feet bgs) ²	4 to 8 (feet bgs)	12 to 16 (feet bgs)	4 to 8 (feet bgs)	8 to 12 (feet bgs)	8 to 12 (feet bgs)		0 to 1 (feet bgs)	8 to 12 (feet bgs)
Inorganics (mg/kg)																						
Aluminum	7,700 N	99,000 NM	15,770	23200	5790	10900	5430	4180	3350	5960	8120	10200	8040	8920	9630	6450	10400	8080	6310	5190	6170	4660
Antimony	3.1 N	41.0 N	<0.68	5	2.15 U	2.110 U	2.230 U	2.1 U	1.99 U	2.150 U	<u>35</u>	4.0	2.100 U	1.920 U	2.010 U	2.28 U	2.000 U	2.040 U	2.200 U	2.010 U	1.940 U	2.020 U
Arsenic	0.39 C	1.6 C	11	24	0.288 J	2.61	0.893 U	0.743 J	0.693 J	0.88	1.73	2.6	0.882	1.85	1.61	0.549 J	1.95	1.02	1.44	0.519	1.51	0.526 J
Barium	1,500 N	19,000 NM	25	43.4	8.64	13.5	7.15	7.44	5.57	10.9	223	11.7	11.2	76.4	9.7	12.9	13.2	17.6	12.7	10.7	27.2	8.9
Beryllium	16 N	200 N	0.7	1.1	0.251 J	0.177 J	0.302	0.233 J	0.213 J	0.209 J	0.185 J	0.099 J	0.167 J	0.171 J	0.084 J	0.203 J	0.092 J	0.176 J	0.191 J	0.159 J	0.19 J	0.129 J
Cadmium	7 N	80 N	<0.050	1.3	0.861 U	0.846 U	0.893 U	0.839 U	0.798 U	0.858 U	<u>1.87</u>		0.842 U	0.767 U	0.805 U	0.911 U	0.799 U	0.818 U	0.879 U	0.805 U	0.778 U	0.809 U
Calcium	--	--	292	420	136	119	34.4 J	131	114	134	8590	442	80 J	2530	213	188	47.8 J	72.8 J	89.9	116	370	57.2 J
Chromium	28.0 ⁽²⁾ C	140.0 C	20	40.3	7.78	24.9	10.2	8.89	4.95	8.83	<u>27.2</u>	33.1	12.5	17	21.5	13.1	20.3	17.8	13.9	9.73	8.9	9.56
Cobalt	2.3 N	30 N	2.1	11.6	0.642 J	0.39 J	2.15	1.01 J	0.758 J	0.378 J	1.6	0.373 J	0.315 J	1.03 J	0.287 J	0.454 J	0.336 J	0.211 J	0.394 J	0.167 J	0.736 J	0.18 J
Copper	310 N	4,100 N	11	23.6	5.45	6.66	7.57	5.72	3.21	5.96	<u>42.5</u>	6.13	7.05	15.6	6.17	6.79	6.9	5.28	5.98	4.690	3.56	2.77
Iron	5,500 N	72,000 NM	69,700	69700	8100	17700	11600	7480	4070	7780	7660	23800	10800	8800	17300	9380	18200	12800	12900	9560	6980	6910
Lead	40 N	80 N	14	61.2	7.22	7.37	7.94	6.44	5.09	8.22	1240	11.1	8.86	333	7.18	12.3	8.51	11.7	10.4	8.160	67.5	9.78
Magnesium	--	--	270	747	101	135	84.2 J	76.1 J	55.2 J	81.5 J	<u>522</u>	149	102	<u>288</u>	148	123	139	128	116	102	172	85.1
Manganese	180 N	2,300 N	347	347	12.7	4.58	16.4	12.7	13	8.16	63.1	8.98	7.93	29.2	11.2	8.95	8.15	3.55	7.82	3.030	30	3.52
Mercury	2.3 ⁽³⁾ N	31 N	0.050	0.13	0.02	0.028	0.01 J	0.01 J	0.013	0.013	0.023	0.08	0.012 U	0.027	0.033	0.019	0.026	0.044	0.019	0.016	0.017	0.01 J
Nickel	150 ⁽⁴⁾ N	2,000 N	5.7	13.4	1.57 J	0.868 J	2.71	1.78	1.05 J	0.993 J	3.52	0.734 J	0.948 J	2.32	0.721 J	1.07 J	0.787 J	0.553 J	0.552 J	0.325 J	1.69	0.392 J
Potassium	--	--	584	1540	212	143 J	245	179	137 J	189	354	214	197	393	164	253	176	203	208	171	156	167
Selenium	39 N	510 N	3.5	5	0.22 J	0.846 U	0.893 U	0.839 U	0.798 U	0.162 J	0.169 J	0.35 J	0.278 J	0.185 J	0.805 U	0.911 U	0.799 U	0.818 U	0.879 U	0.805 U	0.778 U	0.163 J
Silver	39 N	510 N	<0.030	1.4	0.431 U	0.423 U	0.446 U	0.42 U	0.399 U	0.429 U	<u>1.43</u>	0.359 J	0.421 U	<u>0.601</u>	0.403 U	0.456 U	0.400 U	0.409 U	0.440 U	0.403 U	0.389 U	0.405 U
Sodium	--	--	164	214	146	151	188	133	151	129	222	42.5 J	167	110	51.1 J	184	42.5 J	119	162	131	55.9 J	174
Thallium	0.51 N	6.6 N	4.6	10	1.720 U	1.690 U	1.790 U	1.680 U	1.600 U	1.720 U	1.590 U	1.630 U	1.680 U	1.530 U	1.610 U	1.82 U	1.600 U	1.640 U	1.760 U	1.610 U	1.560 U	1.620 U
Vanadium	39 ⁽⁵⁾ N	520 N	62	99.5	23.9	58.9	27	24	15	33.2	20.2	62.7	32.4	24.3	48.1	38	52.8	48.8	49.4	29.2	17.7	33.8
Zinc	2,300 N	31,000 N	10	35.4	10	8.67	18.9	8.57	6.93	7.83	265	8.87	8.1	66.4	7.76	8.77	7.62	6.37	8	6.680	13.4	5.02
Misc. (mg/Kg)																						
Total Organic Carbon	-	-	NA	NA	2500	770	260	370	200	2100	6900	1300	2500	6600	940	3700	2600	1100	490	680	4800	3300

Notes:
1.) EPA Region III - Regional Screening Levels (May 19, 2009). RSLs adjusted for a Hazard Quotient of 0.1 for noncancer compounds (i.e., divided by 10) to account for additive effects.
2.) DPT6 (0-1) and DPT7 (0-1) were re-analyzed due to laboratory internal control criteria. Results from the re-analyzed sample are reported.
NA - Not Applicable or Not Analyzed
- Analyte was not detected
N - Non-carcinogen
C - Carcinogen

Columns with a gray header contain data for surface soils
1.750 U Indicates the reporting limit is above the screening level for residential and/or industrial soils.
550 Bolded text indicates analyte was detected
550 Underlined text indicates analyte detected above site background values
200 Yellow shaded box indicates analyte detected above EPA RBC for residential soils only
800 Pink shaded box indicates analyte detected above EPA RBC for both residential and industrial soils

Data Qualifiers:
U Not detected
J Analyte present. Reported value between detection and quantitation limits
D Sample diluted due to exceedance of calibration range in original sample
B Analyte present in associated method blank
E Exceeded calibration range of instrument

**Table 3-1
November - December 2007 Soil Investigation Results
Fire Training Pit**

Boring Location	EPA Region III SL ¹		Background Values		DPT11		DPT12	DPT12	DUPA	DPT13		DPT14		Trip Blank	Trip Blank
	Residential Soils	Industrial Soils	Surface Soil	Subsurface Soil	4 to 8 (feet bgs)	8 to 12 (feet bgs)	0 to 1 (feet bgs)	12 to 16 (feet bgs)		4 to 8 (feet bgs)	12 to 16 (feet bgs)	0 to 1 (feet bgs)	12 to 16 (feet bgs)	11/30/2007	12/10/2007
Volatile Organic Analysis (ug/kg)															
1,1-Dichloroethane	3,400 C	17,000 C	NA	NA	31 U	30 U	29 U	30 U	31 U	30 U	29 U	29 U	31 U	1.0 U	5.0 U
Acetone	6,100,000 N	61,000,000 N	NA	NA	110 J	150 U	140 U	150 U	160 U	150 U	140 U	140 U	160 U	5.0 U	25 U
Methyl tert-butyl Ether	39,000 C	190,000 C	NA	NA	31 U	30 U	29 U	30 U	31 U	30 U	29 U	29 U	31 U	1.0 U	5.0 U
Methyl Acetate	7,800,000 NS	100,000,000 NS	NA	NA	31 U	30 U	29 U	30 U	31 U	30 U	29 U	29 U	31 U	1.0 U	5.0 U
Methylene Chloride	11,000 C	54,000 C	NA	NA	29 J	17 J	20 J	22 J	22 J	18 J	21 J	26 J	25 J	1.0 U	5.0 U
Cyclohexane	720,000 NS	3,000,000 NS	NA	NA	31 U	30 U	29 U	30 U	31 U	30 U	29 U	29 U	31 U	1.0 U	5.0 U
1,1,1-Trichloroethane	900,000 NS	3,900,000 NS	NA	NA	31 U	30 U	29 U	30 U	31 U	30 U	29 U	29 U	31 U	1.0 U	5.0 U
Methylcyclohexane	---	---	NA	NA	31 U	30 U	29 U	30 U	31 U	30 U	29 U	29 U	31 U	1.0 U	5.0 U
Benzene	1,100 C	5,600 C	NA	NA	31 U	30 U	29 U	30 U	31 U	30 U	29 U	29 U	31 U	1.0 U	5.0 U
Toluene	500,000 NS	4,600,000 NS	NA	NA	31 U	30 U	29 U	30 U	31 U	30 U	29 U	29 U	31 U	1.0 U	5.0 U
Tetrachloroethene	570 C	2,700 C	NA	NA	22 J	35	29 U	30 U	31 U	30 U	29 U	29 U	31 U	1.0 U	5.0 U
Ethyl Benzene	5,700 C	29,000 C	NA	NA	31 U	210	29 U	30 U	31 U	30 U	29 U	29 U	31 U	1.0 U	5.0 U
m/p-Xylenes	60,000 NS	260,000 NS	NA	NA	61 U	660	58 U	61 U	62 U	61 U	58 U	58 U	62 U	2.0 U	10 U
o-Xylene	530,000 NS	2,300,000 NS	NA	NA	36	400	29 U	30 U	31 U	30 U	29 U	29 U	31 U	1.0 U	5.0 U
Isopropylbenzene	220,000 NS	1,100,000 NS	NA	NA	31 U	110	29 U	30 U	31 U	30 U	29 U	29 U	31 U	1.0 U	5.0 U
Semi-Volatile Organic Analysis (ug/kg)															
Naphthalene	3,900 C	20,000 C	NA	NA	4.1 U	8100	11	400	400	4.1 U	3.9 U	3.8	410	NA	NA
Acenaphthylene	340,000 N	3,300,000 N	NA	NA	4.1 U	790	3.7 U	4.0 U	4.2 U	4.1 U	3.9 U	0.76 J	55	NA	NA
Acenaphthene	340,000 N	3,300,000 N	NA	NA	150	3200	3.7 U	110	110	4.1 U	3.9 U	3.8 U	140	NA	NA
Fluorene	230,000 N	2,200,000 N	NA	NA	4.1 U	4700	6	4.0 U	4.2 U	4.1 U	3.9 U	3.8 U	330	NA	NA
Phenanthrene	---	---	NA	NA	170	5400	11	200	200	260	16	5	460	NA	NA
Anthracene	1,700,000 N	17,000,000 NM	NA	NA	4.1 U	280	1.1 J	4.0 U	4.2 U	4.1 U	0.78 J	1.1 J	36	NA	NA
Fluoranthene	230,000 N	2,200,000 N	NA	NA	7	100	2.6 J	4.9	4.9	24	1.2 J	2.3 J	8.5	NA	NA
Pyrene	170,000 N	1,700,000 N	NA	NA	14	310	3 J	13	13	100	1.2 J	2.7 J	22	NA	NA
Benzo(a)anthracene	150 C	2,100 C	NA	NA	4.1 U	20 U	3.7 U	4.0 U	4.2 U	4.1 U	3.9 U	3.8 U	4.0 U	NA	NA
Chrysene	15,000 C	210,000 C	NA	NA	4.1 U	20 U	3.7 U	4.0 U	4.2 U	4.1 U	3.9 U	3.8 U	4.0 U	NA	NA
Benzo(b)fluoranthene	150 C	2,100 C	NA	NA	4.1 U	20 U	1.9 J	4.0 U	4.2 U	4.1 U	0.78 J	3.4 J	0.81 J	NA	NA
Benzo(k)fluoranthene	1,500 C	21,000 C	NA	NA	4.1 U	20 U	1.1 J	4.0 U	4.2 U	4.1 U	3.9 U	1.1 J	4.0 U	NA	NA
Benzo(a)pyrene	15 C	210 C	NA	NA	4.1 U	20 U	1.1 J	4.0 U	4.2 U	4.1 U	3.9 U	1.5 J	4.0 U	NA	NA
Indeno(1,2,3-cd)pyrene	150 C	2,100 C	NA	NA	4.1 U	20 U	3.7 U	4.0 U	4.2 U	4.1 U	3.9 U	3.8 U	4.0 U	NA	NA
Dibenz(a,h)anthracene	15 C	210 C	NA	NA	4.1 U	20 U	3.7 U	4.0 U	4.2 U	4.1 U	3.9 U	3.8 U	4.0 U	NA	NA
Benzo(g,h,i)perylene	---	---	NA	NA	4.1 U	20 U	3.7 U	4.0 U	4.2 U	4.1 U	0.78 J	3.8 U	4.0 U	NA	NA

Notes:

1.) EPA Region III - Regional Screening Levels (May 19, 2009). RSLs adjusted for a Hazard Quotient of 0.1 for noncancer compounds (i.e., divided by 10) to account for additive effects.

2.) DPT6 (0-1) and DPT7 (0-1) were re-analyzed due to laboratory internal control criteria.

Results from the re-analyzed sample are reported.

NA - Not Applicable or Not Analyzed

- Analyte was not detected

N - Non-carcinogen

C - Carcinogen

Columns with a gray header contain data for surface soils

1.750 U Indicates the reporting limit is above the screening level for residential and/or industrial soils.

550 Bolded text indicates analyte was detected

550 Underlined text indicates analyte detected above site background values

200 Yellow shaded box indicates analyte detected above EPA RBC for residential soils only

800 Pink shaded box indicates analyte detected above EPA RBC for both residential and industrial soils

Data Qualifiers:

U Not detected

J Analyte present. Reported value between detection and quantitation limits

D Sample diluted due to exceedance of calibration range in original sample

B Analyte present in associated method blank

E Exceeded calibration range of instrument

**Table 3-1
November - December 2007 Soil Investigation Results
Fire Training Pit**

Boring Location	EPA Region III SL ¹		Background Values		DPT11		DPT12	DPT12	DUPA	DPT13		DPT14		Trip Blank	Trip Blank
	Residential Soils	Industrial Soils	Surface Soil	Subsurface Soil	4 to 8 (feet bgs)	8 to 12 (feet bgs)	0 to 1 (feet bgs)	12 to 16 (feet bgs)		4 to 8 (feet bgs)	12 to 16 (feet bgs)	0 to 1 (feet bgs)	12 to 16 (feet bgs)	11/30/2007	12/10/2007
Inorganics (mg/kg)															
Aluminum	7,700 N	99,000 NM	15,770	23200	11000	7550	8290	6950	7640	12200	7010	8510	8500	NA	NA
Antimony	3.1 N	41.0 N	<0.68	5	13.1	2.040 U	1.900 U	2.040 U	2.100 U	2.090 U	1.960 U	1.910 U	2.070 U	NA	NA
Arsenic	0.39 C	1.6 C	11	24	2.52	0.871	1.37	0.862	0.483 J	2.16	1.21	1.82	1.59	NA	NA
Barium	1,500 N	19,000 NM	25	43.4	11.5	14.2	30.4	8.98	11.5	14.6	8.77	23	10.2	NA	NA
Beryllium	16 N	200 N	0.7	1.1	0.098 J	0.081 J	0.169 J	0.145 J	0.204 J	0.125 J	0.162 J	0.194 J	0.161 J	NA	NA
Cadmium	7 N	80 N	<0.050	1.3	0.820 U	0.815 U	0.760 U	0.814 U	0.842 U	0.834 U	0.784 U	0.765 U	0.828	NA	NA
Calcium	--	--	292	420	56 J	88.9	233	76.5 J	49.8 J	68 J	50.1 J	165	63.3 J	NA	NA
Chromium	28.0 ⁽²⁾ C	140.0 C	20	40.3	28.5	11	10.4	11.6	12.6	28.4	12.9	11.8	12.4	NA	NA
Cobalt	2.3 N	30 N	2.1	11.6	0.396 J	0.249 J	0.96 J	0.534 J	0.774 J	0.397 J	0.517 J	0.993 J	0.59 J	NA	NA
Copper	310 N	4,100 N	11	23.6	7.04	3.82	2.92	8.54	10.3	7.68	8.04	3.7	8.56	NA	NA
Iron	5,500 N	72,000 NM	69,700	69700	19800	5910	8360	11300	14600	21900	11100	9400	11500	NA	NA
Lead	40 N	80 N	14	61.2	9.88	9.84	7.16	8.84	11	9.79	7.38	12.6	9.17	NA	NA
Magnesium	--	--	270	747	134	119	250	92.7	124	147	87.7	207	106	NA	NA
Manganese	180 N	2,300 N	347	347	6.64	8.99	24.3	15.1	24.1	7.14	9.06	26	10.7	NA	NA
Mercury	2.3 ⁽³⁾ N	31 N	0.050	0.13	0.057	0.011 J	0.022	0.012 U	0.007 J	0.132	0.006 J	0.015	0.011 J	NA	NA
Nickel	150 ⁽⁴⁾ N	2,000 N	5.7	13.4	0.76 J	0.786 J	1.89	1.29 J	1.78	0.798 J	1.21 J	1.72	1.45 J	NA	NA
Potassium	--	--	584	1540	192	261	205	225	307	204	187	189	236	NA	NA
Selenium	39 N	510 N	3.5	5	0.282 J	0.815 U	0.760 U	0.814 U	0.842 U	0.834 U	0.784 U	0.765 U	0.828 U	NA	NA
Silver	39 N	510 N	<0.030	1.4	0.25 J	0.407 U	0.380 U	0.407 U	0.421 U	0.417 U	0.392 U	0.383 U	0.414 U	NA	NA
Sodium	--	--	164	214	67.4 J	61.1 J	62.2 J	64 J	38 J	56.7 J	57.4 J	52.2 J	64.7 J	NA	NA
Thallium	0.51 N	6.6 N	4.6	10	1.640 U	1.630 U	1.520 U	1.630 U	1.680 U	1.670 U	1.570 U	1.530 U	1.660 U	NA	NA
Vanadium	39 ⁽⁵⁾ N	520 N	62	99.5	64	35.9	19.8	33.8	36.8	66.2	34.3	22.7	38.8	NA	NA
Zinc	2,300 N	31,000 N	10	35.4	8.04	5.59	9.34	10.7	14.8	9.52	8.32	10	8.91	NA	NA
Misc. (mg/Kg)															
Total Organic Carbon	-	-	NA	NA	1500	4600	4600	1100	500	1700	450	2500	890	NA	NA

Notes:

1.) EPA Region III - Regional Screening Levels (May 19, 2009). RSLs adjusted for a Hazard Quotient of 0.1 for noncancer compounds (i.e., divided by 10) to account for additive effects.

2.) DPT6 (0-1) and DPT7 (0-1) were re-analyzed due to laboratory internal control criteria. Results from the re-analyzed sample are reported.

NA - Not Applicable or Not Analyzed

- Analyte was not detected

N - Non-carcinogen

C - Carcinogen

Columns with a gray header contain data for surface soils

1.750 U Indicates the reporting limit is above the screening level for residential and/or industrial soils.

550 Bolded text indicates analyte was detected

550 Underlined text indicates analyte detected above site background values

200 Yellow shaded box indicates analyte detected above EPA RBC for residential soils only

800 Pink shaded box indicates analyte detected above EPA RBC for both residential and industrial soils

Data Qualifiers:

U Not detected

J Analyte present. Reported value between detection and quantitation limits

D Sample diluted due to exceedance of calibration range in original sample

B Analyte present in associated method blank

E Exceeded calibration range of instrument

**Table 4-1: 2009 Soil Excavation Results
Fire Training Pit**

Parameters	Screening Level Residential Soils ⁽¹⁾	Screening Level Industrial Soils ⁽¹⁾	Background Values (Surface Soil) ⁽²⁾	Background Values (Subsurface Soil) ⁽²⁾	A2	B3	C2	C3	BOTT	DUP2	ESW1	ESW2	NSW1	NSW2
Depth (feet bgs)	---	---	---	---	16	3.5	14	16	16	BOTT (16)	9-10	9-10	9-10	9-10
Diesel (mg/kg)														
Diesel Range Organics	---	---	---	---	---	2900	---	---	---	---	---	---	---	---
Gasoline (mg/kg)														
Gasoline Range Organics	---	---	---	---	---	3.3 B	---	---	---	---	---	---	---	---
TCL VOCs (ug/kg)														
Acetone	6,100,000	61,000,000	N/A	N/A	---	---	610 J	---	390 J	24	22	11 J	420 JB	340 JB
Methylene Chloride	11,000	54,000	N/A	N/A	---	---	430 U	---	310 U	4.3 JB	2.4 JB	2.2 JB	310 U	310 U
1,1-Dichloroethane	3,400	17,000	N/A	N/A	---	---	430 U	---	310 U	3.1 J	6.2 U	6.1 U	310 U	310 U
2-butanone	2,800,000	19,000,000	N/A	N/A	---	---	1,100 U	---	780 U	16 U	11 J	15 U	780 U	770 U
1,1,1-Trichloroethane	900,000	3,900,000	N/A	N/A	---	---	340 J	---	310 U	27	6.2 U	6.1 U	310 U	310 U
Benzene	1,100	5,600	N/A	N/A	---	---	800	---	57 J	58	6.2 U	6.1 U	310 U	310 U
Toluene	500,000	4,600,000	N/A	N/A	---	---	280 J	---	310 U	13	1.5 J	6.1 U	310 U	310 U
Ethylbenzene	5,700	29,000	N/A	N/A	---	---	6,200	---	340	190	5.6 J	6.1 U	190 J	290 J
Isopropyl benzene (cumene)	220,000	1,100,000	N/A	N/A	---	---	2,200	---	150 J	52	6.2 U	6.1 U	110 J	140 J
1,2,4-Trichlorobenzene	8,700	40,000	N/A	N/A	---	---	430 U	---	310 U	6.4 U	6.2 U	6.1 U	310 U	310 U
Xylenes (total)	60,000	260,000	N/A	N/A	---	---	15,000	---	920	440	58	17 J	970	1,100
Cyclohexane	720,000	3,000,000	N/A	N/A	---	---	430 U	---	310 U	6.4 U	6.2 U	6.1 U	310 U	310 U
Methylcyclohexane	---	---	N/A	N/A	---	---	4,100	---	450	190	6.2 U	6.1 U	110 J	310
SVOCs (ug/kg)														
Naphthalene	3,900	20,000	NA	N/A	---	---	11,000	---	5,400 D	5,900 D	180 J	<i>210 U</i>	2,500	540
2-Methylnaphthalene	31,000	410,000	NA	N/A	---	---	45,000	---	30,000 D	32,000 D	1,800	230	11,000 D	2,700 D
1-Methylnaphthalene	22,000	99,000	NA	N/A	---	---	17,000	---	9,900 D	11,000 D	670	99 J	4,000 D	1,300
Acenaphthene	340,000	3,300,000	NA	N/A	---	---	<i>1500 U</i>	---	600	590	210 U	210 U	730	190 J
Fluorene	230,000	2,200,000	NA	N/A	---	---	<i>1500 U</i>	---	1200	1100	190 J	<i>210 U</i>	1400	300
Phenanthrene	---	---	NA	N/A	---	---	6200	---	1800	2200	480	110 J	2600	670
Pyrene	170,000	1,700,000	NA	N/A	---	---	<i>1500 U</i>	---	91 J	100 J	<i>210 U</i>	<i>210 U</i>	120 J	<i>210 U</i>

Notes:

- (1) EPA Region III - Regional Screening Levels (May 19, 2009). RSLs adjusted for a Hazard Quotient of 0.1 for noncancer compounds (i.e., divided by 10) to account for additive effects.
- (2) Background values are from "Final Surface Soils Background Metals and Anthropogenic Pesticides Report, Fort Lee, Virginia. Dated January 1999."
- (3) Data were compared to the "Total Chromium" values in the EPA Region III RSL table.
- (4) Data were compared to the "Mercury Inorganic Salts" values in the EPA Region III RSL table.
- (5) Data were compared to the "Nickel Soluble Salts" values in the EPA Region III RSL table.
- (6) Data were compared to the "Vanadium and Compounds" values in the EPA Region III RSL tables.

--- No sample collected or the compound/element was not listed in the EPA Region III RSL tables

12.4	Bolded text indicates analyte was detected
2.0	Indicates the analyte was detected above the site specific background value.
67.5	Yellow shaded box indicates analyte detected above EPA Region 3 SL for residential soils.
2	Red shaded box indicates analyte detected above the EPA Region 3 SL for industrial soils.

Data Qualifiers:

- B = Blank Contamination
- D = Diluted for Analysis
- J = Estimated Concentration
- U = Not Detected

**Table 4-1: 2009 Soil Excavation Results
Fire Training Pit**

Parameters	Screening Level Residential Soils ⁽¹⁾	Screening Level Industrial Soils ⁽¹⁾	Background Values (Surface Soil) ⁽²⁾	Background Values (Subsurface Soil) ⁽²⁾	A2	B3	C2	C3	BOTT	DUP2	ESW1	ESW2	NSW1	NSW2
Depth (feet bgs)					16	3.5	14	16	16	BOTT (16)	9-10	9-10	9-10	9-10
Dioxin/Furans (ug/kg)														
1,2,3,4,6,7,8-HpCDD	---	---	NA	N/A	0.014 BJ	---	---	0.0108 BJ	---	---	---	---	---	---
OCDD	15	61	NA	N/A	0.991 BJ	---	---	0.311 BJ	---	---	---	---	---	---
1,2,3,4,6,7,8-HpCDF	---	---	NA	N/A	0.00137 BJ	---	---	0.00132 BJ	---	---	---	---	---	---
Total Hepta-Dioxins	---	---	NA	N/A	0.0350 J	---	---	0.0262 J	---	---	---	---	---	---
Total Hepta-Furans	---	---	NA	N/A	0.00137 J	---	---	0.00132 J	---	---	---	---	---	---
Total TAL Metals (mg/kg)														
Aluminum	7,700	99,000	23,200.0	99,000	---	---	9,750	---	7,470	7,780	12,100	9,480	10,900	12,300
Antimony	3.1	41.0	5.0	41.0	---	---	0.48 B	---	0.42 B	0.43 B	0.9 B	0.85 B	0.69 B	0.7 B
Arsenic	0.39	1.6	24.0	1.6	---	---	0.62 B	---	0.95	0.26	1.2	0.76 B	1.4	1.0 B
Barium	1,500.0	19,000.0	43.4	19,000	---	---	13.3 B	---	12.4 B	13.5 B	18.9 B	16.7 B	16 B	14.9 B
Beryllium	16.0	200.0	1.1	200	---	---	0.14 B	---	0.17 B	0.14 B	<i>0.05 U</i>	<i>0.05 U</i>	<i>0.05 U</i>	<i>0.05 U</i>
Cadmium	7.0	80.0	1.3	80	---	---	<i>0.08 U</i>	---	0.18 B	<i>0.07 U</i>	0.46 B	<i>0.07 U</i>	0.11 B	<i>0.07 U</i>
Calcium	--	--	420.0	--	---	---	25.6 B	---	19.6 B	25.3 B	30.6 B	26.7 B	44.6 B	51.9 B
Chromium	28.0 ⁽³⁾	140.0	40.3	140	---	---	11.1	---	10.5	9.6	25	16.3	18.8	15.8
Copper	310.0	4,100.0	23.6	4,100	---	---	8.1	---	9.6	6.3	9.2	7	7.4	6
Iron	5,500.0	72,000.0	69,700.0	72,000	---	---	10,500	---	13,800	9,030	23,000	12,400	15,700	11,200
Lead	40.0	80.0	61.2	80	---	---	10.3	---	8.4	8.3	13.5	11.9	12.3	11.1
Magnesium	--	--	747.0	--	---	---	122 B	---	126 B	126 B	170 B	142 B	143 B	146 B
Manganese	180.0	2,300.0	347.0	2,300	---	---	12.2	---	19.9	13.1	7.6	7.9	5	5
Mercury	2.3 ⁽⁴⁾	31.0	0.1	31	---	---	<i>0.020 U</i>	---	<i>0.019 U</i>	<i>0.020 U</i>	0.041	<i>0.020 U</i>	0.039 B	0.022 B
Nickel	150 ⁽⁵⁾	2,000.0	13.4	2,000	---	---	2.3 B	---	2.8 B	2.4 B	1.8 B	1.7 B	1.2 B	1.5 B
Potassium	--	--	1,540.0	--	---	---	319 BE	---	307 BE	305 BE	371 BE	328 BE	366 BE	282 BE
Selenium	39.0	510.0	5.0	510	---	---	0.92	---	1.4	0.67	2	1.4	1.7	1.1
Sodium	--	--	214.0	--	---	---	127 B	---	152 B	202 B	97 B	115 B	115 B	105 B
Vanadium	39 ⁽⁶⁾	520.0	99.5	520	---	---	33.5	---	31.2	23.4	64.2	46.6	67.5	51.6
Zinc	2,300.0	31,000.0	35.4	31,000	---	---	6.3	---	12.4	8.1	4	4.9	3.6	3.7

Notes:

- (1) EPA Region III - Regional Screening Levels (May 19, 2009). RSLs adjusted for a Hazard Quotient of 0.1 for noncancer compounds (i.e., divided by 10) to account for additive effects.
- (2) Background values are from "Final Surface Soils Background Metals and Anthropogenic Pesticides Report, Fort Lee, Virginia. Dated January 1999."
- (3) Data were compared to the "Total Chromium" values in the EPA Region III RSL table.
- (4) Data were compared to the "Mercury Inorganic Salts" values in the EPA Region III RSL table.
- (5) Data were compared to the "Nickel Soluble Salts" values in the EPA Region III RSL table.
- (6) Data were compared to the "Vanadium and Compounds" values in the EPA Region III RSL tables.

--- No sample collected or the compound/element was not listed in the EPA Region III RSL tables

12.4	Bolded text indicates analyte was detected
2.0	Indicates the analyte was detected above the site specific background value.
67.5	Yellow shaded box indicates analyte detected above EPA Region 3 SL for residential soils.
2	Red shaded box indicates analyte detected above the EPA Region 3 SL for industrial soils.

Data Qualifiers:

- B = Blank Contamination
- D = Diluted for Analysis
- J = Estimated Concentration
- U = Not Detected

**Table 4-1: 2009 Soil Excavation Results
Fire Training Pit**

Parameters	Screening Level Residential Soils ⁽¹⁾	Screening Level Industrial Soils ⁽¹⁾	Background Values (Surface Soil) ⁽²⁾	Background Values (Subsurface Soil) ⁽²⁾	NSW3	SSW1	DUP1	SSW2	SSW3	WSW1	WSW2	TB021009	TB021109	TB021309
Depth (feet bgs)					9-10	9-10	SSW1 (9-10)	9-10	9-10	9-10	9-10	TRIP BLANKS		
Diesel (mg/kg)														
Diesel Range Organics	---	---			---	---	---	---	---	---	---	---	---	---
Gasoline (mg/kg)														
Gasoline Range Organics	---	---			---	---	---	---	---	---	---	---	---	---
TCL VOCs (ug/kg)														
Acetone	6,100,000	61,000,000	N/A	N/A	24	33	31	270 JB	17	22	20	13 U	13 U	8.1 JB
Methylene Chloride	11,000	54,000	N/A	N/A	2.2 JB	2.6 JB	2.3 JB	310 U	2.3 JB	1.8 JB	2.1 JB	5 U	0.84 JB	1 JB
1,1-Dichloroethane	3,400	17,000	N/A	N/A	6.3 U	6.3 U	6.3 U	310 U	6.2 U	6.2 U	6.3 U	5 U	5 U	5 U
2-butanone	2,800,000	19,000,000	N/A	N/A	10 J	16	16	770 U	15 U	12 J	12 J	13 U	13 U	13 U
1,1,1-Trichloroethane	900,000	3,900,000	N/A	N/A	6.3 U	6.3 U	6.3 U	310 U	6.2 U	6.2 U	6.3 U	5 U	5 U	5 U
Benzene	1,100	5,600	N/A	N/A	6.3 U	6.3 U	6.3 U	310 U	6.2 U	6.2 U	6.3 U	5 U	5 U	5 U
Toluene	500,000	4,600,000	N/A	N/A	3.8 J	4.5 J	5.7 J	310 U	6.2 U	5.1 J	1.8 J	5 U	5 U	5 U
Ethylbenzene	5,700	29,000	N/A	N/A	60	6.3 U	6.3 U	300 J	2.7 J	36	17	5 U	5 U	5 U
Isopropyl benzene (cumene)	220,000	1,100,000	N/A	N/A	33	6.3 U	6.3 U	150 J	6.2 U	16	8.8	5 U	5 U	5 U
1,2,4-Trichlorobenzene	8,700	40,000	N/A	N/A	6.3 U	6.3 U	6.3 U	290 J	6.2 U	6.2 U	6.3 U	5 U	5 U	5 U
Xylenes (total)	60,000	260,000	N/A	N/A	200	2.1 J	1.7 J	1,600	17 J	170	120	5 U	5 U	5 U
Cyclohexane	720,000	3,000,000	N/A	N/A	6.3 U	6.3 U	6.3 U	310 U	6.2 U	6.2 U	6.3 U	1.9 JB	2 JB	5 U
Methylcyclohexane	---	---	N/A	N/A	27	6.3 U	6.3 U	110 J	6.2 U	100	1.7 J	5 U	5 U	5 U
SVOCs (ug/kg)														
Naphthalene	3,900	20,000	NA	N/A	660	210 U	210 U	3,000	210 U	390	490	---	---	---
2-Methylnaphthalene	31,000	410,000	NA	N/A	4,500 D	130 J	210 U	11,000 D	320	4,200 D	3,900 D	---	---	---
1-Methylnaphthalene	22,000	99,000	NA	N/A	1,700	210 U	210 U	5,700	130 J	1,600	1,400	---	---	---
Acenaphthene	340,000	3,300,000	NA	N/A	210 J	210 U	210 U	690 J	210 U	250	160 J	---	---	---
Fluorene	230,000	2,200,000	NA	N/A	340	210 U	210 U	1,200	210 U	450	370	---	---	---
Phenanthrene	---	---	NA	N/A	770	210 U	210 U	2,700	140 J	1,200	920	---	---	---
Pyrene	170,000	1,700,000	NA	N/A	210 U	210 U	210 U	840 U	210 U	210 U	210 U	---	---	---

Notes:

- (1) EPA Region III - Regional Screening Levels (May 19, 2009). RSLs adjusted for a Hazard Quotient of 0.1 for noncancer compounds (i.e., divided by 10) to account for additive effects.
- (2) Background values are from "Final Surface Soils Background Metals and Anthropogenic Pesticides Report, Fort Lee, Virginia. Dated January 1999."
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- (4) Data were compared to the "Mercury Inorganic Salts" values in the EPA Region III RSL table.
- (5) Data were compared to the "Nickel Soluble Salts" values in the EPA Region III RSL table.
- (6) Data were compared to the "Vanadium and Compounds" values in the EPA Region III RSL tables.

--- No sample collected or the compound/element was not listed in the EPA Region III RSL tables

12.4	Bolded text indicates analyte was detected
2.0	Indicates the analyte was detected above the site specific background value.
67.5	Yellow shaded box indicates analyte detected above EPA Region 3 SL for residential soils.
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Data Qualifiers:

- B = Blank Contamination
- D = Diluted for Analysis
- J = Estimated Concentration
- U = Not Detected

**Table 4-1: 2009 Soil Excavation Results
Fire Training Pit**

Parameters	Screening Level Residential Soils ⁽¹⁾	Screening Level Industrial Soils ⁽¹⁾	Background Values (Surface Soil) ⁽²⁾	Background Values (Subsurface Soil) ⁽²⁾	NSW3	SSW1	DUP1	SSW2	SSW3	WSW1	WSW2	TB021009	TB021109	TB021309
Depth (feet bgs)					9-10	9-10	SSW1 (9-10)	9-10	9-10	9-10	9-10	TRIP BLANKS		
Dioxin/Furans (ug/kg)														
1,2,3,4,6,7,8-HpCDD	---	---	NA	N/A	---	---	---	---	---	---	---	---	---	---
OCDD	15	61	NA	N/A	---	---	---	---	---	---	---	---	---	---
1,2,3,4,6,7,8-HpCDF	---	---	NA	N/A	---	---	---	---	---	---	---	---	---	---
Total Hepta-Dioxins	---	---	NA	N/A	---	---	---	---	---	---	---	---	---	---
Total Hepta-Furans	---	---	NA	N/A	---	---	---	---	---	---	---	---	---	---
Total TAL Metals (mg/kg)														
Aluminum	7,700	99,000	23,200.0	99,000	10,900	11,500	11,100	12,300	11,300	13,000	12,300	---	---	---
Antimony	3.1	41.0	5.0	41.0	0.4 B	0.69 B	0.62 B	0.85 B	0.98 B	0.33 B	0.98 B	---	---	---
Arsenic	0.39	1.6	24.0	1.6	1.5	0.61 B	0.5 B	0.91 B	2.0	0.78 B	0.97 B	---	---	---
Barium	1,500.0	19,000.0	43.4	19,000	13.1 B	20.3 B	19.3 B	18.3 B	19 B	16.7 B	19.4 B	---	---	---
Beryllium	16.0	200.0	1.1	200	0.07 B	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	---	---	---
Cadmium	7.0	80.0	1.3	80	0.2 B	0.08 U	0.08 U	0.08 U	0.41 B	0.08 U	0.08 U	---	---	---
Calcium	--	--	420.0	--	25.9 B	25.8 B	25.3 B	30.2 B	27.1 B	30.6 B	23 B	---	---	---
Chromium	28.0 ⁽³⁾	140.0	40.3	140	16.4	13.9	13.3	14.2	37.6	15.3	19.7	---	---	---
Copper	310.0	4,100.0	23.6	4,100	11	6.8	6.3	7.1	6	8.9	6.8	---	---	---
Iron	5,500.0	72,000.0	69,700.0	72,000	15,200	10,000	9,650	9,630	21,100	10,200	13,200	---	---	---
Lead	40.0	80.0	61.2	80	9.7	12.1	11.8	10.8	13.2	12.2	13.5	---	---	---
Magnesium	--	--	747.0	--	136 B	172 B	163 B	174 B	142 B	163 B	170 B	---	---	---
Manganese	180.0	2,300.0	347.0	2,300	8.7	5.2	5.6	5.7	4.0	6.0	5.9	---	---	---
Mercury	2.3 ⁽⁴⁾	31.0	0.1	31	0.020 U	0.020 U	0.022 B	0.022 B	0.036 B	0.020 U	0.049	---	---	---
Nickel	150 ⁽⁵⁾	2,000.0	13.4	2,000	1.9 B	1.6 B	1.5 B	1.6 B	1.3 B	1.5 B	2.2 B	---	---	---
Potassium	--	--	1,540.0	--	301 BE	336 BE	336 BE	290 BE	327 BE	262 BE	340 BE	---	---	---
Selenium	39.0	510.0	5.0	510	1.5	0.92	0.85	0.92	2.2	0.91	1.3	---	---	---
Sodium	--	--	214.0	--	161 B	126 B	142 B	108 B	110 B	99.5 B	108 B	---	---	---
Vanadium	39 ⁽⁶⁾	520.0	99.5	520	48.3	45.9	48.6	44.6	72	49.1	57.4	---	---	---
Zinc	2,300.0	31,000.0	35.4	31,000	6.6	4.1	4	4.2	2.8	4.3	4.1	---	---	---

Notes:

- (1) EPA Region III - Regional Screening Levels (May 19, 2009). RSLs adjusted for a Hazard Quotient of 0.1 for noncancer compounds (i.e., divided by 10) to account for additive effects.
- (2) Background values are from "Final Surface Soils Background Metals and Anthropogenic Pesticides Report, Fort Lee, Virginia. Dated January 1999."
- (3) Data were compared to the "Total Chromium" values in the EPA Region III RSL table.
- (4) Data were compared to the "Mercury Inorganic Salts" values in the EPA Region III RSL table.
- (5) Data were compared to the "Nickel Soluble Salts" values in the EPA Region III RSL table.
- (6) Data were compared to the "Vanadium and Compounds" values in the EPA Region III RSL tables.

--- No sample collected or the compound/element was not listed in the EPA Region III RSL tables

12.4	Bolded text indicates analyte was detected
2.0	Indicates the analyte was detected above the site specific background value.
67.5	Yellow shaded box indicates analyte detected above EPA Region 3 SL for residential soils.
2	Red shaded box indicates analyte detected above the EPA Region 3 SL for industrial soils.

Data Qualifiers:

- B = Blank Contamination
- D = Diluted for Analysis
- J = Estimated Concentration
- U = Not Detected

TABLE 4-2
February 2009 Groundwater Analytical Summary
DIOXIN/FURANS
Fire Training Pit

Parameter	MW-5	USEPA Region III RSL - Tap Water (1)
Dioxin/Furans (ug/L)		
2,3,7,8-TCDD Toxic Equivalents (TEQ)	2.44E-07	5.2E-07

Notes:

1 - USEPA Region III risk-based screening levels (12SEP2008)

TABLE 4-3
May 2009 Groundwater Analytical Summary
Fire Training Pit

	Screening Level (SL) for Tap Water ¹	Maximum Contaminant Level (MCL) ¹	Ft. Lee Groundwater Background Values	MW-1	MW-2	MW2 DUP	MW3	MW4	TB050609
Volatile Organics Analysis (ug/L)									
1,1-dichloroethane	NA ²	NA ²	NA ²	--	--	--	2.1 J	--	--
Acetone	2200	--	NA ²	13	--	--	--	--	--
Benzene	0.41	5	NA ²	--	2.8 J	2.4 J	17	--	--
Carbon disulfide	100	--	NA ²	1.3 J	--	--	--	--	--
Ethylbenzene	1.5	700	NA ²	5	6.6	4.9 J	13	--	--
Isopropyl benzene	68	--	NA ²	--	7.4	7.4	3.8 J	--	--
M,p-xylene (part of total)	140	--	NA ²	10	160	160	--	--	--
Methylcyclohexane	NA ²	NA ²	NA ²	--	1.1 J	--	2.7 J	--	--
Methyl-tert-butyl ether	12	--	NA ²	--	3.0 J	2.7 J	--	--	--
O-xylene (part of total)	140	--	NA ²	--	150	150	6	--	--
Toluene	230	100	NA ²	--	1.1 J	0.97 J	--	--	--
Xylene (total)	20	10000	NA ²	10	310	310	6	--	--
Semi-Volatile Organics Analysis (ug/L)									
1-methylnaphthalene	2.3	--	NA ²	17 E	17 E	16 E	6.2 EB	1.4 B	--
2-methylnaphthalene	15	--	NA ²	22 E	26 E	24 E	11 E	2.2 E	--
Acenaphthene	220	--	NA ²	1.7	0.22	0.21	0.26 B	--	--
Anthracene	1100	--	NA ²	0.13 J	--	--	0.091 JB	--	--
Fluoranthene	150	--	NA ²	0.018 J	0.012 J	0.011 J	0.023 JB	--	--
Fluorene	150	--	NA ²	2.2 E	1	1.1	0.81 B	0.053 JB	--
Naphthalene	0.14	--	NA ²	13 E	25 E	23 E	10 E	2.4 E	--
Phenanthrene	NA ²	NA ²	NA ²	1.9	1.5	1.5	2.9 EB	0.049 JB	--
Pyrene	110	--	NA ²	0.039 J	0.021 J	0.017 J	0.04 JB	--	--
Total Inorganics (ug/L)									
Aluminum	3,700	--	16,500	567	85.4 B	89.9 B	123 B	131 B	--
Antimony	1.50	6.0	50	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	--
Arsenic	0.045	10	27	2.4 U	2.4 U	2.4 U	2.4 U	2.4 U	--
Barium	730	2,000	555	10.4 B	37.4 B	40.6 B	12 B	37 B	--
Beryllium	7.3	4	5	0.35 U	0.350 U	0.350 U	0.350 U	0.350 U	--
Cadmium	1.8	5	10	0.27 U	0.3 U	0.3 U	0.27 U	0.27 U	--
Calcium	NA ²	NA ²	10,500	257 B	73.5 B	73.2 B	156 B	186 B	--
Chromium	--	100	26	0.82 B	0.640 U	0.640 U	0.64 U	0.64 U	--
Cobalt	1.1	--	40	4.9 B	7.8	8.4	0.58 U	4.2 B	--
Copper	150	1,300	23	1.6 B	1.6 B	1.5 B	0.88 U	8.5	--
Iron	2,600	--	10,900	12,700	159	162	1,140.0	123	--
Lead	--	15	41	1.8 U	3.6	4.1	1.8 U	3.0	--
Magnesium	NA ²	NA ²	3,900	537 B	356 B	395 B	502 B	583 B	--
Manganese	88	--	300	175	78.5	92.7	11.1	100	--
Mercury	0.057	2	1	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	--
Nickel	73	--	40	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	--
Potassium	NA ²	NA ²	3,700	171 B	148 B	167 B	118 B	206 B	--
Selenium	18	50	6	2.9 U	2.9 U	2.9 U	2.9 U	2.9 U	--
Silver	18	--	10	0.33 U	0.3 U	0.3 U	0.33 U	0.33 U	--
Sodium	NA ²	NA ²	59,000	3,670 B	3,120 B	3,420 B	2,870 B	2,690 B	--
Thallium	0.24	2	22	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	--
Vanadium	26	--	31	1.7 B	0.46 U	0.46 U	0.46 U	0.46 U	--
Zinc	1100	--	110	4.2 B	4 B	5.6 B	5 B	7.7 B	--
Other (mg/L)									
TSS	NA ²	NA ²	NA ²	29.2	0 U	0 U	0 U	0 U	--
NITRATE+NITRITE	NA ²	NA ²	NA ²	--	0.18	0.22	0.13	0.11	--
TDS	NA ²	NA ²	NA ²	34	7 J	8 J	0 U	8 J	--
TOC	NA ²	NA ²	NA ²	3.9 J	2.3 J	1.7 J	2.8 J	1.5 J	--
DOC	NA ²	NA ²	NA ²	3.5 J	1.9 J	2.3 J	2.7 J	1.6 J	--

Notes:

¹ EPA Region III - Regional Screening Levels (May 19, 2009). SL for Tap Water adjusted for a Hazard Quotient of 0.1 for noncancer compounds (i.e., divided by 10) to account for additive effects.

² Analyte is not listed in the respective guidance.

-- Indicates that the analyte is listed in the respective guidance but that a value was not given for the comparison criteria

NA - Not applicable or not analyzed

550 U Italicized text indicated the reporting limit is above one or more of the regulatory criteria

550 Bolded text indicates analyte was detected.

550 Underline text indicates analyte detected above site specific background levels

200 Yellow shaded box indicates analyte detected above SL for Tap Water

800 Pink shaded box indicates analyte detected above both SL for Tap Water and MCL

Data Qualifiers:

- U Not detected
- J Analyte present. Reported value between detection and quantitation limits
- D Sample diluted due to exceedance of calibration range in original sample
- B Analyte present in associated method blank
- E Exceeded calibration range of instrument
- P Greater than 25% difference for detected levels in two GC columns

TABLE 5-1
Post-Removal Action Groundwater Analytical Results
Fire Training Pit

	Screening Level (SL) for Tap Water ¹	Maximum Contaminant Level (MCL) ¹	Ft. Lee Groundwater Background Values	MW-1		MW-2		MW-3		MW-4	
				Dec-07	May-09	Dec-07	May-09	Dec-07	May-09	Dec-07	May-09
Volatile Organics Analysis (ug/L)											
1,1-Dichloroethene	2.4	--	NA	1.0 U	5.0 U	1.0 U	5.0 U	1.0 U	5.0 U	2.3	5.0 U
4-Methyl-2-Pentanone	200	--	NA	5.0 U	13 U	5.0 U	13 U	5.0 U	13 U	5.0 U	13 U
Benzene	0.41	5.0	NA	7.5	5.0 U	0.67 J	2.8 J	30	17	42	5.0 U
Ethylbenzene	1.5	700	NA	19	5.0	18	6.6	15	13	13	5.0 U
m/p-Xylenes	20	10000	NA	2.8	10	95	160	2.0 U	10 U	12	10 U
o-Xylene	140	--	NA	2.3	5.0 U	110	150	11	6.0	13	5.0 U
Semi-Volatile Organics Analysis (ug/L)											
2-methylnaphthalene	15	--	NA	-	27 D	-	36 D	-	17 D	-	2.8 D
Naphthalene	0.14	--	NA	150 E	16 D	52	31 D	68 E	12 D	92	3.0 D
Total Inorganics (ug/L)											
Antimony	1.50	6.0	50	<i>25.0 U</i>	1.8 U	<i>25 U</i>	1.8 U	<i>25 U</i>	1.8 U	<i>25 U</i>	1.8 U
Cobalt	1.1	--	40	3.550 J	4.9 B	29.6	7.8	<i>15 U</i>	0.58 U	7.55 J	4.2 B
Iron	2,600	--	10,900	7,700	12,700	1,060	159	735	1,140	3,640	123
Manganese	88	--	300	136	175	659	78.5	24.1	11.1	377	100
Thallium	0.24	2	22	<i>20.0 U</i>	<i>3.7 U</i>	13.9 J	<i>3.7 U</i>	<i>20.0 U</i>	<i>3.7 U</i>	3.57 J	<i>3.7 U</i>
Dissolved Inorganics (ug/L)											
Antimony	1.50	6.0	50	<i>25.0 U</i>	<i>2.1 U</i>	3.88 J	<i>2.1 U</i>	<i>25 U</i>	<i>2.1 U</i>	19.3 J	<i>2.1 U</i>
Arsenic	0.045	10	27	<i>10.0 U</i>	3.0 B	<i>10 U</i>	<i>2.5 U</i>	<i>10 U</i>	2.9 B	<i>10 U</i>	2.6 B
Cobalt	1.1	--	40	4.150 J	<i>1.8 U</i>	25.4	2.1 B	<i>15 U</i>	<i>1.8 U</i>	7.85 J	<i>1.8 U</i>
Iron	2,600	--	10,900	7,040	12,700	154	71.6 B	326	1,030	3,660	53.4 B
Manganese	88	--	300	148	182	552	83.8	23.8	10.8	382	97.4
Thallium	0.24	2	22	5.3 J	<i>3.6 U</i>	5.61 J	<i>3.6 U</i>	<i>20.0 U</i>	<i>3.6 U</i>	8.5 J	<i>3.6 U</i>
Indicator Parameters (mg/L)											
Alkalinity	NA ²	NA ²	NA	2 U	-	2 U	-	2 U	-	2 U	-
TSS	NA ²	NA ²	NA	4 U	29.2	28	1.00 U	14	1.00 U	4 U	1.00 U
NITRATE+NITRITE	NA ²	NA ²	NA	0.22	0.02 U	0.67	0.18	0.19	0.13	0.2	0.11
TDS	NA ²	NA ²	NA	21	34	24	7	27	10 U	10 U	8
TOC	NA ²	NA ²	NA	3.63	3.9	0.79	2.3	2.33	2.8	7	1.5
DOC	NA ²	NA ²	NA	4.25	3.5	0.97	1.9	3.94	2.7	8.93	1.6

Notes:

¹ EPA Region III - Regional Screening Levels (May 19, 2009). SL for Tap Water adjusted for a Hazard Quotient of 0.1 for noncancer compounds (i.e., divided by 10) to account for additive effects.

² Analyte is not listed in the respective guidance.

-- Indicates that the analyte is listed in the respective guidance but that a value was not given for the comparison criteria

NA - Not applicable or not analyzed

<i>550 U</i>	Italicized text indicated the reporting limit is above one or more of the regulatory criteria
550	Bolded text indicates analyte was detected.
<u>550</u>	Underline text indicates analyte detected above site specific background levels
200	Yellow shaded box indicates analyte detected above SL for Tap Water
800	Pink shaded box indicates analyte detected above both SL for Tap Water and MCL

Data Qualifiers:

- U Not detected
- J Analyte present. Reported value between detection and quantitation limits
- K Reported value may be biased high. Actual value is expected to be lower
- L Reported value may be biased low. Actual value is expected to be higher
- D Sample diluted due to exceedance of calibration range in original sample
- B Analyte present in associated method blank
- E Exceeded calibration range of instrument
- P Greater than 25% difference for detected levels in two GC columns
- R Reported value is "unusable" or unreliable. Analyte may or may not be present.

**TABLE 8-1
Historical Groundwater Analytical Results
Fire Training Pit**

	Screening Level (SL) for Tap Water ¹	Maximum Contaminant Level (MCL) ¹	Ft. Lee Groundwater Background Values	MW-1			MW-2				MW-3			MW-4		
				Dec-07	May-09	May-10	Dec-07	May-09	May-10	May-10	Dec-07	May-09	May-10	Dec-07	May-09	May-10
Volatile Organics Analysis (ug/L)				Duplicate												
1,1-Dichloroethene	2.4	--	NA	1.0 U	5.0 U	0.50 U	1.0 U	5.0 U	0.50 U	0.50 U	1.0 U	5.0 U	0.27 J	2.3	5.0 U	0.42 J
4-Methyl-2-Pentanone	200	--	NA	5.0 U	13 U	2.5 U	5.0 U	13 U	2.5 U	2.5 U	5.0 U	13 U	2.5 U	5.0 U	13 U	2.5 U
Benzene	0.41	5.0	NA	7.5	5.0 U	1.6	0.67 J	2.8 J	0.65	0.65	30	17	12	42	5.0 U	9.8
Ethylbenzene	1.5	700	NA	19	5.0	9.4	18	6.6	3.5	3.4	15	13	8.0	13	5.0 U	2.6
m/p-Xylenes	20	10000	NA	2.8	10	12	95	160	40	41	2.0 U	10 U	0.60 J	12	10 U	2.3
o-Xylene	140	--	NA	2.3	5.0 U	2.0	110	150	51 D	51 D	11	6.0	5.7	13	5.0 U	4.3
Semi-Volatile Organics Analysis (ug/L)																
2-methylnaphthalene	15	--	NA	-	27 D	56 DJ	-	36 D	15 DJ	11 DL	-	17 D	14 DJ	-	2.8 D	12 DJ
Naphthalene	0.14	--	NA	150 E	16 D	39 DJ	52	31 D	15 DJ	11 DL	68 E	12 D	11 DJ	92	3.0 D	10 DJ
Total Inorganics (ug/L)																
Antimony	1.50	6.0	50	25.0 U	1.8 U	5.3 BJ	25 U	1.8 U	4.8 BJ	4.3 BJ	25 U	1.8 U	5.7 BJ	25 U	1.8 U	6.2 BJ
Cobalt	1.1	--	40	3.550 J	4.9 B	3.4 L	29.6	7.8	11.0 L	9.3 L	15 U	0.58 U	1.5 UL	7.55 J	4.2 B	1.9 L
Iron	2,600	--	10,900	7,700	12,700	18,400	1,060	159	265	257	735	1,140	1,760	3,640	123	40.4 J
Manganese	88	--	300	136	175	187	659	78.5	116	113	24.1	11.1	12.2	377	100	73.8
Thallium	0.24	2	22	20.0 U	3.7 U	3.0 U	13.9 J	3.7 U	3.0 U	3.0 U	20.0 U	3.7 U	3.0 U	3.57 J	3.7 U	3.0 U
Dissolved Inorganics (ug/L)																
Antimony	1.50	6.0	50	25.0 U	2.1 U	6.3 BJ	3.88 J	2.1 U	5.0 J	6.3 BJ	25 U	2.1 U	5.0 BJ	19.3 J	2.1 U	4.8 BJ
Arsenic	0.045	10	27	10.0 U	3.0 B	2.5 U	10 U	2.5 U	2.5 U	2.5 U	10 U	2.9 B	2.5 U	10 U	2.6 B	2.5 U
Cobalt	1.1	--	40	4.150 J	1.8 U	1.8 L	25.4	2.1 B	9.8 L	10.2 L	15 U	1.8 U	1.5 UL	7.85 J	1.8 U	3.5 L
Iron	2,600	--	10,900	7,040	12,700	16,800 B	154	71.6 B	251 B	281 B	326	1,030	1,670 B	3,660	53.4 B	18.4 BJ
Manganese	88	--	300	148	182	174	552	83.8	116	119	23.8	10.8	12.3	382	97.4	79.0
Thallium	0.24	2	22	5.3 J	3.6 U	3.0 U	5.61 J	3.6 U	3.0 U	3.0 U	20.0 U	3.6 U	3.0 U	8.5 J	3.6 U	3.0 U
Indicator Parameters (mg/L)																
Alkalinity	NA ²	NA ²	NA	2 U	-	18.2 L	2 U	-	10.0 UL	-	2 U	-	10.0 UL	2 U	-	10.0 UL
TSS	NA ²	NA ²	NA	4 U	29.2	5.60	28	1.00 U	2.50 U	-	14	1.00 U	3.60	4 U	1.00 U	2.50 U
NITRATE+NITRITE	NA ²	NA ²	NA	0.22	0.02 U	0.146	0.67	0.18	0.67	-	0.19	0.13	0.11	0.2	0.11	0.149
TDS	NA ²	NA ²	NA	21	34	43.0	24	7	17.0	-	27	10 U	30.0	10 U	8	25.0
TOC	NA ²	NA ²	NA	3.63	3.9	8.4	0.79	2.3	0.90 B	-	2.33	2.8	2.5	7	1.5	3.0
DOC	NA ²	NA ²	NA	4.25	3.5	8.0	0.97	1.9	0.89 B	-	3.94	2.7	2.2	8.93	1.6	2.7

Notes:

¹ EPA Region III - Regional Screening Levels (May 19, 2009). SL for Tap Water adjusted for a Hazard Quotient of 0.1 for noncancer compounds (i.e., divided by 10) to account for additive effects.

² Analyte is not listed in the respective guidance.

-- Indicates that the analyte is listed in the respective guidance but that a value was not given for the comparison criteria

NA - Not applicable or not analyzed

<i>550 U</i>	Italicized text indicated the reporting limit is above one or more of the regulatory criteria
550	Bolded text indicates analyte was detected.
<u>550</u>	Underline text indicates analyte detected above site specific background levels
200	Yellow shaded box indicates analyte detected above SL for Tap Water
800	Pink shaded box indicates analyte detected above both SL for Tap Water and MCL

Data Qualifiers:

U	Not detected
J	Analyte present. Reported value between detection and quantitation limits
K	Reported value may be biased high. Actual value is expected to be lower
L	Reported value may be biased low. Actual value is expected to be higher
D	Sample diluted due to exceedance of calibration range in original sample
B	Analyte present in associated method blank
E	Exceeded calibration range of instrument
P	Greater than 25% difference for detected levels in two GC columns
R	Reported value is "unusable" or unreliable. Analyte may or may not be present.

**IRA Completion Report
Fire Training Pit
Fort Lee, Virginia**

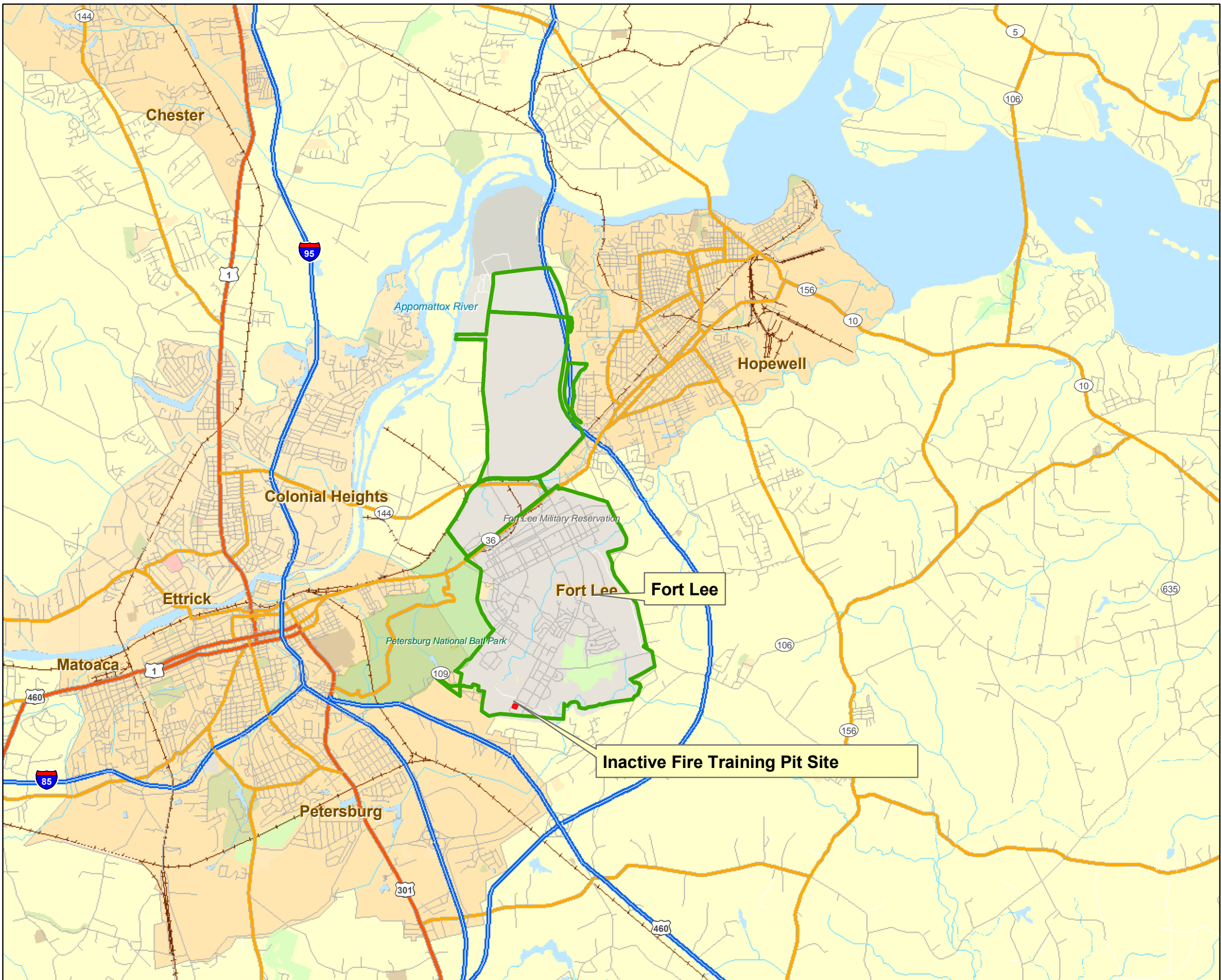
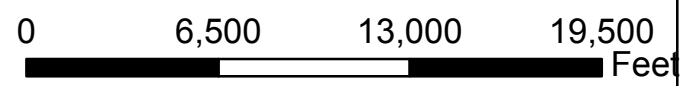
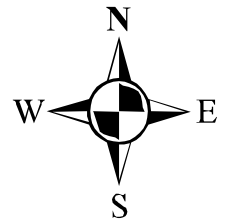


Figure 1-1
Site Overview Map
 Inactive Fire Training Pit Site
 Fort Lee, Virginia

Legend

- Inactive Fire Fighting Training Pit Site
- Installation Boundary



1 inch = 6,500 feet

Source: ESRI, StreetMap USA

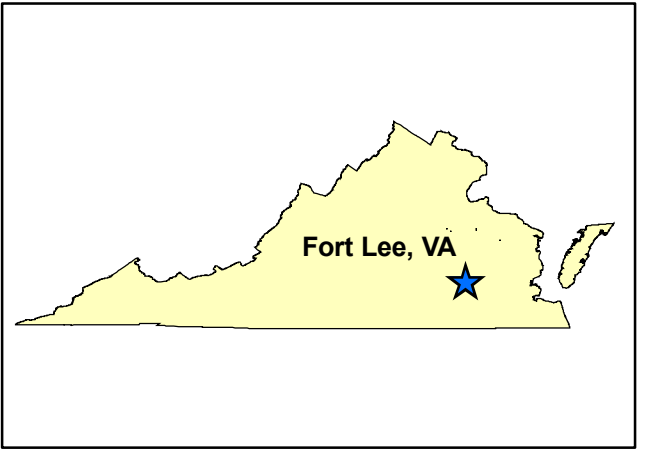
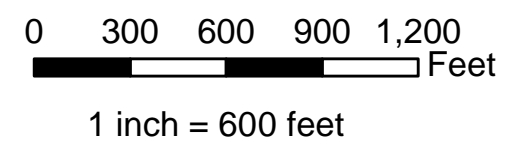
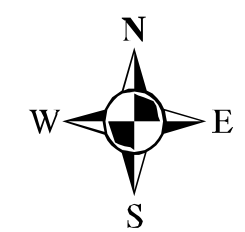




Figure 1-2
Site Location Map
 Inactive Fire Training Pit Site
 Fort Lee, Virginia

Legend

- Installation Boundary
- Area of Investigation**
- Inactive Fire Training Pit Site



Source: Aerial photography provided by Fort Lee

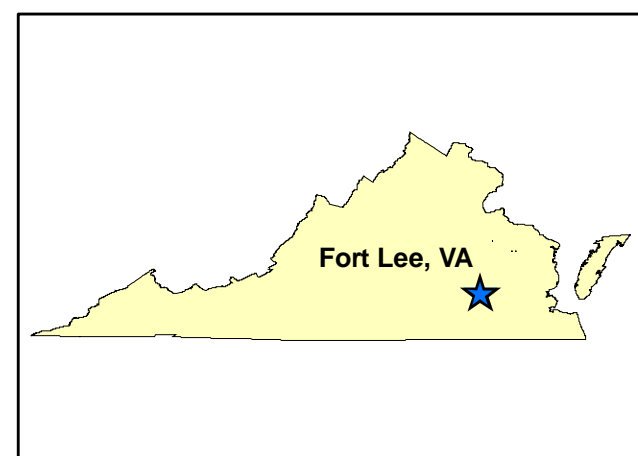




Figure 3-1

**November - December 2007
Soil RBC Exceedances
Inactive Fire Training Pit Site
Fort Lee, Virginia**

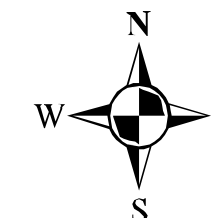
Legend

Fire Training Pit Location

Field Activity Locations

Direct Push Technology Location

DPT and Monitoring Well Location



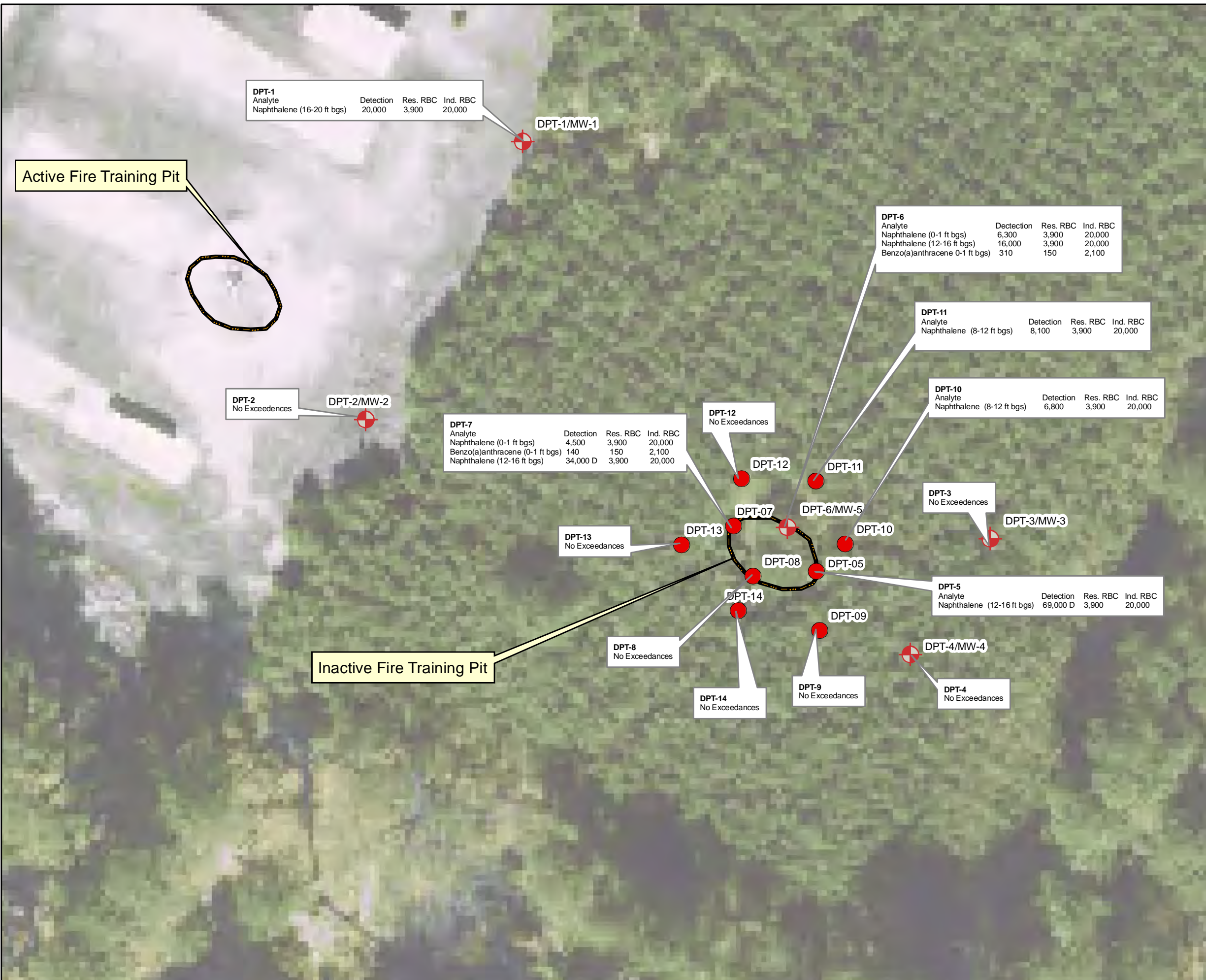
0 15 30 45 60 Feet

1 inch = 31 feet

Note: All DPT Samples are reported in mg/kg for metals and ug/kg for organics.

MS/MSD/DUP sample values are shown on Table 3-1.

Source: Aerial photography provided by Fort Lee



DPT-1			
Analyte	Detection	Res. RBC	Ind. RBC
Naphthalene (16-20 ft bgs)	20,000	3,900	20,000

DPT-1/MW-1

Active Fire Training Pit

DPT-2	
No Exceedances	

DPT-2/MW-2

DPT-7			
Analyte	Detection	Res. RBC	Ind. RBC
Naphthalene (0-1 ft bgs)	4,500	3,900	20,000
Benzo(a)anthracene (0-1 ft bgs)	140	150	2,100
Naphthalene (12-16 ft bgs)	34,000 D	3,900	20,000

DPT-12
No Exceedances

DPT-12

DPT-11

DPT-6			
Analyte	Detection	Res. RBC	Ind. RBC
Naphthalene (0-1 ft bgs)	6,300	3,900	20,000
Naphthalene (12-16 ft bgs)	16,000	3,900	20,000
Benzo(a)anthracene 0-1 ft bgs)	310	150	2,100

DPT-11			
Analyte	Detection	Res. RBC	Ind. RBC
Naphthalene (8-12 ft bgs)	8,100	3,900	20,000

DPT-10			
Analyte	Detection	Res. RBC	Ind. RBC
Naphthalene (8-12 ft bgs)	6,800	3,900	20,000

DPT-3
No Exceedances

DPT-3/MW-3

DPT-13
No Exceedances

DPT-13

DPT-07

DPT-6/MW-5

DPT-10

DPT-08

DPT-05

DPT-5			
Analyte	Detection	Res. RBC	Ind. RBC
Naphthalene (12-16 ft bgs)	69,000 D	3,900	20,000

Inactive Fire Training Pit

DPT-8
No Exceedances

DPT-14
No Exceedances

DPT-9
No Exceedances

DPT-4/MW-4



DPT-4
No Exceedances

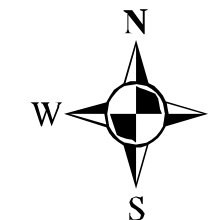




Figure 3-2
2007 Groundwater SL, MCL, and Background Exceedances
 Inactive Fire Training Pit Site
 Fort Lee, Virginia

Legend

-  Fire Fighting Training Pit Location
-  DPT and Monitoring Well Location



0 15 30 45 60 Feet

1 inch = 31 feet

Note: All MW samples are reported in ug/L.

All inorganic values are dissolved.

Source: Aerial photography provided by Fort Lee



MW-1				
Analyte	Detection	SL	MCL	Background
Benzene	7.5	0.41	5.0	NA
Ethyl Benzene	19	1.5	700	NA
Napthalene	150 E	0.14	--	NA
Cobalt	4,150 J	1.1	--	40
Iron	7,040	2,600	--	10,900
Manganese	148	88	--	300
Thallium	5.3 J	0.24	2	22

MW-5/MW-5 DUP				
Analyte	Detection	SL	MCL	Background
1,1-Dichloroethene	8.8	2.4	--	NA
4-Methyl-2-Pentanone	250	200	--	NA
Benzene	180	0.41	5.0	NA
Ethyl Benzene	47	1.5	700	NA
m/p-Xylenes	48	20	10,000	NA
Napthalene	240	0.14	--	NA
Antimony	22.4 J	1.50	6.0	50
Cobalt	103	1.1	--	40
Iron	21,000	2,600	--	10,900
Manganese	3,370	88	--	300
Thallium	6.03 J	0.24	2	22

MW-3				
Analyte	Detection	SL	MCL	Background
Benzene	30	0.41	5.0	NA
Ethyl Benzene	15	1.5	700	NA
Napthalene	68 E	0.14	--	NA

MW-4				
Analyte	Detection	SL	MCL	Background
Benzene	42	0.41	5.0	NA
Ethyl Benzene	13	1.5	700	NA
Napthalene	92	0.14	--	NA
Antimony	19.3	1.50	6.0	50
Cobalt	7.85 J	1.1	--	40
Iron	3,660	2,600	--	10,900
Manganese	382	88	--	300
Thallium	8.5 J	0.24	2	22

MW-2				
Analyte	Detection	SL	MCL	Background
Benzene	0.67	0.41	5.0	NA
Ethyl Benzene	18	1.5	700	NA
m/p-Xylenes	95	20	10,000	NA
Napthalene	52	0.14	--	NA
Antimony	3.88 J	1.5	6.0	50
Cobalt	25.4	1.1	--	40
Manganese	552	88	--	300
Thallium	5.61 J	0.24	2	22

Active Fire Training Pit

Inactive Fire Training Pit

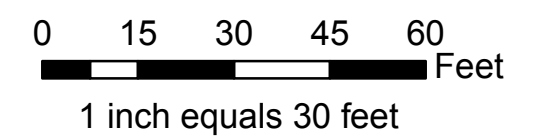
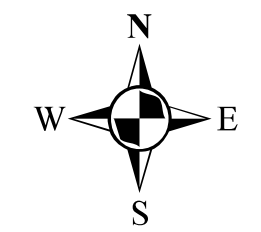




Figure 3-3
2007 Groundwater Contours
 Inactive Fire Training Pit Site
 Fort Lee, Virginia
Legend

- DPT/Monitoring Well Locations - GW Elevations
- Groundwater Elevation Contours
- Interpolated Groundwater Elevation Contours
- Inactive Fire Training Pit Site
- Fire Training Pit Location

Notes: Groundwater Contours are based on GW elevation data from MW-1, MW-2, MW-3, and MW-4. MW-5 was measured to 0.1 foot accuracy, which is not sufficient to discern groundwater flow trends.



Source: Aerial photography provided by Fort Lee

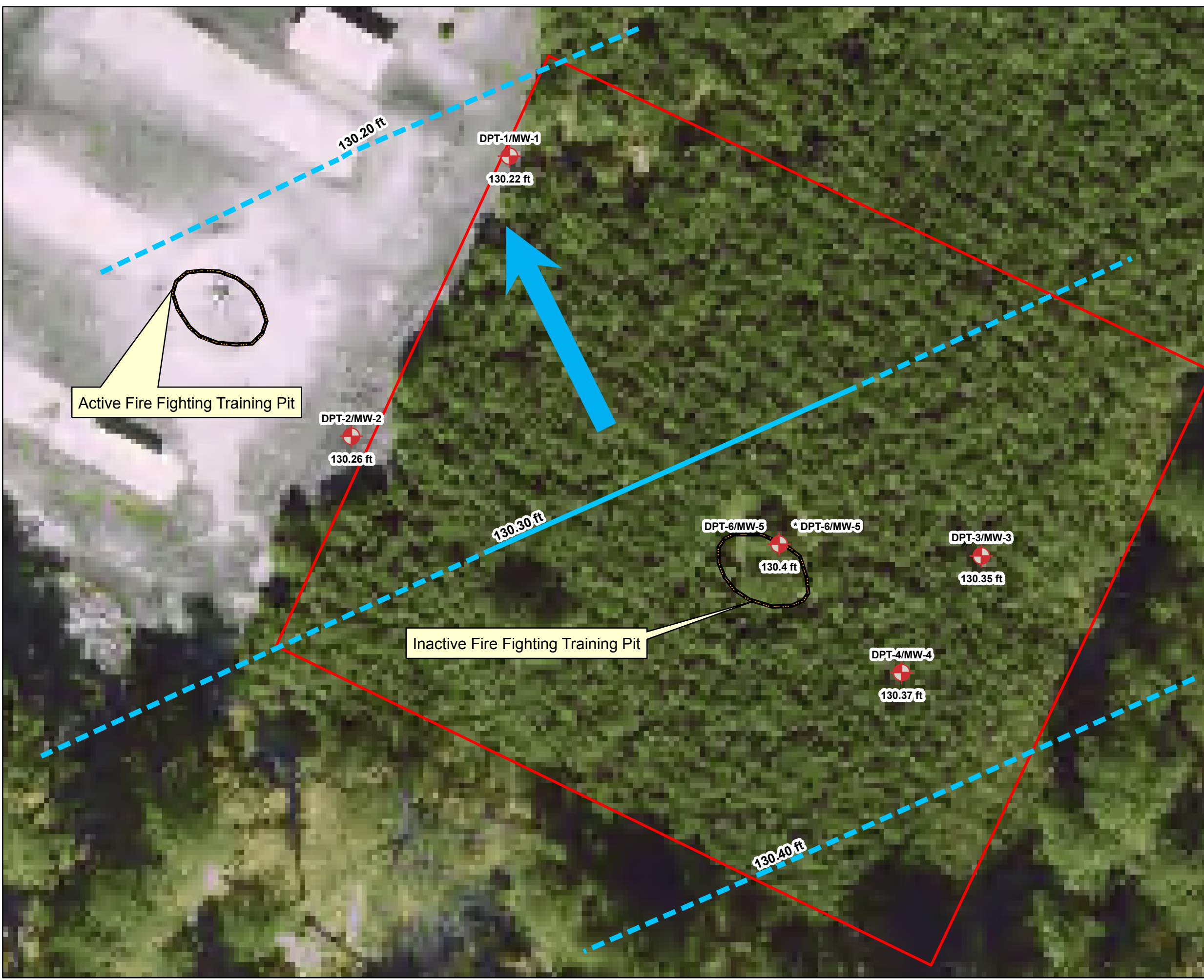




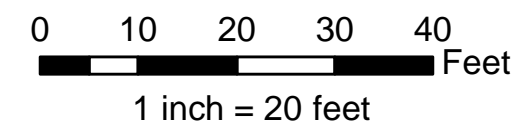
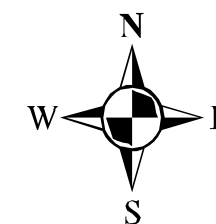




Figure 4-1
February 2009 Sample Locations
 Inactive Fire Training Pit Site
 Fort Lee, Virginia

Legend

-  Fire Fighting Training Pit Location
-  Approximate Excavation Area
-  Confirmatory Samples, February 2009
-  Monitoring Well



Source: Aerial photography provided by Fort Lee

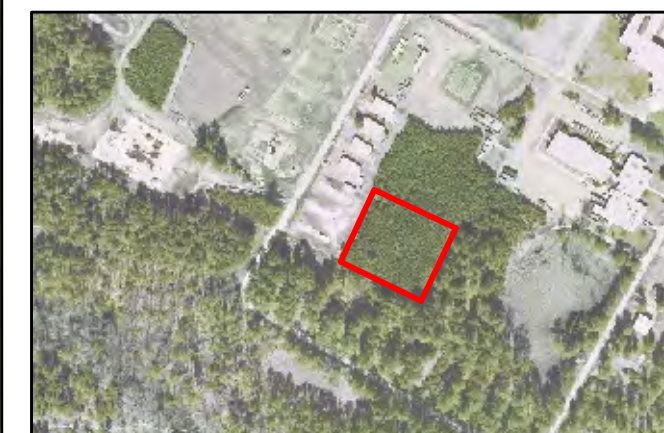



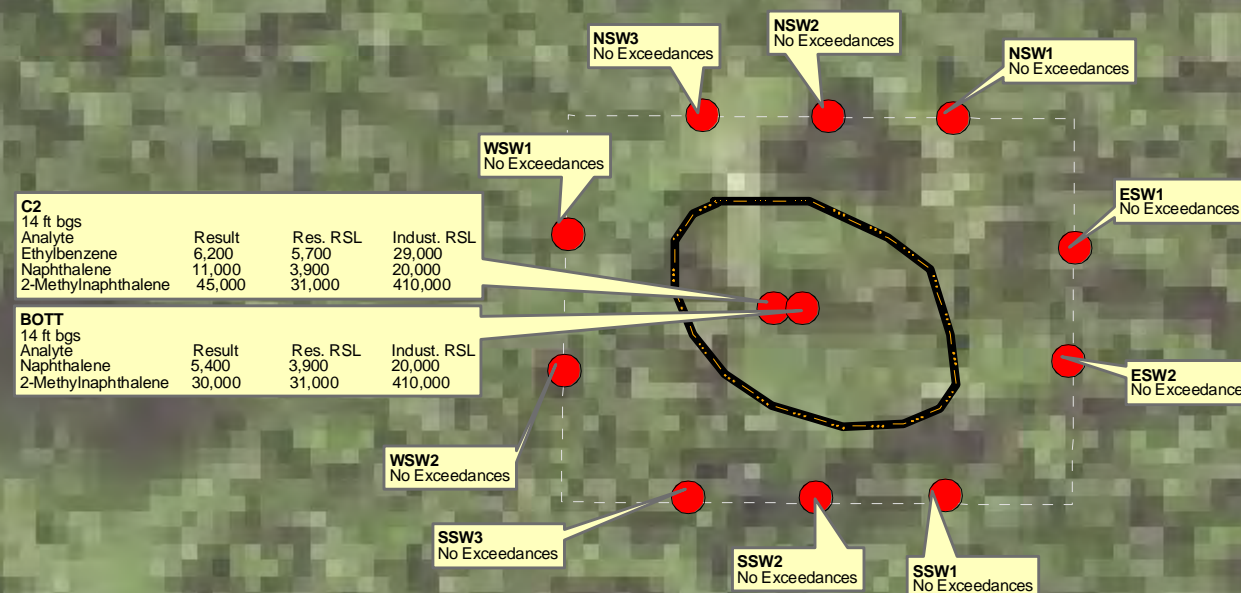
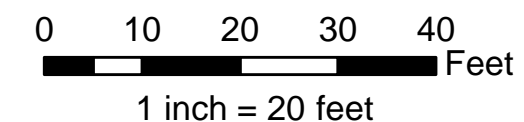
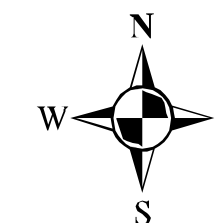




Figure 4-2
February 2009
Soil VOC & SVOC RSL Exceedances
 Inactive Fire Training Pit Site
 Fort Lee, Virginia

Legend

-  Fire Fighting Training Pit Location
-  Approximate Excavation Area
-  Confirmatory Samples, February 2009





Source: Aerial photography provided by Fort Lee

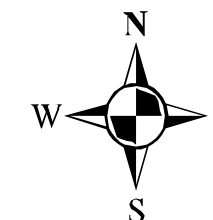




Figure 4-3
May 2009 Groundwater SL, MCL, and Background Exceedances
 Inactive Fire Training Pit Site
 Fort Lee, Virginia

Legend

-  Fire Fighting Training Pit Location
-  DPT and Monitoring Well Location



0 15 30 45 60 Feet

1 inch = 31 feet

Note: All MW samples are reported in ug/L.

Total inorganic values were used.

Source: Aerial photography provided by Fort Lee



Analyte	Detection	SL	MCL	Background
Ethylbenzene	5	1.5	700	NA
1-methylnaphthalene	17 E	2.3	--	NA
2-Methylnaphthalene	22 E	15	--	NA
Napthalene	13 E	0.14	--	NA
Cobalt	4.9 B	1.1	--	40
Iron	12700	2600	--	10900
Manganese	175	88	--	300

Active Fire Training Pit

Analyte	Detection	SL	MCL	Background
Benzene	2.8 J	0.41	5	NA
Ethylbenzene	6.6	1.5	700	NA
m,p-xylene (part of total)	160	140	--	NA
o-xylene (part of total)	150	140	--	NA
Xylene (total)	310	20	10,000	NA
1-methylnaphthalene	17 E	2.3	--	NA
2-methylnaphthalene	26 E	15	--	NA
Napthalene	25 E	0.14	--	NA
Cobalt	7.8	1.1	--	40
Manganese	78.5	88	--	300

MW-5/MW-5 DUP
 Not sampled in May 2009.

Analyte	Detection	SL	MCL	Background
Benzene	17	0.41	5	NA
Ethylbenzene	13	1.5	700	NA
1-methylnaphthalene	6.2 EB	2.3	--	NA
Napthalene	10 E	0.14	--	NA

Inactive Fire Training Pit

Analyte	Detection	SL	MCL	Background
Napthalene	2.4 E	0.14	--	NA
Cobalt	4.2 B	1.1	--	40
Manganese	100	88	--	300





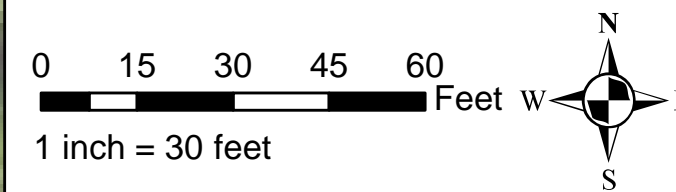
Figure 4-4
 Proposed Monitoring Well Location
 Inactive Fire Training Pit Site
 Fort Lee, Virginia



Legend

- Inactive Fire Fighting Training Pit Site
- Fire Fighting Training Pit Location
- Approximate Excavation Area
- + Monitoring Well

Source: Aerial photography provided by Fort Lee



Source: Aerial photography provided by Fort Lee



***APPENDIX A
REFERENCES***

**IRA Completion Report
Fire Training Pit
Fort Lee, Virginia**

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***APPENDIX B
FIELD NOTES***

**IRA Completion Report
Fire Training Pit
Fort Lee, Virginia**

FIELD NOTES FOR FEBRUARY 2009 EXCAVATION EVENT

Fort Lee
FTP

FL-QL-01
2/5/09

Objective: site prep at FTP
weather: ±21, sunny

- 0745 LS, BM, FR meet at FTP. LS/BM
conduct H&S tailgate. BM goes over
schedule for the day.
- 0800 FR continues prepping truck entrance. Prep
to FR perform equipment inspection
on backhoe
- 1300 LS, BM, FR go to 10K Barnack
to check condition of drums
& it all full - a total of 15
drums on site.
- 1430 LS, BM, FR go to LFB to check
condition of drums - a total of
3 drums onsite.
- 1520 ELL back at

Location Fort Lee

FL-QL-01
2/6/09

Project Title FIFPI 10K Barnacks, LFB

Objective: Disposal of IDW at different location
± 25, sunny

- 0745 LS, BM, FR meet at FTP. LS/BM
conduct H&S tailgate (rigging). BM
goes over activities for the day
- 0800 FR performs equip inspection & drives
backhoe to Geta to fuel backhoe
- 0900 ELL team escort backhoe to 37th
St. (10K Barnacks) to empty 15 drums
(IDW - non haz) that MP left behind
& never properly disposed of. Test
results indicated: it is non-haz & can
be returned to the site. A total of
15 drums.
- 1148 Delivery of Regens's OROA
- 1209 ELL to LFB disposal of 3
drums (IDW) left by MP. Test
results indicated can be return to site
- 1405 ELL to FTP disposal 2 drums left
by MP - will be disposed of site
during T&D
- 1600 ELL disposal 1 D near Hank's office
- 1640 ELL personnel offsite for phily

2/6/09
Page

Fort Lee
FTP

FL-QC-01
2/9/09

Objective: excavate top 2 feet
weather: +40; sunny

- 0645 LS, BM, FR, RC onsite.
- 0650 LS, BM conduct HHS tail site
on hazards associated w/ excavation.
BM reviews activities of the day
w/ the crew. Prep on excav, segs & transport soil
- 0710 Rena sets up gw collecting equipment
at MW-5. Get out collecting for
dioksi- LS conduct prep on equip down
- 0711 FL conduct inspection on both
the excavation & backline
- 0720 LS & BM spray-paints the
boundary of the excavation.
- 0815 Begin excavating 1st 2' starting
in SE corner. Top 2' will
be disposed
- 1325 Completed removing A1, A2, A3
(1.5ft from 2ft - 3.5 bps)
- 1330 RC is having trouble w/ Petro
kits. Continue get error on cal
soln. Both RC & LS talked to Pine
they are shipping a new kit from
MA. Per Ted they did not ✓ the
cal. kit. They did not have an
available kit.

Fort Lee
FTP

FL-QC-01
2/9/09

- 1320 ^{cont.}
LS was advised that MA will test
the meter prior to sending & will
ship 2 xtr box for free
- 1530 Pulled 1st set of samples
A1 (2-3.5); A2 (2-3.5); A3 (2-2.5)
combined sample b/c we combined
excavation.
- 1640 Track loader delivered
- 1730 All personnel off site for the
day.
- Clayton
Lester

Fort Lee
FTP

FL-02-01
2/10/09

Objective: EXCAVATE AT FTP
Weather: ±50; sunny

- 0800 LS, BM, RC, FR onsite. Lawn S
conducts HOS tailgate - slips / trips /
fall. Prep on Enviro. sampling
- 0820 BM review activities of the day w/
the crew.
- 0830 FR drives equipment to fuel equipment.
- 0930 LS calls hotel & the petro-kit has
arrived.
- 1010 LS returns w/ kits.
- 1015 RC sets up kits & calibrates the
kit.
- 1030 Kit is calibrated for 1,000 ppm
- 1040 A1-A3 (3.5 bgs) = 312 ppm
- 1100 Combine 2 dirty stockpiles so we can
start to load trucks tomorrow (0700)
- 1130 start to excavate next interval
- A3 (6.5' bgs) = 65.5 ppm (acid)
- 1245 Grab 3rd interval sample
A3 (10' bgs)
- 1300 Digging A3 till GW.
- 1306 Sunbelt onsite to work on bucket
(put in pin)
- 1330 Sunbelt off-site.
- 1345 Hit gw @ ~16 ft - completed
excavation at A3.

FL-02-01

Date	Grid	Depth	PID ppm	TFH ppm	Notes
2/10/09	A1-A3	3.5	0.2	312	adulstn
2/10/09	A3	6.5	65.5	-	adulstn
2/10/09	A3	10	189	Exceed 1,000	adulstn
2/10/09	ESW2	9-10	sample	-	adulstn
2/10/09	A2	6.5	62.1	-	adulstn
2/10/09	A2	10	58.1	-	adulstn
2/10/09	A3	16	83.2	-	adulstn
2/10/09	A1	6.5	22.1	-	adulstn
2/10/09	A1	10	14.4	-	adulstn
2/10/09	ESW1	9-10	83.2	-	adulstn
2/11/09	B3	3.5	33.7	14/9	sk order
2/11/09	B5	6.5	52.2	-	sk order
2/11/09	B2	3.5	111	-	sk order
2/11/09	B2	6.5	42-159.1	-	sk order
2/11/09	B1	3.5	58.1-62.1	-	sk order
2/11/09	B1	6.5	41-58.1	-	sk order

FTP
Fort Lee

FL-02-01
2/10/09

- 1607 Completed excavation of A1, A2, A3.
1625 Shape stockpile & cover
1720 All personnel offsite for
the day

2/10/09
6th

Location Fort Lee
Project FTP

FL-02-01
2/11/09

Objective: T&D

Weather: ± 55°; sunny; windy ± 5-10 mph

- 0700 BM, LS, RC, FR onsite. LS/BM
conducts Hds tailgate - heavy equipment
BM review activities of the day w/
the crew
- 0715 FR conduct equipment inspections
on loader & excavator
- 0722 1st truck onsite - (purple truck
truck # 003)
- 0737 1st truck offsite
- 0738 2nd truck onsite - (T. L. Bennett)
- 0747 2nd truck offsite.
- 0748 3rd truck onsite - (Tom Pleasant)
- 0758 3rd truck offsite
- 0759 4th truck onsite. (Hault, Inc. #3)
- 0810 4th truck offsite.
- 0811 5th truck onsite (skippy ponytail
red cap)
- 0821 5th truck offsite
- 0822 6th truck onsite (skippy beard)
- 0833 6th truck offsite
- 0834 7th truck onsite. (skippy, bald)
- 0844 7th truck offsite
- 0847 8th truck onsite/trailer truck (small
son)
- 0907 8th truck offsite.
- 0910 9th truck onsite (Jones & Jones Analy)

Foot Lee
FTP

FL-22-01

2/11/09

- 0820 9th truck offsite
0821 10th truck onsite (Harris Hauling, Inc ^{1st truck})
0929 10th truck offsite
0930 11th truck onsite (Green Shelton & Sons)
0941 11th truck offsite
0942 12th truck onsite (Ty Hauling repeat of 1st truck)
0952 12th truck offsite.
1009 13th truck onsite (A&M Pleasants repeat of 3rd truck)
1019 13th truck offsite.
1022 14th truck onsite (TL Bennett repeat of 2nd truck)
1032 14th truck offsite
1040 15th truck onsite (Snead & Sons - trailer repeat of 8th truck)
1059 BM starts to excavate w/ backhoe (Amalgam BS)
1100 15th truck offsite
1102 16th truck onsite (Hault, Inc repeat of 3rd truck)
1114 16th truck offsite
1116 17th truck onsite (Jones & Jones repeat of 9th truck)
1130 17th truck offsite
1131 18th truck onsite (Harris Hauling repeat of 10th truck)
1144 19th truck onsite (Shelton & Sons repeat of 11th truck)
1152 19th truck offsite
1153 20th truck onsite (Ty Hauling repeat of 1st truck)
1203 20th truck offsite

Location: Foot Lee
Project: FTP

FL-22-02

2/11/09

- 1240 21st truck onsite (Snead & Sons - trailer repeat of 8th truck)
1245 21st truck offsite
1259 22nd truck onsite (TL Bennett repeat of 2nd truck)
1307 22nd truck offsite.
1309 23rd truck onsite (Hault, Inc repeat of 3rd truck)
1320 24th truck onsite (Snead & Sons - new trailer from Snead & Sons)
1345 25th truck onsite - (new Snead & Sons)
1355 25th truck offsite
1405 26th truck onsite (Slippy return of 3rd truck)
1415 26th truck offsite
1425 27th truck onsite (A&M Pleasants return of 3rd truck)
1435 27th truck offsite
1440 28th truck onsite (Jones & Jones repeat of 9th truck)
1450 28th truck offsite
1455 29th truck onsite (return of 1st truck Shelton & Sons)
1505 29th truck offsite
1511 30th truck onsite (Ty's Hauling repeat of 1st truck)
1520 30th truck offsite
1525 31st truck onsite (Snead & Sons repeat of 1st truck)
1540 31st truck offsite - hot truck of the day
1600 Continue to excavate & stockpile
1735 All personnel offsite for the day

2/11/09

Fort Lee
FTP

FL-QL-01
2/12/09

Objective: Excavate & T&D
Weather: 50; sunny; windy 15-20 mph

- 0700 LS, BM, RC, FR onsite. LS conducts H&S tailgate → EZ & SZ
- 0710 BM discusses day activities w/ crew
- 0720 FR performs equipment inspections on excavator & loader.
- 0730 Begin to excavate & stockpile (3rd load)
- 0731 1st truck onsite (small & sand) 1st load
Will only have 1 truck today so
ECC can connect later on excavating
- 0732 truck offsite
- 0735 Need to go to get to rebuild equipment.
- 0740 LS conducts prep. on oxidizer operations & site restoration & dump.
- 0940 Truck back onsite (2nd load) (3rd load)
- 0954 Truck offsite.
- 1216 Truck back onsite (3rd load, 3rd load)
- H25 Truck back onsite (4th load, 3^{5th} truck)
- 1455 Truck offsite
- * re: Drums left by MP on pg 23. Drums were left @ H&H request. Said to leave them until FTP was dug out so heavy equip could safely move them. Concern of injury if done by hand.

Date	Grid	Depth	Volume	Location	Material/Color
2/11/09	B1	10	111		
2/11/09	NSW (9-10)	9-10	108		
2/11/09	C3	3.5	0.1	202	
2/11/09	C3	6.5	84		
2/11/09	C3	10	-		usual grey
2/11/09	C2	3.5	-		usual grey
2/11/09	C1	3.5	-		usual grey
2/12/09	B3	10	4.7		color
2/12/09	SSW1	9-10	5.1		color
2/12/09	B2	10	28.2		color
2/12/09	C3	10	15.9		color
2/12/09	SSW2	9-10	14.5		color
2/12/09	C3	14	131		color
2/12/09	D1	3.5	-		color
2/12/09	B1	10	147		color
2/12/09	C1	6.5	97.3		color

FTP
FT Lee

2/12/09

Note on samples:

Dup 1 = SSW1 (9-10)
(south seawall)

Dup 2 = Bott (16) aka C2 (16)

Date	Grid	Depth	PID (mm)	TPO (mm)	Notes
2/12/09	C2	6.5	133	—	petrol d petrol odor
2/12/09	C2	10	52.8	—	petrol odor
2/12/09	C1	10	162	—	petrol odor
2/12/09	NSW2 ^{pc} GT1	9-10	169	—	petrol odor
2/12/09	C2	14	299	—	stucco, petrol odor
2/12/09	C2	16	146	—	bott, petrol odor

6. Emergency Planning (See Section 14 of the Accident Prevention Plan)

EMERGENCY CALL LIST AND PROJECT ORGANIZATION		
Organization	Name	Phone number(s)
Fire/Police/Emergency Medical	Fort Lee Fire Department (non-emergency)	911 (Emergency)
	Fort Lee Military Police (non-emergency)	(804) 734-7037 (Non Emergency)
Hospital	John Randolph Medical Center, Hopewell, VA	(804) 734-7400 (Non Emergency)
Client Representative	Hank Hennigar, USAEC COR	804-541-1600
National Response Center		804-734-5068 (office) 804-370-8692 (mobile)
Regulatory Agency (Spill & Release Notification)	VADeQ Hotline	800-424-8802
		800-592-5482 804-698-4000
ECC Project Manager	Rob Wasserman	845-489-8926 (mobile)
ECC Project Safety and Health Manager	Will Stephan, CHMM	201-247-4847 (mobile)
ECC SSHS/QCSM	Lauren Sparkman	808-479-0668 (mobile)
Environmental Consultant	Malcolm Pirnie	757-873-8700 (MPI office)
	Rena Chadwick	757-814-6935 (mobile)
ECC HOTLINE		877-987-1240 (x318 / 372)

POST THIS LIST NEAR TELEPHONES.

KEY PROJECT PERSONNEL ARE TO HAVE A COPY OF THIS LIST READILY
AVAILABLE AT ALL TIMES

DAILY NOTES

PROJECT: FTP PROJECT NO: 4729011 PAGE _____ OF _____
 PERSONNEL: RJC LOCATION: Ft Lee DATE: 2/9/09
 WEATHER: PC, SO OTHER: _____

TIME:	LOG ENTRY
0700	Arrive at site
0803	Complete GW sample at MW5. ECC marking out grid
0830	Cal (TPH kit) + PID. Exc removes top 2 ft
0900-0930	Hank comes by. Top 2 ft look relatively clean. Seg into clean + cont piles by field obs, PID, and if necessary TPH kit.
1010	ECC speaks w/ Rob. Top 2 feet to be hauled due to possible droppings. Move to dirty pile
1150-1245	Lunch. Sunbelt stops by to fix exc.
1430	Jay and re Call Pine re: cal problem w/ TPH kit. Ck batt. Suspect its the meter after walking me thru cal. Sending new meter.
1500	ECC wants to move forward. Ask Pine if we can bag samples + store for analysis tomorrow. Reply: Get all air out of bag + watch temps. Minimize chance for volatilization + will probably be OK.
1526	ECC Exc to 3.5 ft in A1-A3. Put all in one stockpile accidentally so bagged a composite of A1-A3. Screen w/ PID = 0.2 ppm
1600	Call Cathy Damer re: ECC needs Coc + Herb results
1730	End w/ A1-A3 at 5 ft. Snow fence around pit. Stockpiles covered.

SIGNATURE: _____ CHECKED BY: _____ TITLE: _____ DATE: _____

DAILY NOTES

PROJECT: FTP PROJECT NO: 4729011 PAGE _____ OF _____
 PERSONNEL: RJC LOCATION: FT Lee DATE: 2/10/09
 WEATHER: OC, upper 40s OTHER: _____

TIME:	LOG ENTRY
0800	Arrive @ site. TG meeting (ecc). Asked to get tracking # for package. Have to call back w/ #. Mac + Frank set up machines, open up fencing + uncover stockpiles.
0934	Package @ hotel. LSO to pickup. Cal PID
1010	LS back, begin TPH cal
1035	A1A3 test result = 312 ppm = stockpile for removal. Since sample was >100, means most likely other samples will be too. Decided to send to lab for TPH ref.
1203	A3 (6.5) PID = 65.5. Smell + visual petrol = haul
1245	A3 (10) PID = 10.1 Slight petrol odor. TPH = EEEE
1350	ESW2 (9-10) pd 40. Vol PAH met
1405	A2 (6.5) PID 61.2 sl petrol odor
1432	A2 (10) PID 51.8 petrol odor
1430	A2 (10) PID 83.2 petrol odor. Both sample (best), sent in for dxp
1550 1550	ESW1 (9-10) + A1 (10)
	A1 6.5
~ 1550	A10 10 + ESW1 (9-10). Pack cooler
1700 1630	Leave site

SIGNATURE: _____ CHECKED BY: _____ TITLE: _____ DATE: _____

DAILY NOTES

PROJECT: FTP PROJECT NO: 4729011 PAGE _____ OF _____
 PERSONNEL: RC LOCATION: F Lee DATE: 2/13/09
 WEATHER: OC, 50's OTHER: _____

TIME:	LOG ENTRY		
0650	Arrive @ FTP. 4 trucks lined up. Get paperwork set + load first truck (#36) RR, RR + RC onsite		
0711	Truck 1 (#36) leaves		
0730	Truck 2 (#37) leaves. TT.		
0742	Truck 3 (#38) leaves		
0755	Truck 4 (#39) leaves		
0807	Truck 5 (#40) leaves		
0824	Truck 6 (#41) leaves		
0844	Truck 7 (#42) leaves		
0901	Truck 8 (#43) leaves		
0915	Truck 9 (#44) leaves		
0920	Cal PD		
0930	Truck 10 (#45) leaves		
0945	Truck 11 (#46) leaves		
0959	Truck 12 (#47) leaves		
1020	Truck 13 (#48) leaves		
	Get readings on Row D @ 3.5 Note Row D = 21 ft x 13 ft. Due to ← + logistics		
1128	Truck 14 (#49) leaves		
1201	Truck 15 (#50) leaves		
1220	Truck 16 (#51) leaves. Cont sampling D3 @ 10 ft		
1319	Truck 17 (#52) leaves		
1319	Truck 18 (#53) leaves		
1405	Truck 19 (#54) leaves		
1450	Truck 20 (#55) leaves		
SIGNATURE:	CHECKED BY:	TITLE:	DATE:

1459 Truck 21 (#56) leaves
 1515 Truck 22 (#57) leaves. Sample WSWZ

DAILY NOTES

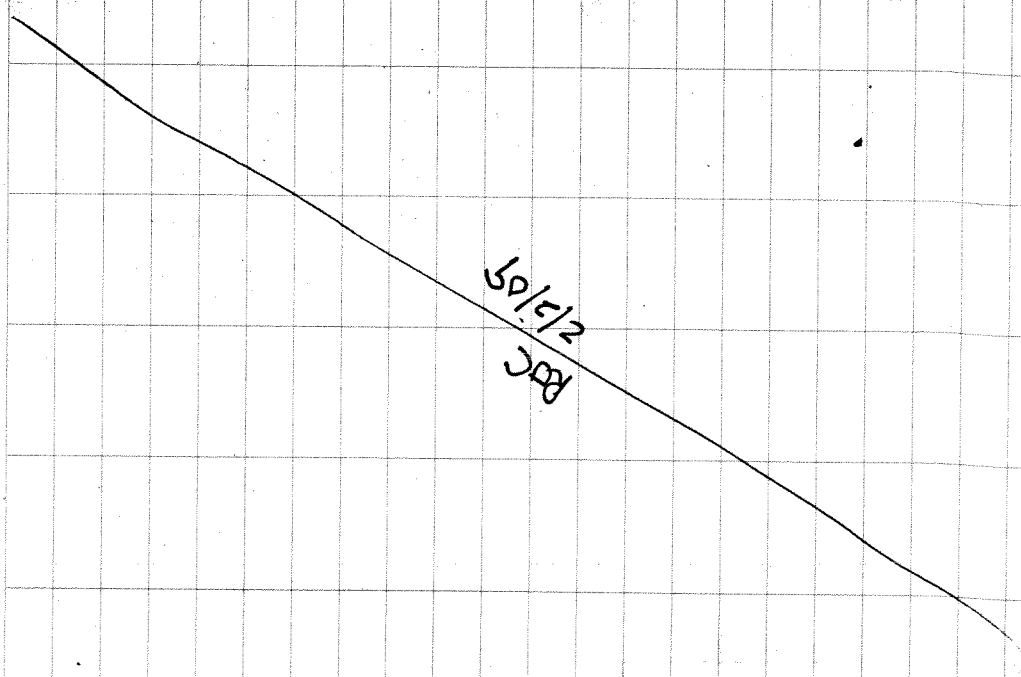
PROJECT# 4729011 PROJECT NO: FTP PAGE _____ OF _____
 PERSONNEL: RJC LOCATION: FLee DATE: 2/16/09
 WEATHER: Sunny 40s OTHER: _____

TIME:	LOG ENTRY
0840	Arrive @ site. Leave Pirnie @ 7am.
0945	Collect NSW1 (9-10). GPS excavation limits
1100	Collect NSW3 (9-10)
1215	Leave site. Return to Pirnie after Fed Ex. Upload timelapse
SIGNATURE:	CHECKED BY:
TITLE:	DATE:

Date

Location

Project / Client



Date 2-2-09

Location, FTP

Project / Client FT Lee

IND sampling

TP	PID	Overall
0-2	0.0	21.7
2-4	0.0	A
4-6	43.5	
6-8	83.3	
8-10	41.4	
10-12	80.2	
10-12 bottom	155	

TP	PID	Overall
0-2	0.0	PID
2-4	8.0	40.3
4-6	50.6	
6-8	80.2	
8-10	74.6	
10-12	210	

TP3

0-2	0.0
2-4	22.8
4-6	82.1
6-8	200
8-16	320
16-12	58.0

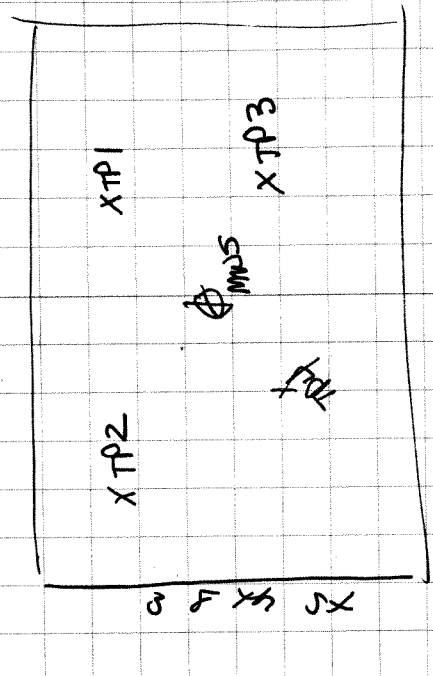
avg = 78.4

TP4

0-2	1.9
2-4	51.3
4-6	106
6-8	124
8-10	28.1
10-12	22.6

* comb = 24.5

TD10 - sample



1+4 - TPH + BTX
 2+3 - Hold for now

Bioremed = TPH > 3000 ppm
 BTX > 10
 1:100 yd²
 TPH
 BTX
 TPH
 BTX
 TPH
 BTX

FIELD NOTES FOR MAY 2009 SAMPLING EVENT

GROUNDWATER MONITORING WELL SAMPLE COLLECTION LOGS

PROJECT NUMBER: 472901 DATE: 5/6/09

PROJECT NAME: FTP SAMPLER: ROCK WCR

SITE LOCATION: Richmond Virginia Fort Lee, VA

SITE CONTACT: Steph WEATHER CONDITIONS: 60% cloudy

WELL IDENTIFICATION NUMBER: MW-1

DEPTH TO WATER (Before Purging): 18.53 FEET FROM TOP OF CASING

WELL DEPTH: 26.22 FEET FROM TOP OF CASING

HEIGHT OF WATER IN WELL: _____ FEET

WELL VOLUME: _____ GAL PURGE VOLUME: 1 GAL

PURGE START TIME: 1140 PURGE FINISH TIME: 1200

WELL EVACUATION DEVICE: Peristaltic/Grundfos (circle one)

SAMPLE COLLECTION DEVICE: Peristaltic/Grundfos (circle one)

SAMPLING START TIME: 1201 SAMPLING FINISH TIME: 1214

FIELD PARAMETERS	FIRST	SECOND	THIRD	FOURTH	FIFTH
Time	1145	1150	1155	1200	
Water Level (feet below TOC)	-	-	-		
temperature (degrees C)	15.92	15.30	15.20	15.22	
specific conductivity (umhos/cm)	0.080	0.079	0.084	0.085	
pH (SU)	5.19	-	5.30	5.33	
dissolved oxygen (mg/l)	0.00	0.00	0.00	0.00	
turbidity	5.47.0	11.9	6.7	3.1	
volume purged (gallons)	0.4	0.5	0.75	1	
ORP (mv)	119	110	102	99	

ANALYSIS REQUIRED: _____

LABORATORY: Compuchem CONTACT: Cathy Dover

NOTES (continued on back): 1" dia well

Label = 1200

Casing Diameter (in)	Casing Volume (Gal per Ft)
2.0	0.1632
4.0	0.6528
6.0	1.4687

GROUNDWATER MONITORING WELL SAMPLE COLLECTION LOGS

PROJECT NUMBER: 4729010 DATE: 5/6/09

PROJECT NAME: Weth KTR SAMPLER: RC&CK WRC & RS

SITE LOCATION: Richmond, Virginia Fort Lee, VA

SITE CONTACT: Stephane Heed Hank Hanger WEATHER CONDITIONS: 60F, cloudy

WELL IDENTIFICATION NUMBER: MW-2

DEPTH TO WATER (Before Purging): 17.68 FEET FROM TOP OF CASING

WELL DEPTH: 26.66 FEET FROM TOP OF CASING

HEIGHT OF WATER IN WELL: _____ FEET

WELL VOLUME: _____ GAL PURGE VOLUME: 2.2 GAL

PURGE START TIME: 1222 PURGE FINISH TIME: 1241

WELL EVACUATION DEVICE: Peristaltic/Grundfos (circle one)

SAMPLE COLLECTION DEVICE: Peristaltic/Grundfos (circle one)

SAMPLING START TIME: 1242 SAMPLING FINISH TIME: 1312

FIELD PARAMETERS	FIRST	SECOND	THIRD	FOURTH	FIFTH
Time	1230	1234	1238	1241	
Water Level (feet below TOC)	-	-	-	-	
temperature (degrees C)	15.83	15.40	15.40	15.51	
specific conductivity (umhos/cm)	0.102	0.034	0.033	0.035	
pH (SU)	4.62	4.46	4.46	4.44	
dissolved oxygen (mg/l)	1.73	0.20	0.00	0.00	
turbidity	17.6	23.4	21.3	27.5	
volume purged (gallons)	1.0	1.5	1.8	2.2	
ORP (mv)	138	140	139	139	

ANALYSIS REQUIRED: _____

LABORATORY: Compuchem CONTACT: Cathy Dover

NOTES (continued on back): 1" dia well, no room for water level
label = 1300

Casing Diameter (in)	Casing Volume (Gal per Ft)
2.0	0.1632
4.0	0.6528
6.0	1.4687

GROUNDWATER MONITORING WELL SAMPLE COLLECTION LOGS

PROJECT NUMBER: 4729010 DATE: 5/6/09

PROJECT NAME: Wyeth FTP SAMPLERS: RG-OK WC JRC

SITE LOCATION: Richmond, Virginia Ft Lee

SITE CONTACT: Stephanie Hood Hank Hennigar WEATHER CONDITIONS: 60S, cloudy
WELL IDENTIFICATION NUMBER: MW-3

DEPTH TO WATER (Before Purging): 17.23 FEET FROM TOP OF CASING

WELL DEPTH: 26.88 FEET FROM TOP OF CASING

HEIGHT OF WATER IN WELL: _____ FEET

WELL VOLUME: _____ GAL PURGE VOLUME: 2.25 GAL

PURGE START TIME: 1040 PURGE FINISH TIME: 1104

WELL EVACUATION DEVICE: Peristaltic/Grundfos (circle one)

SAMPLE COLLECTION DEVICE: Peristaltic/Grundfos (circle one)

SAMPLING START TIME: 1106 SAMPLING FINISH TIME: 1128

FIELD PARAMETERS	FIRST	SECOND	THIRD	FOURTH	FIFTH
Time	1052	1056	1100	1104	
Water Level (feet below TOC)	-	-	-	-	
temperature (degrees C)	14.19	14.13	14.09	14.13	
specific conductivity (umhos/cm)	0.153 0.153	0.055	0.043	0.053	
pH (SU)	4.33	4.34	4.34	4.37	
dissolved oxygen (mg/l)	0.00	0.00	0.00	0.00	
turbidity	9.9	2.2	2.4	2.7	
volume purged (gallons)	1.5	1.75	2	2.25	
ORP (mv)	159	154	154	149	

ANALYSIS REQUIRED: _____
LABORATORY: Compuchem CONTAC Cathy Dover

NOTES (continued on back): 1" dia well, cannot determine WL during purging
Label = 1105

Casing Diameter (in)	Casing Volume (Gal. per Ft)
2.0	0.1632
4.0	0.6528
6.0	1.4687

GROUNDWATER MONITORING WELL SAMPLE COLLECTION LOGS

PROJECT NUMBER: 4789011 DATE: 5/6/09

PROJECT NAME: Wyeaf FTP SAMPLER: RC&CK WCRRC

SITE LOCATION: Richmond, Virginia Ft Lee, VA

SITE CONTACT: Stephanie Hood Hank Hennigar WEATHER CONDITIONS: 60's, cloudy

WELL IDENTIFICATION NUMBER: MW-4

DEPTH TO WATER (Before Purging): 16.10 FEET FROM TOP OF CASING

WELL DEPTH: 25.65 FEET FROM TOP OF CASING

HEIGHT OF WATER IN WELL: _____ FEET

WELL VOLUME: _____ GAL PURGE VOLUME: _____ GAL

PURGE START TIME: 0930 PURGE FINISH TIME: 1010

WELL EVACUATION DEVICE: Peristaltic/Grundfos (circle one)

SAMPLE COLLECTION DEVICE: Peristaltic/Grundfos (circle one)

SAMPLING START TIME: 1010 SAMPLING FINISH TIME: 1032

FIELD PARAMETERS	FIRST	SECOND	THIRD	FOURTH	FIFTH	
Time	0950	0955	1000	1005	1009	
Water Level (feet below TOC)	-	-	-	-	-	
temperature (degrees C)	14.44	14.36	14.16	14.13	14.13	
specific conductivity (umhos/cm)	0.596	0.168	0.083	0.044	0.043	
pH (SU)	4.15	4.25	4.21	4.19	4.19	
dissolved oxygen (mg/l)	2.75	0.72	0.42	0.08	0.01	
turbidity	6.5	4.8	2.6	1.5	0.8	
volume purged (gallons)	1	1.20	1.4	1.6	1.9	
ORP (mv)		ORP(mv)	176	166	161	157
						156

ANALYSIS REQUIRED: _____

LABORATORY: Compuchem CONTACT: Cathy Dover




NOTES (continued on back): 1" dia well, cannot determine WL during purging
Label=1010

Casing Diameter (in)	Casing Volume (Gal per Ft)
2.0	0.1632
4.0	0.6528
6.0	1.4667

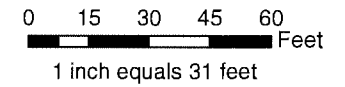
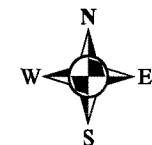


Figure 1-6
 Groundwater Elevations
 Inactive Fire Fighting Training Pit Site
 Fort Lee, Virginia

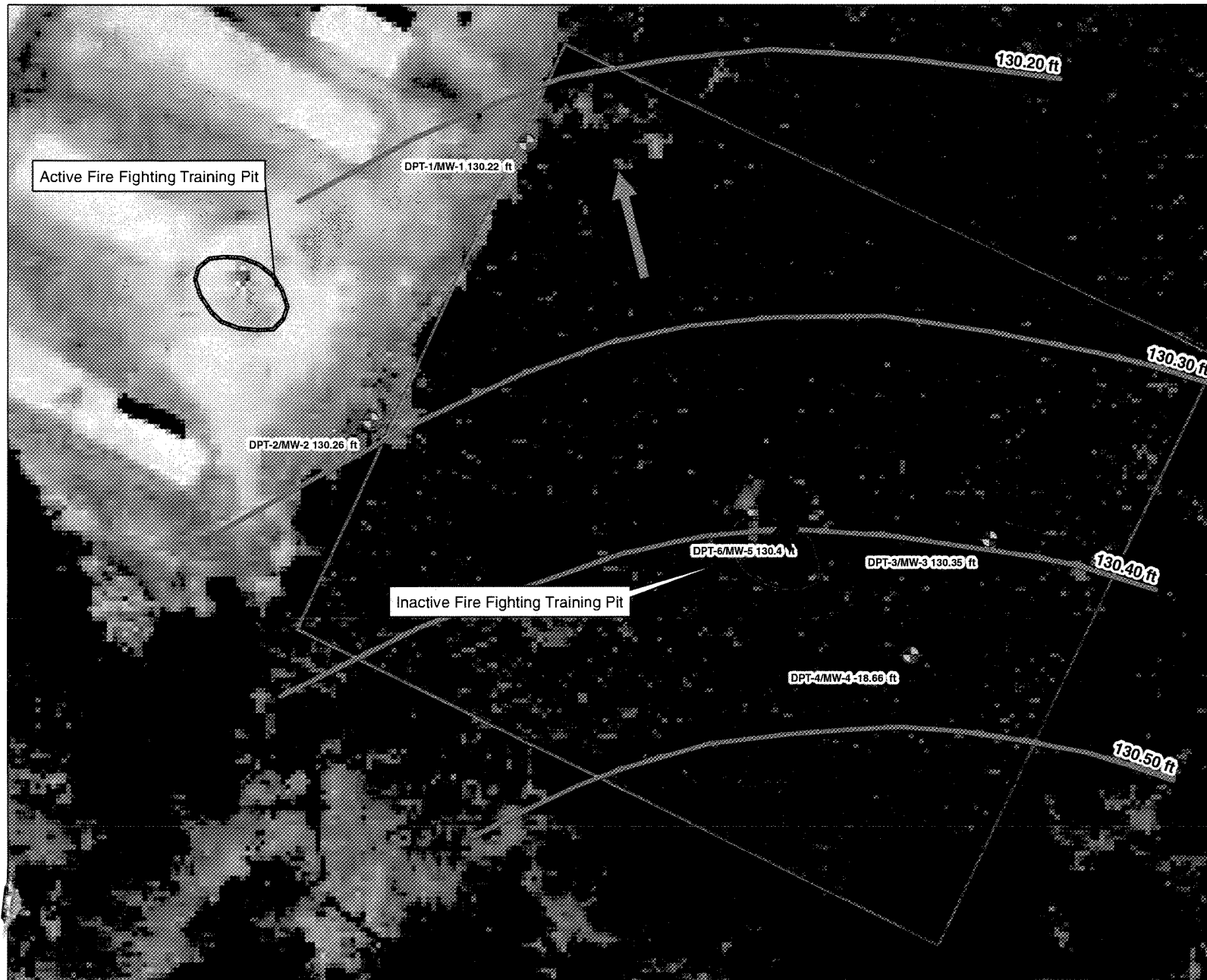
Legend

-  Inactive Fire Fighting Training Pit Site
-  Fire Fighting Training Pit Location
-  Groundwater Elevation Contours

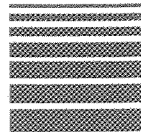
MW1	18.53	(26.22)
2	17.68	(26.66)
3	17.23	(26.88)
4	16.1	(25.65)



Source: Aerial photography provided by Fort Lee



CHAIN OF CUSTODY



CompuChem
a division of Liberty Analytical Corp.

501 Madison Ave.
Cary, NC 27513

Phone: 919-379-4100 Fax 919-379-4040

Courier
Airbill No.
Sampling Complete? Y or N

Client/Reporting Information		Project Information				Requested Analysis (include method and bottle type)												Matrices																				
Company Name Malden Power	Project Name FTP															GW - Ground water WW - Waste water SW - Surface water SO - Soil/Sediment TB - Trip Blank RI - Rinsate WP - Wipe O - Other pH - Sample Info (Lab Use)																						
Address 701 Tower Ct Dr Ste 600	Sampling Location Ft Lee, VA																																					
City NN	State VA	Zip 23606																																				
Project Contact Chadwick	Turnaround time																																					
Phone # 757-914-6935	Batch QC or Project Specific? If Specific, which Sample ID?																																					
Sampler's Name Chadwick		Are aqueous samples field filtered for metals? Y or N																																				
		Are high concentrations expected? Y or N? If yes, which ID(s)?																																				
CompuChem No (Lab Use)	Field ID	Collection		Matrix	# of bottles	Number of Preserved Bottles								TCL VOC (total)	PAH SIM (total)	TAL (total)	TAL (Aiss)	TSS/TDS	TOC	DOC	AUX/NO3/NO2																	
		Date	Time			HCl	NaOH	HNO3	H2SO4	MEOH	Other																											
	TB05/x609	5/6/09	1010	TB	3	3																																
	M101	↓	1200	G10	13	3		2	4												X	X	X	X	X	X	X											
	M102	↓	1300	↓	13	3		2	4												X	X	X	X	X	X	X											
	M103	↓	1105	↓	13	3		2	4												X	X	X	X	X	X	X											
	M104	↓	1010	↓	13	3		2	4												X	X	X	X	X	X	X											
	M102 Dup	↓	1300	↓	13	3		2	4												X	X	X	X	X	X	X											

Lab Use Only				Comments					
Sample Unpacked By:	Cyanide samples checked for sulfide & chlorine? Y or NA				Metals (Diss) Gold Nitrate				
Sample Order Entry By:	625 & Phenol samples checked for chlorine? Y or NA								
Samples Received in Good Condition? Y or N	608 samples checked for pH between 5.0-9.0? Y or NA								
If no, explain:									
Sample Custody									
Relinquished by:	Date/Time:	Received by:				Date/Time:			
Relinquished by:	Date/Time:	Received by:				Date/Time:			
Subcontact? Y or N If yes, where?	Custody Seal(s) intact? Y or N			On Ice? Y or N			Cooler Temp: °C		

Samples stored 60 days after date report mailed at no extra charge.

White & Yellow copy to lab • Pink copy for customer

APPENDIX C – ANALYTICAL RESULTS
APPENDIX D – DATA VALIDATION
(Appendices C & D are on CD)

**IRA Completion Report
Fire Training Pit
Fort Lee, Virginia**

***APPENDIX E
RISK ASSESSMENT***

**IRA Completion Report
Fire Training Pit
Fort Lee, Virginia**

USEPA RAGS PART D TABLES

**TABLE E-1
SELECTION OF EXPOSURE PATHWAYS
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA**

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway						
Current	Soil	Surface Soil	Workplace	Installation Personnel	Adult	Dermal Contact	Not Applicable	Surface soil is not an exposure medium of concern at the Inactive Fire Fighting Training Pit (Site). Affected surface soil was excavated and replaced with clean fill.						
						Ingestion	Not Applicable							
						Inhalation (volatile organics & particulates)	Not Applicable							
			Workplace	Site Visitor	Adult	Dermal Contact	Not Applicable		Surface soil is not an exposure medium of concern at the Site. Affected surface soil was excavated and replaced with clean fill. In addition, access to the Site is coordinated with the USAEC's Contracting Officer's Representative (COR) at Fort Lee.					
						Ingestion	Not Applicable							
						Inhalation (volatile organics & particulates)	Not Applicable							
Future	Soil	Surface and Subsurface Soil	Residential	Resident	Adult & Child	Dermal Contact	Not Applicable	The Site is not likely to be redeveloped for residential use. The current primary use of the Site is as a fire training area. Following the 2005 Defense Base Closure and Realignment Commission (BRAC) Report recommendations, Fort Lee will remain an important training installation into the foreseeable future. As such, Fort Lee has a shortage of suitable training areas, according to the Installation Master Planner. Therefore, the Site will likely remain a training area.						
						Ingestion	Not Applicable							
						Inhalation (volatile organics & particulates)	Not Applicable							
	Subsurface Soil	Subsurface Soil	Excavation	Construction/Utility Workers	Adult	Dermal Contact	Quantitative		Dermal contact with soil is a potential exposure pathway during construction/utility work at the Site.					
						Ingestion	Quantitative		Incidental ingestion of soil is a potential exposure pathway during construction/utility work at the Site.					
						Inhalation (volatile organics & particulates)	Quantitative		Inhalation of volatile organics and particulates is possible during construction/utility work at the Site.					
						Groundwater	Groundwater		Excavation	Construction/Utility Workers	Adult	Dermal Contact	Quantitative	Dermal contact with groundwater is a potential exposure pathway during construction/utility work at the Site.
												Ingestion	None	Incidental ingestion of groundwater is not expected during construction/utility work at the Site.
												Inhalation (volatile organics)	Quantitative	Volatile organics were detected in groundwater at the Site.
	Groundwater	Groundwater	Tap Water	Installation Personnel	Adult	Dermal Contact	Not Applicable		Following the Fort Lee's 2005 BRAC Report recommendations, the Installation Master Planner will not allow the installation of potable wells on Fort Lee, where existing potable service is provided by a municipal water provider.					
						Ingestion	Not Applicable							
						Inhalation (volatile organics)	Not Applicable							

**TABLE E-2.1
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - SUBSURFACE SOIL
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA**

Scenario Timeframe:	Future
Medium:	Subsurface Soil
Exposure Medium:	Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (1)	Screening Toxicity Value (2)	Basis (3)	COPC Flag [Y/N]	Rationale for Selection or Deletion
On-site Excavation	Total TAL Metals													
	7429-90-5	Aluminum	7,470	13,000	mg/kg	WSW1	12 / 12	--	13,000	1,350 - 8,200	7,700	n	Y	1
	7440-36-0	Antimony	0.33 B	0.98 B	mg/kg	SSW3 & WSW2	12 / 12	--	0.98	1.2	3.1	n	N	2
	7440-38-2	Arsenic	0.26	2.0	mg/kg	SSW3	12 / 12	--	2.0	0.9 - 10.9	0.39	c	Y	1, 6
	7440-39-3	Barium	12.4 B	20.3 B	mg/kg	SSW1	12 / 12	--	20.3	6.1 - 31.1	1,500	n	N	2
	7440-41-7	Beryllium	0.07 B	0.155 B	mg/kg	Bott	4 / 12	0.00005	0.155	0.14 - 2.5	16	n	N	2
	7440-43-9	Cadmium ^a	0.11 B	0.46 B	mg/kg	ESW1	5 / 12	0.00007 - 0.00008	0.46	0.08 - 1.9	7	n	N	2
	7440-70-2	Calcium*	19.6 B	51.9 B	mg/kg	NSW2	12 / 12	--	51.9	183 - 1,240	NA	--	N	3, 5
	18540-29-9	Chromium ^b	9.6	37.6	mg/kg	SSW3	12 / 12	--	37.6	1.2 - 4.8	280	c	N	2
	7440-50-8	Copper	6	11	mg/kg	NSW3	12 / 12	--	11	1.6 - 7.4	310	n	N	2
	7439-89-6	Iron	9,030	23,000	mg/kg	ESW1	12 / 12	--	23,000	759 - 3,850	5,500	n	Y	1, 6
	7439-92-1	Lead	8.3	13.5	mg/kg	ESW1 & WSW2	12 / 12	--	13.5	8.8 - 21.7	400	n	N	2
	7439-95-4	Magnesium*	122 B	174 B	mg/kg	SSW2	12 / 12	--	174	63.5 - 275	NA	--	N	3, 5
	7439-96-5	Manganese ^c	4	16.5	mg/kg	Bott	12 / 12	--	16.5	6.2 - 41.9	180	n	N	2
	7439-97-6	Mercury ^d	0.022 B	0.049	mg/kg	WSW2	7 / 12	0.00002	0.049	0.08	2.3	n	N	2
	7440-02-0	Nickel ^e	1.2 B	2.6 B	mg/kg	Bott	12 / 12	--	2.6	0.7 - 1.6	150	n	N	2
	7440-09-27	Potassium*	236 BE	371 BE	mg/kg	ESW1	12 / 12	--	371	94.4 - 267	NA	--	N	3, 5
	7782-49-2	Selenium	0.67	2.2	mg/kg	SSW3	12 / 12	--	2.2	0.39 - 4.3	39	n	N	2
	7681-49-4	Sodium*	97 B	177 B	mg/kg	Bott	12 / 12	--	177	314 - 450	NA	--	N	3, 5
	7440-62-2	Vanadium ^f	23.4	72	mg/kg	SSW3	12 / 12	--	72	6.3 - 17.2	55	n	Y	1, 7
7440-66-6	Zinc	2.8	10.25	mg/kg	Bott	12 / 12	--	10.25	7.3 - 32.9	2,300	n	N	2	
	TCL Volatile Organic Compounds													
	67-64-1	Acetone	0.011 J	0.610 J	mg/kg	C2	12 / 12	--	0.61	N/A	6,100	n	N	2
	75-09-2	Methylene Chloride	0.0018 JB	0.0043 JB	mg/kg	Bott	9 / 12	0.310 - 0.430	0.0043	N/A	11	c	N	2
	75-34-3	1,1-Dichloroethane	--	0.0031 J	mg/kg	Bott	1 / 12	0.310 - 0.430	0.0031	N/A	3.4	c	N	2
	78-93-3	2-Butanone	0.010 J	0.016	mg/kg	SSW1	5 / 12	0.77 - 1.1	0.016	N/A	2,800	n	N	2
	71-55-6	1,1,1-Trichloroethane	0.027	0.34 J	mg/kg	C2	2 / 12	0.0063 - 0.310	0.34	N/A	900	n	N	2
	71-43-2	Benzene	0.0575 J	0.8	mg/kg	C2	2 / 12	0.0061 - 0.310	0.8	N/A	1.1	c	Y	6
	108-88-3	Toluene	0.0015 J	0.280 J	mg/kg	C2	8 / 12	0.0061 - 0.310	0.28	N/A	500	n	N	2
	100-41-4	Ethylbenzene	0.0027 J	6.2	mg/kg	C2	10 / 12	0.0061 - 0.0063	6.2	N/A	5.7	c	Y	1
	98-82-8	Isopropylbenzene	0.0088	2.2	mg/kg	C2	9 / 12	0.0062 - 0.0063	2.2	N/A	220	--	N	2
	120-82-1	1,2,4-Trichlorobenzene	--	0.290 J	mg/kg	SSW2	1 / 12	0.0062 - 0.430	0.29	N/A	8.7	n	N	2
	1330-20-7	Xylenes (total)	0.0017 J	15	mg/kg	C2	12 / 12	--	15	N/A	60	n	N	2
	108-87-2	Methylcyclohexane	0.0017 J	4.1	mg/kg	C2	8 / 12	0.0061 - 0.0063	4.1	N/A	NA	--	Y	5
		TCL Polycyclic Aromatic Hydrocarbons												
83-32-9		Acenaphthene	0.160 J	0.73	mg/kg	NSW1	7 / 12	0.210 - 1.5	0.73	N/A	340	n	N	2
86-73-7		Fluorene	0.190 J	1.4	mg/kg	NSW1	8 / 12	0.210 - 1.5	1.4	N/A	230	n	N	2
91-57-6		2-Methylnaphthalene	0.130 J	45	mg/kg	C2	12 / 12	--	45	N/A	31	n	Y	1
90-12-0		1-Methylnaphthalene	0.099 J	17	mg/kg	C2	11 / 12	0.21	17	N/A	22	c	N	2
91-20-3		Naphthalene	0.180 J	11	mg/kg	C2	9 / 12	0.21	11	N/A	3.9	c	Y	1
85-01-8		Phenanthrene	0.110 J	6.2	mg/kg	C2	11 / 12	0.21	6.2	N/A	NA	--	Y	5
129-00-0		Pyrene	0.0955	0.120 J	mg/kg	NSW1	2 / 12	0.210 - 1.5	0.12	N/A	170	n	N	2
	Dioxin/Furans													
1746-01-6	2,3,7,8-TCDD TEQ	0.000000215	0.000000451	mg/kg	A2	2 / 2	--	0.000000451	N/A	0.0000045	--	N	2	

Notes

COPC = Chemical of Potential Concern
 *Chemical is an essential nutrient and was therefore categorically eliminated as a COPC
 J = Estimated concentration
 B = Detected in associated QC blank
 E = High bias
 NA = Not available
 N/A = Not Applicable
 mg/kg - milligrams per kilogram
 a = RSL for Cadmium (diet)
 b = RSL for Chromium (Total Chromium)
 c = RSL for Manganese (water)
 d = RSL for Mercury (inorganic salts)
 e = RSL for Nickel (soluble salts)
 f = RSL for Vanadium (metallic)

Reason Codes:

1 = Maximum detected concentration exceeds Screening Toxicity Value
 2 = Maximum detected concentration does not exceed Screening Toxicity Value
 3 = Chemical is an essential nutrient
 4 = Frequency of detection is less than 5%
 5 = No Screening Toxicity Value available
 6 = Chemical is a known human carcinogen

(1) Background represents the range of detected metals concentrations in surface soil at Fort Lee, VA (Fluor Daniel, 1999)
 (2) USEPA Regional Screening Levels (RSL) for residential soil accessed at <http://www.epa.gov/reg3hscd/risk/human/index.htm>
 (3) c = based on carcinogenic effects n = based on noncarcinogenic effects; RSLs have been reduced by a factor of 10 to account for additive effects

**TABLE E-2.2
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - GROUNDWATER
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA**

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value	Screening Toxicity Value (1)	Basis (2)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag [Y/N]	Rationale for Selection or Deletion	
On-site Excavation	Total TAL Metals																
	7429-90-5	Aluminum	0.0876 B	0.567	mg/l	MW-1	4 / 4	--	0.567	N/A	3.7	n	NA	--	N	2	
	7440-39-3	Barium	0.0104 B	0.039 B	mg/l	MW-2	4 / 4	--	0.039	N/A	0.073	n	2	MCL	N	2	
	7440-70-2	Calcium*	0.073 B	0.257 B	mg/l	MW-1	4 / 4	--	0.257	N/A	NA	--	NA	--	N	3, 5	
	18540-29-9	Chromium ^a	--	0.00082 B	mg/l	MW-1	1 / 4	0.00064	0.00082	N/A	5.5	c	0.1	MCL	N	2	
	7440-48-4	Cobalt	0.0042 B	0.0081	mg/l	MW-2	3 / 4	0.00058	0.0081	N/A	0.0011	n	NA	--	Y	1	
	7440-50-8	Copper	0.00155 B	0.0085	mg/l	MW-4	3 / 4	0.00088	0.0085	N/A	0.15	n	1.3	AL	N	2	
	7439-89-6	Iron	0.123	12.7	mg/l	MW-1	4 / 4	--	12.7	N/A	2.6	n	NA	--	Y	1	
	7439-92-1	Lead ^d	0.003	0.00385	mg/l	MW-2	2 / 4	0.0018	0.00385	N/A	0.015	n	0.015	AL	N	2	
	7439-95-4	Magnesium*	0.375 B	0.583 B	mg/l	MW-4	4 / 4	--	0.583	N/A	NA	--	NA	--	N	3, 5	
	7439-96-5	Manganese ^b	0.011	0.175	mg/l	MW-1	4 / 4	--	0.175	N/A	0.088	n	NA	--	Y	1	
	7440-09-27	Potassium*	0.118 B	0.206 B	mg/l	MW-4	4 / 4	--	0.206	N/A	NA	--	NA	--	N	3, 5	
	7681-49-4	Sodium*	2.69 B	3.67 B	mg/l	MW-1	4 / 4	--	3.670	N/A	NA	--	NA	--	N	3, 5	
	7440-62-2	Vanadium ^c	--	0.0017 B	mg/l	MW-1	1 / 4	0.00046	0.0017	N/A	0.026	n	NA	--	N	2	
	7440-66-6	Zinc	0.0042 B	0.0077 B	mg/l	MW-4	4 / 4	--	0.0077 B	N/A	1.1	n	NA	--	N	2	
	TCL Volatile Organic Compounds																
	67-64-1	Acetone	--	0.013	mg/l	MW-1	1 / 4	2200	0.013	N/A	2.2	n	NA	--	N	1	
	71-43-2	Benzene	0.0026 J	0.017	mg/l	MW-3	2 / 4	0.41	0.017	N/A	0.00041	c	0.005	MCL	Y	1, 6	
	75-15-0	Carbon disulfide	--	0.0013 J	mg/l	MW-1	1 / 4	1000	0.0013	N/A	0.1	n	NA	--	N	2	
	110-82-7	Cyclohexane	--	0.0021 J	mg/l	MW-3	1 / 4	13000	0.0021	N/A	1.3	n	NA	--	N	2	
	75-34-3	1,1-Dichloroethane	--	0.0021 J	mg/l	MW-3	1 / 4	--	0.0021	N/A	0.0024	c	NA	--	N	2	
	100-41-4	Ethylbenzene	0.005	0.013	mg/l	MW-3	3 / 4	1.5	0.013	N/A	0.0015	c	0.7	MCL	Y	1	
	98-82-8	Isopropylbenzene	0.0038 J	0.0074	mg/l	MW-2	2 / 4	68	0.0074	N/A	0.068	n	NA	--	N	2	
	108-87-2	Methylcyclohexane	0.0011 J	0.0027 J	mg/l	MW-3	2 / 4	--	0.0027	N/A	NA	--	NA	--	Y	5	
	1634-04-4	Methyl-tert-butyl ether	--	0.00285 J	mg/l	MW-2	1 / 4	12	0.00285	N/A	0.012	c	NA	--	N	2	
	108-88-3	Toluene	--	0.001035 J	mg/l	MW-2	1 / 4	230	0.001035	N/A	0.23	n	1.0	MCL	N	2	
	1330-20-7	Xylenes (total)	0.006	0.31	mg/l	MW-2	3 / 4	200	0.31	N/A	0.02	n	10	MCL	Y	1	
	TCL Polycyclic Aromatic Hydrocarbons																
	83-32-9	Acenaphthene	0.000215	0.0017	mg/l	MW-1	3 / 4	220	0.0017	N/A	0.22	n	NA	--	N	2	
	120-12-7	Anthracene	0.000091 JB	0.00013 J	mg/l	MW-1	2 / 4	11000	0.00013	N/A	1.1	n	NA	--	N	2	
	206-44-0	Fluoranthene	0.0000115	0.000023 JB	mg/l	MW-3	3 / 4	150	0.000023	N/A	0.15	n	NA	--	N	2	
	86-73-7	Fluorene	0.000053 JB	0.0022 E	mg/l	MW-1	4 / 4	150	0.0022	N/A	0.15	n	NA	--	N	2	
	91-20-3	Naphthalene	0.0024 E	0.024	mg/l	MW-2	4 / 4	0.14	0.024	N/A	0.00014	c	NA	--	Y	1	
	90-12-0	1-Methylnaphthalene	0.0014 B	0.0165 E	mg/l	MW-2	4 / 4	--	0.0165	N/A	0.0023	c	NA	--	Y	1	
	91-57-6	2-Methylnaphthalene	0.0011 E	0.025 E	mg/l	MW-2	4 / 4	--	0.025	N/A	0.015	n	NA	--	Y	1	
	85-01-8	Phenanthrene	0.000049 JB	0.0029 EB	mg/l	MW-3	4 / 4	--	0.0029	N/A	NA	--	NA	--	Y	5	
	129-00-0	Pyrene	0.000019 J	0.00004 JB	mg/l	MW-3	3 / 4	110	0.00004	N/A	0.11	n	NA	--	N	2	
	Dioxin/Furans																
	1746-01-6	2,3,7,8-TCDD TEQ	--	2.44E-07	mg/l	MW - 5	1 / 1	--	2.44E-07	NA	5.20E-10	c	3E-08	MCL	Y	1	

Notes

COPC = Chemical of Potential Concern

*Chemical is an essential nutrient and was therefore categorically eliminated as a COPC

J = Estimated concentration

B = Detected in associated QC blank

E = High bias

NA = Not available

N/A = Not Applicable

mg/l - milligrams per liter

a = RSL for Chromium III (Insoluble salts)

b = RSL for Manganese (water)

c = RSL for Vanadium (metallic)

MCL = Maximum Contaminant Level for drinking water

AL = Action Level for drinking water

(1) USEPA Regional Screening Levels (RSL) for tap water accessed at <http://www.epa.gov/reg3hscd/risk/human/index.htm>

Reason Codes:

1 = Maximum detected concentration exceeds Screening Toxicity Value

2 = Maximum detected concentration does not exceed Screening Toxicity Value

3 = Chemical is an essential nutrient

4 = Frequency of detection is less than 5%

5 = No Screening Toxicity Value available

6 = Chemical is a known human carcinogen

TABLE E-3.1
EXPOSURE POINT CONCENTRATION SUMMARY - SUBSURFACE SOIL
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA

Scenario Timeframe:	Future
Medium:	Subsurface Soil
Exposure Medium:	Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration	Exposure Point Concentration (EPC)			
						Value	Units	Statistic	Rationale
On-site Excavation	Aluminum	mg/kg	11,105	11,896 (N)	13,000	11,896	mg/kg	95% Student's-t-UCL	Data appear normally distributed
	Arsenic	mg/kg	1.025	1.249 (N)	2	1.249	mg/kg	95% Student's-t-UCL	Data appear normally distributed
	Benzene	mg/kg	0.429	0.643 (NP)	0.8	0.643	mg/kg	97.5% KM Chebyshev UCL	No discernable distribution
	Iron	mg/kg	13,614	16,047 (G)	23,000	16,047	mg/kg	95% Approximate Gamma UCL	Data appear gamma distributed
	Vanadium	mg/kg	50.78	57.56 (N)	72	57.56	mg/kg	95% Student's-t-UCL	Data appear normally distributed
	Ethylbenzene	mg/kg	0.737	5.725 (NP)	6	5.725	mg/kg	99% KM Chebyshev UCL	No discernable distribution
	Naphthalene	mg/kg	2.712	6.256 (NP)	11	6.256	mg/kg	95% KM Chebyshev UCL	No discernable distribution
	2-Methylnaphthalene	mg/kg	9.647	23.19 (G)	45	23.19	mg/kg	95 % Approximate Gamma UCL	Data appear gamma distributed

Notes

- (1) Distribution of the 95% UCL is defined by the following codes:
G - Gamma
N - Normal
NP - Nonparametric

TABLE E-3.2
EXPOSURE POINT CONCENTRATION SUMMARY - GROUNDWATER
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical of Potential Concern	Units	Maximum Concentration
On-site excavation	Benzene	mg/l	0.017
	Cobalt	mg/l	0.008
	Ethylbenzene	mg/l	0.013
	Iron	mg/l	12.7
	Manganese	mg/l	0.18
	Naphthalene	mg/l	0.024
	1-Methylnaphthalene	mg/l	0.0165
	2-Methylnaphthalene	mg/l	0.025
	Xylenes	mg/l	0.31
	2,3,7,8-TCDD TEQ	mg/l	2.4E-07

**TABLE E-4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA**

Scenario Timeframe:	Future
Medium:	Soil
Exposure Medium:	Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/Model Name
Ingestion	Construction/Utility Worker	Adult	Soil	CS	Chemical Concentration in Soil	See Table E-3.1	mg/kg	--	Daily Intake (DI) (mg/kg-day) = CS x CF x IR-S x FI x EF x ED x 1/BW x 1/AT
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				IR-S	Ingestion Rate of Soil	330	mg/day	USEPA, 2002b	
				FI	Fraction Ingested	1	unitless	(1)	
				EF	Exposure Frequency	60	days/year	(1)	
				ED	Exposure Duration	1	years	(1)	
				BW	Body Weight	70	kg	USEPA, 2002b	
				AT-N	Averaging Time (Non-Cancer)	365	days	--	
AT-C	Averaging Time (Cancer)	25,550	days	--					
Dermal	Construction/Utility Worker	Adult	Soil	CS	Chemical Concentration in Soil	See Table E-3.1	mg/kg	--	Dermally Absorbed Dose (DAD) (mg/kg-day) = DAevent x EF x ED x EV x SA x 1/BW x 1/AT where: Absorbed Dose per Event (DAevent) (mg/cm ² -event) = CS x CF x AF x ABS-d
				DAevent	Absorbed dose per event	Chemical-specific	mg/cm ² -event	USEPA, 2004	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				SA	Skin Surface Area Available for Contact	3,300	cm ²	USEPA, 2002b	
				AF	Soil to Skin Adherence Factor	0.3	mg/cm ² -event	USEPA, 2002b	
				ABS-d	Dermal Absorption Fraction	Chemical-specific	unitless	USEPA, 2004	
				EV	Event Frequency	1	events/day	USEPA, 2002b	
				EF	Exposure Frequency	60	days/year	(1)	
				ED	Exposure Duration	1	years	(1)	
				BW	Body Weight	70	kg	USEPA, 2002b	
				AT-N	Averaging Time (Non-Cancer)	365	days	--	
AT-C	Averaging Time (Cancer)	25,550	days	--					

Notes

(1) Professional judgment

TABLE E-4.2.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Outdoor Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/Model Name
Inhalation	Construction/Utility Worker	Adult	Ambient Air	CA	Chemical Concentration in Air	See Tables E-10 and E-12	µg/m ³	See Appendix E USEPA, 2002b (1) (1) USEPA, 2009c USEPA, 2009c	Exposure concentration (EC) (µg/m ³) = (CA x ET x EF x ED)/AT
				ET	Exposure Time	8	hours/day		
				EF	Exposure Frequency	5	days/week		
				ED	Exposure Duration	12	weeks		
				AT-N	Averaging Time (Non-Cancer)	2,016	hours		
				AT-C	Averaging Time (Cancer)	613,200	hours		

Notes
(1) Professional Judgement

**TABLE E-4.3.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA**

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/Model Name
Dermal	Construction/Utility Worker	Adult	Top of Groundwater Table	CW	Chemical Concentration in Groundwater	See Table E-3.2	mg/l	--	Dermal Absorbed Dose (DAD) (mg/kg-day) = $DA_{event} \times EV \times ED \times EF \times SA \times 1/BW \times 1/AT$ where for organic chemicals: Absorbed Dose per Event (DA _{event}) (mg/cm ² -event) = If t-event < t*, then: $DA_{event} = 2FA \times Kp \times CW \times CF \times \text{SQRT}((6 \times \text{tau-event} \times t\text{-event})/\pi)$ or If t-event > t*, then: $DA_{event} = FA \times Kp \times CW \times CF \times ((t\text{-event}/(1 + B)) + 2 \times \text{tau-event} \times ((1 + (3 \times B) + (3 \times B \times B))/(1 + B)^2))$ and where for inorganic chemicals: $DA_{event} = Kp \times CW \times t\text{-event} \times CF$
				DA _{event}	Absorbed dose per event	Chemical-specific	mg/cm ² -event	USEPA, 2004	
				FA	Fraction Absorbed Water	Chemical-specific	unitless	See Appendix F	
				Kp	Permeability Coefficient	Chemical-specific	cm/hour	See Appendix F	
				SA	Skin Surface Area Available for Contact	3,300	cm ²	USEPA, 2002b	
				tau-event	Lag time per event	Chemical-specific	hours/event	See Appendix F	
				t-event	Event Duration	8	hours/event	(1)	
				t*	Time to reach steady-state = 2.4 x tau-event	Chemical-specific	hours	See Appendix F	
				B	Ratio of permeability coefficient of a chemical through the stratum corneum relative to its permeability coefficient across the viable epidermis	Chemical-specific	unitless	See Appendix F	
				EV	Event Frequency	1	events/day	USEPA, 2002b	
				EF	Exposure Frequency	60	days/year	(1)	
				ED	Exposure Duration	1	years	(1)	
				CF	Volumetric Conversion Factor for Water	0.001	l/cm ³	--	
				BW	Body Weight	70	kg	USEPA, 2002b	
AT-N	Averaging Time (Non-Cancer)	365	days	--					
AT-C	Averaging Time (Cancer)	25,550	days	--					

Notes
(1) Professional Judgement

TABLE E-4.4.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Outdoor Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Construction/Utility Worker	Adult	Ambient Air	CA	Chemical Concentration in Air	See Table E-11	$\mu\text{g}/\text{m}^3$	See Appendix E	Exposure concentration (EC) ($\mu\text{g}/\text{m}^3$) = (CA x ET x EF x ED)/AT
				ET	Exposure Time	8	hours/day	USEPA, 2002b	
				EF	Exposure Frequency	5	days/week	(1)	
				ED	Exposure Duration	12	weeks	(1)	
				AT-N	Averaging Time (Non-Cancer)	2,016	hours	USEPA, 2009c	
				AT-C	Averaging Time (Cancer)	613,200	hours	USEPA, 2009c	

Notes

(1) Professional judgment

TABLE E-5.1
NON-CANCER TOXICITY DATA - ORAL/DERMAL
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA

Chemical of Potential Concern	Chronic/ Subchronic	Oral Reference Dose		Oral to Dermal Adjustment Factor	Adjusted Dermal Reference Dose		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	Source	Date (MM/DD/YYYY)
		Value	Units		Value	Units				
Aluminum	Chronic	1.0E+00	mg/kg-day	1	1.0E+00	mg/kg-day	Developmental nervous system	100	PPRTV	10/23/2006
Arsenic	Chronic	3.0E-04	mg/kg-day	1	3.0E-04	mg/kg-day	Hyperpigmentation, keratosis and possible vascular complications	3	IRIS	7/1/2009
Benzene	Chronic	4.0E-03	mg/kg-day	1	4.0E-03	mg/kg-day	Decreased lymphocyte count	300	IRIS	7/1/2009
	Subchronic	1.2E-02	mg/kg-day	1	1.2E-02	mg/kg-day		100		
Cobalt	Chronic	3.0E-04	mg/kg-day	1	1.0E+00	mg/kg-day	Thyroid toxicity	1000	PPRTV	8/25/2008
	Subchronic	3.0E-03	mg/kg-day	1	1.0E+00	mg/kg-day				
Iron	Chronic	7.0E-01	mg/kg-day	1	7.0E-01	mg/kg-day	Gastrointestinal effects	1.5	PPRTV	9/11/2006
	Subchronic	7.0E-01	mg/kg-day	1	7.0E-01	mg/kg-day				
Vanadium	Chronic	7.0E-03	mg/kg-day	0.026	1.8E-04	mg/kg-day	--	100	HEAST	7/00/1997
	Subchronic	7.0E-03	mg/kg-day	0.026	1.8E-04	mg/kg-day				
Ethylbenzene	Chronic	1.0E-01	mg/kg-day	1	1.0E-01	mg/kg-day	Liver and kidney toxicity	1,000	IRIS	7/1/2009
	Subchronic	1.0E+00	mg/kg-day	1	1.0E+00	mg/kg-day				
1-Methylnaphthalene	Chronic	7.0E-02	mg/kg-day	1	7.0E-02	mg/kg-day	Respiratory system effects	1,000	ATSDR	12/00/2008
2-Methylnaphthalene	Chronic	4.0E-03	mg/kg-day	1	4.0E-03	mg/kg-day	Pulmonary alveolar proteinosis	1,000	IRIS	7/1/2009
Naphthalene	Chronic	2.0E-02	mg/kg-day	1	2.0E-02	mg/kg-day	Decreased mean body weight	3,000	IRIS	7/1/2009
	Subchronic	2.0E-01	mg/kg-day	1	2.0E-01	mg/kg-day				
Manganese	Chronic	1.4E-01	mg/kg-day	0.04	5.6E-03	mg/kg-day	Central nervous system effects	1	IRIS	7/1/2009
Methylcyclohexane	Chronic	NA	--	1	NA	--	--	--	PPRTV	2/24/2005
Phenanthrene	Chronic	NA	--	1	NA	--	--	--	--	--
Xylenes	Chronic	2.0E-01	mg/kg-day	1	2.0E-01	mg/kg-day	Decreased body weight, increased mortality	1,000	IRIS	7/1/2009
2,3,7,8-TCDD	Chronic	1.0E-09	mg/kg-day	1	1.0E-09	mg/kg-day	Developmental effects	90	ATSDR	12/00/2008
	Subchronic	2.0E-08	mg/kg-day	1	2.0E-08	mg/kg-day	Lymphoreticular system effects	30		

Notes

ATSDR = Agency for Toxic Substances and Disease Registry

IRIS = Integrated Risk Information System

PPRTV = Provisional Peer-Reviewed Toxicity Value

HEAST = Health Effects Assessment Summary Tables

NA = Not Available

TABLE E-5.2
NON-CANCER TOXICITY DATA - INHALATION
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation Reference Concentration		Inhalation Reference Dose (not used)		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	Source(s)	Date(s) (MM/DD/YYYY)
		Value	Units	Value	Units				
Aluminum	Chronic	5.0E-03	mg/m ³	NA	mg/kg-day	Psychomotor and cognitive impairment	300	PPRTV	10/23/2006
Arsenic	Chronic	1.5E-05	mg/m ³	4.3E-06	mg/kg-day	Development, cardiovascular system and nervous system	--	CalEPA	7/1/2009
Benzene	Chronic	3.0E-02	mg/m ³	8.6E-03	mg/kg-day	Decreased lymphocyte count	300	IRIS	7/1/2009
	Subchronic	9.0E-02	mg/m ³	2.6E-02	mg/kg-day				
Cobalt	Chronic	6.0E-06	mg/m ³	1.7E-06	mg/kg-day	Decreased pulmonary function and respiratory tract irritation	300	PPRTV	5/25/2008
	Subchronic	2.0E-05	mg/m ³	5.7E-06	mg/kg-day				
Iron	Chronic	NA	--	NA	--	Blood, liver, gastrointestinal	--	--	--
Vanadium	Chronic	NA	--	NA	--	--	--	--	--
Ethylbenzene	Chronic	1.0E+00	mg/m ³	2.9E-01	mg/kg-day	Developmental toxicity	--	IRIS	7/1/2009
1-Methylnaphthalene	Chronic	NA	--	NA	--	--	--	--	--
2-Methylnaphthalene	Chronic	NA	--	NA	--	Lung effects	--	--	--
Naphthalene	Chronic	3.0E-03	mg/m ³	8.6E-04	mg/kg-day	Nasal effects	3,000	IRIS	7/1/2009
Manganese	Chronic	5.0E-05	mg/m ³	1.4E-05	mg/kg-day	Impairment of neurobehavioral function	1,000	IRIS	7/1/2009
Methylcyclohexane	Chronic	NA	--	NA	--	--	--	PPRTV	2/24/2005
Phenanthrene	Chronic	NA	--	NA	--	--	--	--	--
Xylenes	Chronic	1.0E-01	mg/m ³	2.9E-02	mg/kg-day	Impaired motor coordination	300	IRIS	7/1/2009
	Subchronic	3.0E-01	mg/m ³	8.6E-02	mg/kg-day				
2,3,7,8-TCDD	Chronic	NA	--	NA	--	--	--	--	--

Notes

IRIS = Integrated Risk Information System

PPRTV = Provisional Peer-Reviewed Toxicity Value

CalEPA = California Environmental Protection Agency

NA = Not Available

**TABLE E-6.1
CANCER TOXICITY DATA - ORAL/DERMAL
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA**

Chemical of Potential Concern	Oral Slope Factor	Oral to Dermal Adjustment Factor	Adjusted Dermal Slope Factor	Units	USEPA Weight of Evidence/ Cancer Guideline Description	Source	Date (MM/DD/YYYY)
Aluminum	NA	1	NA	--	Inadequate data	PPRTV	10/23/2006
Arsenic	1.5E+00	1	1.5E+00	(mg/kg-day) ⁻¹	A	IRIS	7/1/2009
Benzene	5.5E-02	1	5.5E-02	(mg/kg-day) ⁻¹	A	IRIS	7/1/2009
Cobalt	NA	1	NA	--	N/A	PPRTV	8/25/2008
Iron	NA	1	NA	--	N/A	--	4/15/2009
Vanadium	NA	0.026	NA	--	N/A	--	--
Ethylbenzene	1.1E-02	1	1.1E-02	(mg/kg-day) ⁻¹	D	CalEPA	7/1/2009
1-Methylnaphthalene	2.9E-02	1	2.9E-02	(mg/kg-day) ⁻¹	--	PPRTV	*
2-Methylnaphthalene	NA	1	NA	--	N/A	--	--
Naphthalene	NA	1	NA	--	C	--	--
Manganese	NA	1	NA	--	D	IRIS	7/1/2009
Methylcyclohexane	NA	1	NA	--	Inadequate data	PPRTV	2/24/2005
Phenanthrene	NA	1	NA	--	--	--	--
Xylenes	NA	1	NA	--	Inadequate data	IRIS	7/1/2009
2,3,7,8-TCDD	1.3E+05	1	1.3E+05	(mg/kg-day) ⁻¹	B2	CalEPA	7/1/2009

Notes

IRIS = Integrated Risk Information System

CalEPA = California Environmental Protection Agency

NA = Not Available

N/A = Not Applicable

* Obtained from the USEPA, Region III RSL Table (April 2009)

USEPA Weight of Evidence Classifications

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

**TABLE E-6.2
CANCER TOXICITY DATA - INHALATION
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA**

Chemical of Potential Concern	Inhalation Unit Risk	Units	Inhalation Slope Factor (not used)	Units	USEPA Weight of Evidence/ Cancer Guideline Description	Source	Date (MM/DD/YYYY)
Aluminum	NA	--	NA	--	Inadequate data	PPRTV	10/23/2006
Arsenic	4.3E-03	($\mu\text{g}/\text{m}^3$) ⁻¹	1.5E+01	($\text{mg}/\text{kg}\text{-day}$) ⁻¹	A	IRIS	7/1/2009
Benzene	7.8E-06	($\mu\text{g}/\text{m}^3$) ⁻¹	2.7E-02		A	IRIS	7/1/2009
Cobalt	9.0E-03	($\mu\text{g}/\text{m}^3$) ⁻¹	3.2E+01	($\text{mg}/\text{kg}\text{-day}$) ⁻¹	Likely to be carcinogenic in humans	PPRTV	8/25/2008
Iron	NA	--	NA		N/A	--	--
Vanadium	NA	--	NA	--	N/A	--	--
Ethylbenzene	2.5E-06	($\mu\text{g}/\text{m}^3$) ⁻¹	8.8E-03	($\text{mg}/\text{kg}\text{-day}$) ⁻¹	N/A	CalEPA	7/1/2009
1-Methylnaphthalene	NA	--	NA	--	--	--	--
2-Methylnaphthalene	NA	--	NA	--	--	--	--
Naphthalene	3.4E-05	($\mu\text{g}/\text{m}^3$) ⁻¹	1.2E-01	($\text{mg}/\text{kg}\text{-day}$) ⁻¹	C	CalEPA	7/1/2-009
Manganese	NA	--	NA	--	D	IRIS	7/1/2009
Methylcyclohexane	NA	--	NA	--	Inadequate data	PPRTV	2/24/2005
Phenanthrene	NA	--	NA	--	--	--	--
Xylenes	NA	--	NA	--	Inadequate data	IRIS	7/1/2009
2,3,7,8-TCDD	3.8E+01	($\mu\text{g}/\text{m}^3$) ⁻¹	1.3E+05	($\text{mg}/\text{kg}\text{-day}$) ⁻¹	B2	CalEPA	7/1/2009

Notes

IRIS = Integrated Risk Information System
 CalEPA = California Environmental Protection Agency
 NA = Not Available
 N/A = Not Applicable

USEPA Weight of Evidence Classifications

A - Human carcinogen
 B1 - Probable human carcinogen - indicates that limited human data are available
 B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
 C - Possible human carcinogen
 D - Not classifiable as a human carcinogen
 E - Evidence of noncarcinogenicity

TABLE E-7.1.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA

Scenario Timeframe: Future
Receptor Population: Construction/Utility Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	Exposure Point Concentration		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Intake/Exposure Concentration		Cancer Slope Factor or Inhalation Unit Risk		Cancer Risk	Intake/Exposure Concentration		Reference Dose or Reference Concentration		Hazard Quotient		
					Value	Units	Value	Units		Value	Units	Value	Units		Value	Units
Soil	Subsurface Soil	Excavation	Ingestion	Aluminum	1.2E+04	mg/kg	1.3E-04	mg/kg-day	NA	--	--	9.2E-03	mg/kg-day	1.0E+00	mg/kg-day	9E-03
				Arsenic	1.2E+00	mg/kg	1.4E-08	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	2E-08	9.7E-07	mg/kg-day	3.0E-04	mg/kg-day	3E-03
				Benzene	6.4E-01	mg/kg	7.1E-09	mg/kg-day	5.5E-02	(mg/kg-day) ⁻¹	4E-10	5.0E-07	mg/kg-day	1.2E-02	mg/kg-day	4E-05
				Iron	1.6E+04	mg/kg	1.8E-04	mg/kg-day	NA	--	--	1.2E-02	mg/kg-day	7.0E-01	mg/kg-day	2E-02
				Vanadium	5.8E+01	mg/kg	6.4E-07	mg/kg-day	NA	--	--	4.5E-05	mg/kg-day	7.0E-03	mg/kg-day	6E-03
				Ethylbenzene	5.7E+00	mg/kg	6.3E-08	mg/kg-day	1.1E-02	(mg/kg-day) ⁻¹	7E-10	4.4E-06	mg/kg-day	1.0E+00	mg/kg-day	4E-06
				Naphthalene	6.3E+00	mg/kg	6.9E-08	mg/kg-day	NA	--	--	4.8E-06	mg/kg-day	2.0E-01	mg/kg-day	2E-05
				2-Methylnaphthalene	2.3E+01	mg/kg	2.6E-07	mg/kg-day	NA	--	--	1.8E-05	mg/kg-day	4.0E-03	mg/kg-day	4E-03
			Exp. Route Total							2E-08					4E-02	
			Dermal	Aluminum	1.2E+04	mg/kg	4.0E-06	mg/kg-day	NA	--	--	2.8E-04	mg/kg-day	1.0E+00	mg/kg-day	3E-04
				Arsenic	1.2E+00	mg/kg	1.2E-09	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	2E-09	8.7E-08	mg/kg-day	3.0E-04	mg/kg-day	3E-04
				Benzene	6.4E-01	mg/kg	1.1E-09	mg/kg-day	5.5E-02	(mg/kg-day) ⁻¹	6E-11	7.5E-08	mg/kg-day	1.2E-02	mg/kg-day	6E-06
				Iron	1.6E+04	mg/kg	5.3E-06	mg/kg-day	NA	--	--	3.7E-04	mg/kg-day	7.0E-01	mg/kg-day	5E-04
				Vanadium	5.8E+01	mg/kg	1.9E-08	mg/kg-day	NA	--	--	1.3E-06	mg/kg-day	1.8E-04	mg/kg-day	7E-03
	Ethylbenzene	5.7E+00		mg/kg	5.7E-09	mg/kg-day	1.1E-02	(mg/kg-day) ⁻¹	6E-11	4.0E-07	mg/kg-day	1.0E+00	mg/kg-day	4E-07		
	Naphthalene	6.3E+00		mg/kg	2.7E-08	mg/kg-day	NA	--	--	1.9E-06	mg/kg-day	2.0E-01	mg/kg-day	9E-06		
	2-Methylnaphthalene	2.3E+01		mg/kg	1.0E-07	mg/kg-day	NA	--	--	7.0E-06	mg/kg-day	4.0E-03	mg/kg-day	2E-03		
	Exp. Route Total							2E-09					1E-02			
	Outdoor Air	Excavation	Inhalation	Aluminum	1.7E+01	µg/m ³	1.3E-02	µg/m ³	NA	(µg/m ³) ⁻¹	--	4.0E+00	µg/m ³	5.0E+00	µg/m ³	8E-01
				Arsenic	1.8E-03	µg/m ³	1.4E-06	µg/m ³	4.3E-03	(µg/m ³) ⁻¹	6E-09	4.3E-04	µg/m ³	1.5E-02	µg/m ³	3E-02
				Benzene	1.6E+01	µg/m ³	1.2E-02	µg/m ³	7.8E-06	(µg/m ³) ⁻¹	1E-07	3.7E+00	µg/m ³	9.0E+01	µg/m ³	4E-02
				Iron	2.2E+01	µg/m ³	1.7E-02	µg/m ³	NA	(µg/m ³) ⁻¹	--	5.3E+00	µg/m ³	NA	--	--
				Vanadium	8.0E-02	µg/m ³	6.3E-05	µg/m ³	NA	(µg/m ³) ⁻¹	--	1.9E-02	µg/m ³	NA	--	--
				Ethylbenzene	5.4E+01	µg/m ³	4.2E-02	µg/m ³	2.5E-06	(µg/m ³) ⁻¹	1E-07	1.3E+01	µg/m ³	1.0E+03	µg/m ³	1E-02
				Naphthalene	9.7E-01	µg/m ³	7.6E-04	µg/m ³	3.4E-05	(µg/m ³) ⁻¹	3E-08	2.3E-01	µg/m ³	3.0E+00	µg/m ³	8E-02
				2-Methylnaphthalene	7.1E-01	µg/m ³	5.6E-04	µg/m ³	NA	(µg/m ³) ⁻¹	--	1.7E-01	µg/m ³	NA	--	--
				Exp. Route Total							2E-07					1E+00
				Exposure Point Total									3E-07			1E+00
Total of Receptor Risks Across Medium										3E-07			1E+00			

**TABLE E-7.2.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA**

Scenario Timeframe:	Future
Receptor Population:	Construction/Utility Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	Exposure Point Concentration		Cancer Risk Calculations					Non-Cancer Hazard Calculations							
					Value	Units	Intake/Exposure Concentration		Cancer Slope Factor or Inhalation Unit Risk		Cancer Risk	Intake/Exposure Concentration		Reference Dose or Reference Concentration		Hazard Quotient			
							Value	Units	Value	Units		Value	Units	Value	Units				
Groundwater	Groundwater	Excavation	Dermal	Benzene	1.7E-02	mg/l	2.3E-07	mg/kg-day	5.5E-02	(mg/kg-day) ⁻¹	1E-08	1.6E-05	mg/kg-day	1.2E-02	mg/kg-day	1E-03			
				Cobalt	8.1E-03	mg/l	1.4E-08	mg/kg-day	NA	--	--	1.0E-06	mg/kg-day	1.0E+00	mg/kg-day	1E-06			
				Ethylbenzene	1.3E-02	mg/l	5.5E-07	mg/kg-day	1.1E-02	(mg/kg-day) ⁻¹	6E-09	3.8E-05	mg/kg-day	1.0E+00	mg/kg-day	4E-05			
				Iron	1.3E+01	mg/l	1.1E-05	mg/kg-day	NA	--	--	7.9E-04	mg/kg-day	7.0E-01	mg/kg-day	1E-03			
				Manganese	1.8E-01	mg/l	1.5E-07	mg/kg-day	NA	--	--	1.1E-05	mg/kg-day	5.6E-03	mg/kg-day	2E-03			
				Naphthalene	2.4E-02	mg/l	9.8E-07	mg/kg-day	NA	--	--	6.9E-05	mg/kg-day	2.0E-01	mg/kg-day	3E-04			
				1-Methylnaphthalene	1.7E-02	mg/l	3.7E-06	mg/kg-day	2.9E-02	(mg/kg-day) ⁻¹	1E-07	2.6E-04	mg/kg-day	7.0E-02	mg/kg-day	--			
				2-Methylnaphthalene	2.5E-02	mg/l	1.9E-06	mg/kg-day	NA	--	--	1.3E-04	mg/kg-day	4.0E-03	mg/kg-day	3E-02			
				Xylenes	3.1E-01	mg/l	1.4E-05	mg/kg-day	NA	--	--	9.8E-04	mg/kg-day	2.0E-01	mg/kg-day	5E-03			
				2,3,7,8-TCDD TEQ	2.4E-07	mg/l	2.2E-10	mg/kg-day	1.3E+05	(mg/kg-day) ⁻¹	3E-05	1.6E-08	mg/kg-day	2.0E-08	mg/kg-day	8E-01			
				Exp. Route Total														8E-01	
	Outdoor Air	Excavation	Inhalation	Benzene	5.5E-03	µg/m ³	4.3E-06	µg/m ³	7.8E-06	(µg/m ³) ⁻¹	3E-11	1.3E-03	µg/m ³	9.0E+01	µg/m ³	1E-05			
				Ethylbenzene	3.6E-03	µg/m ³	2.8E-06	µg/m ³	2.5E-06	(µg/m ³) ⁻¹	7E-12	8.6E-04	µg/m ³	1.0E+03	µg/m ³	9E-07			
				Naphthalene	5.5E-03	µg/m ³	4.3E-06	µg/m ³	3.4E-05	(µg/m ³) ⁻¹	1E-10	1.3E-03	µg/m ³	3.0E+00	µg/m ³	4E-04			
				1-Methylnaphthalene	3.6E-03	µg/m ³	2.8E-06	µg/m ³	NA	(µg/m ³) ⁻¹	--	8.6E-04	µg/m ³	N/A	µg/m ³	--			
				2-Methylnaphthalene	5.5E-03	µg/m ³	4.3E-06	µg/m ³	NA	(µg/m ³) ⁻¹	--	1.3E-03	µg/m ³	NA	µg/m ³	--			
				Xylenes	8.6E-02	µg/m ³	6.8E-05	µg/m ³	NA	(µg/m ³) ⁻¹	--	2.1E-02	µg/m ³	3.0E+02	µg/m ³	7E-05			
				Exposure Point								2E-10						5E-04	
				Total of Receptor Risks Across Medium								3E-05						8E-01	

**TABLE E-9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA**

Scenario Timeframe: Future
Receptor Population: Construction/Utility Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Subsurface Soil	Excavation	Aluminum	--	--	--	--	Developmental, nervous system & Psychomotor and cognitive impairment Hyperpigmentation, keratosis, and possible vascular complications & Development, cardiovascular system and nervous system	9E-03	8E-01	3E-04	8E-01
			Arsenic	2E-08	6E-09	2E-09	3E-08		3E-03	3E-02	3E-04	3E-02
			Benzene	4E-10	1E-07	6E-11	1E-07	Decreased lymphocyte count	4E-05	4E-02	6E-06	4E-02
			Iron	--	--	--	--	Gastrointestinal effects & Blood, liver, and gastrointestinal effects	2E-02	--	5E-04	2E-02
			Vanadium	--	--	--	--	--	6E-03	--	7E-03	1E-02
			Ethylbenzene	7E-10	1E-07	6E-11	1E-07	Liver and kidney toxicity & Developmental toxicity	4E-06	1E-02	4E-07	1E-02
			Naphthalene	--	3E-08	--	3E-08	Decreased mean body weight & Nasal effects	2E-05	8E-02	9E-06	8E-02
			2-Methylnaphthalene	--	--	--	--	Pulmonary alveolar proteinosis & Lung effects	4E-03	--	2E-03	6E-03
Exposure Medium Total						3E-07					1E+00	
Subsurface Soil Total							3E-07					1E+00
Groundwater	Groundwater	Excavation	Benzene	N/A	3E-11	1E-08	1E-08	Decreased lymphocyte count Thyroid toxicity	N/A	1E-05	1E-03	1E-03
			Cobalt	N/A	--	--	--		N/A	N/A	1E-06	1E-06
			Ethylbenzene	N/A	7E-12	6E-09	6E-09	Liver and kidney toxicity & Developmental toxicity	N/A	9E-07	4E-05	4E-05
			Iron	N/A	--	--	--	Gastrointestinal effects & Blood, liver, and gastrointestinal effects	N/A	N/A	1E-03	1E-03
			Manganese	N/A	--	--	--	Central nervous system effects & Impairment of neurobehavioral function	N/A	N/A	2E-03	2E-03
			Naphthalene	N/A	1E-10	--	1E-10	Decreased mean body weight & Nasal effects	N/A	4E-04	3E-04	8E-04
			1-Methylnaphthalene	N/A	--	1E-07	1E-07	Respiratory system effects	N/A	--	--	--
			2-Methylnaphthalene	N/A	--	--	--	Pulmonary alveolar proteinosis & Lung effects	N/A	--	3E-02	3E-02
			Xylenes	N/A	--	--	--	Decreased body weight, increased mortality, & Impaired motor function	N/A	7E-05	5E-03	5E-03
			2,3,7,8-TCDD TEQ	N/A	--	3E-05	3E-05	Lymphoreticular system effects	N/A	N/A	8E-01	8E-01
Exposure Medium Total						3E-05					8E-01	
Groundwater Total							3E-05					8E-01
Receptor Total							3E-05					2E+00

Notes
N/A = Not Applicable

Toxic Endpoint-Specific HIs	
Developmental	9E-01
Nervous System	8E-01
Skin	3E-02
Cardiovascular	3E-02
Immune System	8E-01
Gastrointestinal	2E-02
Hematological	2E-02
Liver	3E-02
Kidney	1E-02
Body Weight	8E-02
Nasal Effects	8E-02
Respiratory	3E-02
Endocrine System	1E-06

ProUCL OUTPUT FOR COPCs
IN SUBSURFACE SOIL

Ethylbenzene

General Statistics						
Number of Valid Data	12	Number of Detected Data	10			
Number of Distinct Detected Data	10	Number of Non-Detect Data	2			
		Percent Non-Detects	16.67%			
Raw Statistics		Log-transformed Statistics				
Minimum Detected	0.0027	Minimum Detected	-5.915			
Maximum Detected		6.2 Maximum Detected	1.825			
Mean of Detected	0.737	Mean of Detected	-2.492			
SD of Detected	1.924	SD of Detected	2.265			
Minimum Non-Detect	0.0061	Minimum Non-Detect	-5.099			
Maximum Non-Detect	0.0063	Maximum Non-Detect	-5.067			
Note: Data have multiple DLs - Use of KM Method is recommended			Number treated as Non-Detect	4		
For all methods (except KM, DL/2, and ROS Methods),			Number treated as Detected	8		
Observations < Largest ND are treated as NDs			Single DL Non-Detect Percentage	33.33%		
UCL Statistics		Lognormal Distribution Test with Detected Values Only				
Normal Distribution Test with Detected Values Only		Shapiro Wilk Test Statistic		0.421	Shapiro Wilk Test Statistic	0.957
5% Shapiro Wilk Critical Value		5% Shapiro Wilk Critical Value		0.842	5% Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level				
Assuming Normal Distribution		Assuming Lognormal Distribution				
DL/2 Substitution Method		DL/2 Substitution Method				
Mean	0.614	Mean	-3.039			
SD	1.763	SD	2.415			
95% DL/2 (t) UCL	1.528	95% H-Stat (DL/2) UCL	37.91			
Maximum Likelihood Estimate(MLE) Method		Log ROS Method				
Mean	0.036	Mean in Log Scale	-3.019			
SD	2.191	SD in Log Scale	2.391			
95% MLE (t) UCL	1.172	Mean in Original Scale	0.614			
95% MLE (Tiku) UCL	1.247	SD in Original Scale	1.763			
		95% Percentile Bootstrap UCL	1.617			
		95% BCA Bootstrap UCL	2.143			
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only				
k star (bias corrected)	0.286	Data appear Lognormal at 5% Significance Level				
Theta Star	2.576					
nu star	5.718					
A-D Test Statistic	0.857	Nonparametric Statistics				
5% A-D Critical Value	0.811	Kaplan-Meier (KM) Method				
K-S Test Statistic	0.811	Mean	0.615			
5% K-S Critical Value	0.287	SD	1.688			
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.514			
		95% KM (t) UCL	1.537			
Assuming Gamma Distribution		95% KM (z) UCL	1.459			
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1.529			
Minimum	1.00E-09	95% KM (bootstrap t) UCL	10.14			
Maximum	6.2	95% KM (BCA) UCL	1.657			
Mean	0.614	95% KM (Percentile Bootstrap) UCL	1.616			
Median	0.048	95% KM (Chebyshev) UCL	2.854			
SD	1.763	97.5% KM (Chebyshev) UCL	3.822			
k star	0.17	99% KM (Chebyshev) UCL	5.725			
Theta star	3.619					
Nu star	4.071	Potential UCLs to Use				
AppChi2	0.75	99% KM (Chebyshev) UCL	5.725			
95% Gamma Approximate UCL	3.332					
95% Adjusted Gamma UCL	4.434					
Note: DL/2 is not a recommended method.						

Naphthalene

General Statistics			
Number of Valid Data	12	Number of Detected Data	9
Number of Distinct Detected Data	9	Number of Non-Detect Data	3
		Percent Non-Detects	25.00%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.18	Minimum Detected	-1.715
Maximum Detected		11 Maximum Detected	2.398
Mean of Detected	2.712	Mean of Detected	0.194
SD of Detected	3.59	SD of Detected	1.385
Minimum Non-Detect	0.21	Minimum Non-Detect	-1.561
Maximum Non-Detect	0.21	Maximum Non-Detect	-1.561

Warning: There are only 9 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.744	Shapiro Wilk Test Statistic	0.937
5% Shapiro Wilk Critical Value	0.829	5% Shapiro Wilk Critical Value	0.829
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	2.06	Mean	-0.418
SD	3.281	SD	1.619
95% DL/2 (t) UCL	3.761	95% H-Stat (DL/2) UCL	10.35
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	1.075	Mean in Log Scale	-0.428
SD	4.183	SD in Log Scale	1.655
95% MLE (t) UCL	3.244	Mean in Original Scale	2.063
95% MLE (Tiku) UCL	3.391	SD in Original Scale	3.279
		95% Percentile Bootstrap UCL	3.659
		95% BCA Bootstrap UCL	4.292
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.571	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	4.751		
nu star	10.27		
A-D Test Statistic		0.485 Nonparametric Statistics	
5% A-D Critical Value	0.752	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.752	Mean	2.079
5% K-S Critical Value	0.289	SD	3.13
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.958
		95% KM (t) UCL	3.8
		95% KM (z) UCL	3.655
Assuming Gamma Distribution		95% KM (jackknife) UCL	3.741
Gamma ROS Statistics using Extrapolated Data		95% KM (bootstrap t) UCL	6.105
Minimum	1.00E-09	95% KM (BCA) UCL	3.903
Maximum	11	95% KM (Percentile Bootstrap) UCL	3.728
Mean	2.071	95% KM (Chebyshev) UCL	6.256
Median	0.515	97.5% KM (Chebyshev) UCL	8.064
SD	3.276	99% KM (Chebyshev) UCL	11.61
k star	0.192		
Theta star	10.79		
Nu star	4.608	Potential UCLs to Use	
AppChi2	0.976	95% KM (Chebyshev) UCL	6.256
95% Gamma Approximate UCL	9.782		
95% Adjusted Gamma UCL	12.73		

Note: DL/2 is not a recommended method.

2-Methylnaphthalene

General Statistics		
Number of Valid Observations	12	Number of Distinct Observations 11
Raw Statistics		
	Log-transformed Statistics	
Minimum	0.118	Minimum of Log Data -2.141
Maximum	45	Maximum of Log Data 3.807
Mean	9.647	Mean of log Data 1.097
Median	4.05	SD of log Data 1.88
SD	14.06	
Coefficient of Variation	1.458	
Skewness	1.966	
Relevant UCL Statistics		
Normal Distribution Test		
Shapiro Wilk Test Statistic	0.697	Shapiro Wilk Test Statistic 0.942
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value 0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level
Assuming Normal Distribution		
95% Student's-t UCL	16.94	95% H-UCL 252.1
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL 46.2
95% Adjusted-CLT UCL	18.79	97.5% Chebyshev (MVUE) UCL 60.6
95% Modified-t UCL	17.32	99% Chebyshev (MVUE) UCL 88.9
Gamma Distribution Test		
k star (bias corrected)	0.458	Data appear Gamma Distributed at 5% Significance Level
Theta Star	21.04	
nu star	11	
Approximate Chi Square Value (.05)	4.578	Nonparametric Statistics
Adjusted Level of Significance	0.029	95% CLT UCL 16.32
Adjusted Chi Square Value	3.965	95% Jackknife UCL 16.94
		95% Standard Bootstrap UCL 15.96
Anderson-Darling Test Statistic	0.308	95% Bootstrap-t UCL 31.58
Anderson-Darling 5% Critical Value	0.782	95% Hall's Bootstrap UCL 49.71
Kolmogorov-Smirnov Test Statistic	0.175	95% Percentile Bootstrap UCL 17.04
Kolmogorov-Smirnov 5% Critical Value	0.258	95% BCA Bootstrap UCL 19.31
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 27.34
		97.5% Chebyshev(Mean, Sd) UCL 35
		99% Chebyshev(Mean, Sd) UCL 50.04
Assuming Gamma Distribution		
95% Approximate Gamma UCL	23.19	
95% Adjusted Gamma UCL	26.77	
Potential UCL to Use	Use 95% Approximate Gamma UCL	23.19

Benzene

General Statistics			
Number of Valid Data	12	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	10
		Percent Non-Detects	83.33%
Raw Statistics			
		Log-transformed Statistics	
Minimum Detected	0.0575	Minimum Detected	-2.856
Maximum Detected	0.8	Maximum Detected	-0.223
Mean of Detected	0.429	Mean of Detected	-1.54
SD of Detected	0.525	SD of Detected	1.862
Minimum Non-Detect	0.0061	Minimum Non-Detect	-5.099
Maximum Non-Detect	0.31	Maximum Non-Detect	-1.171

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	11
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	1
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	91.67%

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic		1 Shapiro Wilk Test Statistic	1
5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.112	Mean	-4.09
SD	0.227	SD	2.156
95% DL/2 (t) UCL	0.23	95% H-Stat (DL/2) UCL	1.833
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	N/A	Data do not follow a Discernable Distribution (0.05)	
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic		Nonparametric Statistics	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	0.119
5% K-S Critical Value	N/A	SD	0.205
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0838
		95% KM (t) UCL	0.27
		95% KM (z) UCL	0.257
Assuming Gamma Distribution		95% KM (jackknife) UCL	0.627
Gamma ROS Statistics using Extrapolated Data		95% KM (bootstrap t) UCL	Infinity
Minimum	N/A	95% KM (BCA) UCL	0.8
Maximum	N/A	95% KM (Percentile Bootstrap) UCL	0.8
Mean	N/A	95% KM (Chebyshev) UCL	0.485
Median	N/A	97.5% KM (Chebyshev) UCL	0.643
SD	N/A	99% KM (Chebyshev) UCL	0.953
k star	N/A		
Theta star	N/A		
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	97.5% KM (Chebyshev) UCL	0.643
95% Gamma Approximate UCL	N/A		
95% Adjusted Gamma UCL	N/A		
Note: DL/2 is not a recommended method.			

Aluminum

General Statistics		
Number of Valid Observations	12	Number of Distinct Observations 8
Raw Statistics		
Minimum	7625	Log-transformed Statistics Minimum of Log Data 8.939
Maximum	13000	Maximum of Log Data 9.473
Mean	11105	Mean of log Data 9.305
Median	11300	SD of log Data 0.15
SD	1526	
Coefficient of Variation	0.137	
Skewness	-1.105	
Relevant UCL Statistics		
Normal Distribution Test		
Shapiro Wilk Test Statistic	0.904	Shapiro Wilk Test Statistic 0.864
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value 0.859
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level
Assuming Normal Distribution		
95% Student's-t UCL	11896	Assuming Lognormal Distribution 95% H-UCL 12068
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL 13211
95% Adjusted-CLT UCL	11679	97.5% Chebyshev (MVUE) UCL 14120
95% Modified-t UCL	11872	99% Chebyshev (MVUE) UCL 15905
Gamma Distribution Test		
k star (bias corrected)	38.86	Data Distribution Data appear Normal at 5% Significance Level
Theta Star	285.7	
nu star	932.7	
Approximate Chi Square Value (.05)	862.8	Nonparametric Statistics
Adjusted Level of Significance	0.029	95% CLT UCL 11829
Adjusted Chi Square Value	852.6	95% Jackknife UCL 11896
		95% Standard Bootstrap UCL 11820
Anderson-Darling Test Statistic	0.598	95% Bootstrap-t UCL 11759
Anderson-Darling 5% Critical Value	0.73	95% Hall's Bootstrap UCL 11725
Kolmogorov-Smirnov Test Statistic	0.215	95% Percentile Bootstrap UCL 11781
Kolmogorov-Smirnov 5% Critical Value	0.245	95% BCA Bootstrap UCL 11690
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 13025
		97.5% Chebyshev(Mean, Sd) UCL 13855
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 15487
95% Approximate Gamma UCL	12004	
95% Adjusted Gamma UCL	12149	
Potential UCL to Use		Use 95% Student's-t UCL 11896

Arsenic

General Statistics		
Number of Valid Observations	12 Number of Distinct Observations	12
Raw Statistics	Log-transformed Statistics	
Minimum	0.555 Minimum of Log Data	-0.589
Maximum	2 Maximum of Log Data	0.693
Mean	1.025 Mean of log Data	-0.05
Median	0.94 SD of log Data	0.397
SD	0.432	
Coefficient of Variation	0.422	
Skewness	1.097	
Relevant UCL Statistics		
Normal Distribution Test	Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.905 Shapiro Wilk Test Statistic	0.962
Shapiro Wilk Critical Value	0.859 Shapiro Wilk Critical Value	0.859
Data appear Normal at 5% Significance Level	Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution	Assuming Lognormal Distribution	
95% Student's-t UCL	1.249 95% H-UCL	1.312
95% UCLs (Adjusted for Skewness)	95% Chebyshev (MVUE) UCL	1.541
95% Adjusted-CLT UCL	1.273 97.5% Chebyshev (MVUE) UCL	1.766
95% Modified-t UCL	1.256 99% Chebyshev (MVUE) UCL	2.207
Gamma Distribution Test	Data Distribution	
k star (bias corrected)	5.2 Data appear Normal at 5% Significance Level	
Theta Star	0.197	
nu star	124.8	
Approximate Chi Square Value (.05)	100 Nonparametric Statistics	
Adjusted Level of Significance	0.029 95% CLT UCL	1.23
Adjusted Chi Square Value	96.62 95% Jackknife UCL	1.249
	95% Standard Bootstrap UCL	1.219
Anderson-Darling Test Statistic	0.266 95% Bootstrap-t UCL	1.321
Anderson-Darling 5% Critical Value	0.731 95% Hall's Bootstrap UCL	1.301
Kolmogorov-Smirnov Test Statistic	0.141 95% Percentile Bootstrap UCL	1.234
Kolmogorov-Smirnov 5% Critical Value	0.246 95% BCA Bootstrap UCL	1.26
Data appear Gamma Distributed at 5% Significance Level	95% Chebyshev(Mean, Sd) UCL	1.569
	97.5% Chebyshev(Mean, Sd) UCL	1.804
	99% Chebyshev(Mean, Sd) UCL	2.267
Assuming Gamma Distribution		
95% Approximate Gamma UCL	1.279	
95% Adjusted Gamma UCL	1.324	
Potential UCL to Use	Use 95% Student's-t UCL	1.249

Iron

General Statistics		
Number of Valid Observations	12 Number of Distinct Observations	12
Raw Statistics		
Minimum	9630	9.173
Maximum	23000	10.04
Mean	13614	9.477
Median	11908	0.291
SD	4420	
Coefficient of Variation	0.325	
Skewness	1.32	
Log-transformed Statistics		
Relevant UCL Statistics		
Normal Distribution Test	Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.826 Shapiro Wilk Test Statistic	0.883
Shapiro Wilk Critical Value	0.859 Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level	Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		
95% Student's-t UCL	15906 95% H-UCL	16126
95% UCLs (Adjusted for Skewness)	95% Chebyshev (MVUE) UCL	18595
95% Adjusted-CLT UCL	16233 97.5% Chebyshev (MVUE) UCL	20768
95% Modified-t UCL	15987 99% Chebyshev (MVUE) UCL	25036
Gamma Distribution Test		
k star (bias corrected)	9.156 Data appear Gamma Distributed at 5% Significance Level	
Theta Star	1487	
nu star	219.7	
Approximate Chi Square Value (.05)	186.4 Nonparametric Statistics	
Adjusted Level of Significance	0.029 95% CLT UCL	15713
Adjusted Chi Square Value	181.8 95% Jackknife UCL	15906
	95% Standard Bootstrap UCL	15661
Anderson-Darling Test Statistic	0.663 95% Bootstrap-t UCL	17533
Anderson-Darling 5% Critical Value	0.731 95% Hall's Bootstrap UCL	17858
Kolmogorov-Smirnov Test Statistic	0.191 95% Percentile Bootstrap UCL	15678
Kolmogorov-Smirnov 5% Critical Value	0.245 95% BCA Bootstrap UCL	15905
Data appear Gamma Distributed at 5% Significance Level	95% Chebyshev(Mean, Sd) UCL	19176
	97.5% Chebyshev(Mean, Sd) UCL	21582
	99% Chebyshev(Mean, Sd) UCL	26309
Assuming Gamma Distribution		
95% Approximate Gamma UCL	16047	
95% Adjusted Gamma UCL	16460	
Potential UCL to Use	Use 95% Approximate Gamma UCL	16047

Vanadium

General Statistics		
Number of Valid Observations	12	Number of Distinct Observations
		12
Raw Statistics		
	Log-transformed Statistics	
Minimum	27.3	Minimum of Log Data
		3.307
Maximum	72	Maximum of Log Data
		4.277
Mean	50.78	Mean of log Data
		3.894
Median	48.7	SD of log Data
		0.278
SD	13.08	
Coefficient of Variation	0.258	
Skewness	-0.0749	
Relevant UCL Statistics		
Normal Distribution Test		
Shapiro Wilk Test Statistic	0.961	Shapiro Wilk Test Statistic
		0.933
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value
		0.859
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level
Assuming Normal Distribution		
Assuming Lognormal Distribution		
95% Student's-t UCL	57.56	95% H-UCL
		59.9
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL
		68.83
95% Adjusted-CLT UCL	56.9	97.5% Chebyshev (MVUE) UCL
		76.59
95% Modified-t UCL	57.55	99% Chebyshev (MVUE) UCL
		91.85
Gamma Distribution Test		
Data Distribution		
k star (bias corrected)	11.4	Data appear Normal at 5% Significance Level
Theta Star	4.453	
nu star	273.7	
Approximate Chi Square Value (.05)	236.3	Nonparametric Statistics
Adjusted Level of Significance	0.029	95% CLT UCL
		56.99
Adjusted Chi Square Value	231	95% Jackknife UCL
		57.56
		95% Standard Bootstrap UCL
		56.66
Anderson-Darling Test Statistic	0.337	95% Bootstrap-t UCL
		57.62
Anderson-Darling 5% Critical Value	0.731	95% Hall's Bootstrap UCL
		57.06
Kolmogorov-Smirnov Test Statistic	0.175	95% Percentile Bootstrap UCL
		56.38
Kolmogorov-Smirnov 5% Critical Value	0.245	95% BCA Bootstrap UCL
		56.59
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL
		67.24
		97.5% Chebyshev(Mean, Sd) UCL
		74.36
		99% Chebyshev(Mean, Sd) UCL
		88.34
Assuming Gamma Distribution		
95% Approximate Gamma UCL	58.8	
95% Adjusted Gamma UCL	60.14	
Potential UCL to Use		Use 95% Student's-t UCL
		57.56

ESTIMATION OF COPC CONCENTRATIONS
IN OUTDOOR AIR

TABLE E-10
VOLATILE COPC EMISSION FLUX FROM SUBSURFACE SOILS
CONSTRUCTION/UTILITY WORKER
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA

Objective: Determination of outdoor volatile chemical concentrations associated with the excavation of 1.5 m-wide x 5.0 m-long x 3.0 m-deep trench.

Chemical of Potential Concern	CAS Number	MW _i Molecular Weight g/g-mole	P _i Vapor Pressure mm Hg	H Henry's Law Constant atm-m ³ /mole	H' Unitless Henry's Law Constant unitless	K _{oc} Soil Organic Carbon/ Water Coefficient (l/kg)	C _{i,soil} Soil Concentration mg/kg	C _{i,soil} Soil Concentration g/g	D _{a,i} Diffusivity in Air cm ² /s	D _{w,i} Diffusivity in Water cm ² /s	D _i ^{eff} Effective Diffusivity in Air cm ² /s	C _s Mass Loading Soil Concentration g/cm ³	M Total Mass in Soil g
Benzene	71-43-2	78.1	9.5E+01	5.6E-03	2.3E-01	6.2E+01	7.6E-01	7.6E-07	8.8E-02	9.8E-06	3.1E-03	1.3E-06	2.8E+01
Ethylbenzene	100-41-4	106	9.6E+00	7.9E-03	3.2E-01	2.4E+02	3.8E+00	3.8E-06	7.5E-02	7.8E-06	2.6E-03	6.4E-06	1.4E+02
2-Methylnaphthalene	91-57-6	142	5.5E-02	5.2E-04	2.1E-02	3.0E+03	2.3E+01	2.3E-05	4.8E-02	7.8E-06	1.7E-03	3.8E-05	8.7E+02
Naphthalene	91-20-3	128	8.5E-02	4.8E-04	2.0E-02	1.2E+03	4.9E+00	4.9E-06	5.9E-02	7.5E-06	2.1E-03	8.1E-06	1.8E+02

Note

N/A = Not Available

Sources of chemical-specific properties (i.e., Henry's Law Constant, etc.) are USEPA (1996) and USDOE (2008).

Parameter	Value	Source
(1) Dry soil bulk density (ρ_b , g/cm ³) =	1.66	Default for sand (USEPA, 2002)
(2) Air-filled soil porosity (θ_a , L _{air} /L _{soil}) =	0.202	Calculated per USEPA (2002)
(3) Water-filled soil porosity (θ_w , L _{water} /L _{soil}) =	0.172	Calculated per USEPA (1995a)
(4) Total soil porosity (θ_T , L _{pore} /L _{soil}) =	0.374	Calculated per USEPA (2002)
(5) Soil volume (V _{soil} , m ³) =	22.5	1.5m*5m*3m
(6) Cross-sectional area of excavation through which vapors may pass for ERPS (AE,PS, m ²) =	46.5	(2*1.5m*3m)+(2*5m*3m)+(1.5m*5m)
(7) Cross-sectional area of excavation through which vapors may pass for ERDIFF (AE,DIFF, m ²) =	39	(2*1.5m*3m)+(2*5m*3m)
(8) Mean wind speed (U, m/s) =	3.53	for Richmond, VA
(9) Molar gas constant (R, mmHg-cm ³ /g-mole K) =	6.24E+04	Constant
(10) System temperature (T _s , K) =	298	Default (USEPA, 1992a)
(11) Maximum 1-hour unitized impact (ug/m ³ per g/m ² s) =	2.68E+04	Predicted from PAL2.1, for rural land use
(12) Excavation rate (Q, m ³ /s) =	0.04167	= V _{soil} /t _{vsoil}
(13) Time to excavate (t _{vsoil} , sec) =	540	Estimated
(14) Soil gas to atmosphere exchange constant (ExC) =	0.33	Default for dry sandy soils (USEPA, 1992a)
(15) Viscosity of air (U _a , g/cm-s) =	1.81E-04	Default
(16) Air density (ρ_a , g/cm ³) =	1.29E-03	Default
(17) Effective diameter of waste stream surface area (d _e , m) =	7.69	Calc: (4*46.5m ² /3.14) ^{0.5}
(18) Time (t, sec) =	60	Default
(19) Fraction organic carbon (f _{oc}) =	0.006	Default

TABLE E-11
VOLATILE COPC EMISSION FLUX FROM GROUNDWATER
CONSTRUCTION/UTILITY WORKER
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA

Objective: Determination of outdoor volatile chemical concentrations associated with the excavation of 1.5 m-wide x 5.0 m-long x 3.0 m-deep trench.
 Assumes that trench intercepts groundwater.

Chemical of Potential Concern	Groundwater Concentration $C_{i,GW}$ (mg/L)	Groundwater Concentration C_L (g/cm ³)	Henry's Law Constant H' (unitless)	Henry's Law Constant H (atm-m ³ /mole)	Molecular Weight MW_i (g/mol)	Liquid-Phase Mass Transfer Coefficient $k_{i,L}$ (cm/s)	Gas-Phase Mass Transfer Coefficient $k_{i,G}$ (cm/s)	Overall mass Transfer Coefficient K_i (cm/s)	Groundwater Emission Flux EF_{GW} (g/s-m ²)	Outdoor Air Concentration $C_{OUTDOOR, GROUNDWATER}$ (mg/m ³)
Benzene	1.7E-02	1.7E-08	2.3E-01	5.6E-03	78	1.2E-03	4.9E-01	1.2E-03	2.1E-07	5.5E-06
Ethylbenzene	1.3E-02	1.3E-08	3.2E-01	7.9E-03	106	1.0E-03	4.4E-01	1.0E-03	1.4E-07	3.6E-06
Methylcyclohexane	2.7E-03	2.7E-09	1.6E+01	1.6E-04	98	1.1E-03	4.5E-01	8.0E-04	2.2E-08	5.8E-07
1-Methylnaphthalene	1.7E-02	1.7E-08	2.1E-02	5.1E-04	142	9.1E-04	4.0E-01	8.2E-04	1.4E-07	3.6E-06
2-Methylnaphthalene	2.5E-02	2.5E-08	2.1E-02	5.2E-04	142	9.1E-04	4.0E-01	8.2E-04	2.1E-07	5.5E-06
Naphthalene	2.4E-02	2.4E-08	1.8E-02	4.4E-04	128	9.5E-04	4.1E-01	8.5E-04	2.0E-07	5.5E-06
Phenanthrene	2.9E-03	2.9E-09	5.4E-03	5.3E-08	178	8.1E-04	3.7E-01	8.4E-07	2.4E-11	6.5E-10
Xylenes	3.1E-01	3.1E-07	2.7E-01	6.6E-03	106	1.0E-03	4.4E-01	1.0E-03	3.2E-06	8.6E-05

Note

Sources of chemical-specific properties (i.e., Henry's Law Constant, etc.) are USEPA (1996), Syracuse Research Corp. (2005), and USDOE (2005)

Parameters	Value	Source
(1) Maximum 1-hour unitized impact (g/m ³ per g/m ² s) =	2.68E-02	Predicted
(2) Molecular weight of oxygen (MW_{O_2} , g/mol) =	32	Default
(3) System temperature (T_s , K) =	284	Default
(4) Liquid mass phase transfer of oxygen at 25°C (k_{L,O_2} , cm/sec) =	0.002	Default
(5) Molecular weight of water (MW_{H_2O} , g/mol) =	18	Default
(6) Gas phase mass transfer coefficient of water vapor at 25°C (k_G , H ₂ O, cm/sec) =	0.833	Default
(7) Ideal gas constant (R, atm-m ³ /mole-K) =	8.20E-05	Default

TABLE E-12
RESPIRABLE PARTICULATE EMISSION FROM SUBSURFACE SOILS
CONSTRUCTION/UTILITY WORKER
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA

Objective: Determination of outdoor concentrations of chemicals adsorbed to respirable particulates associated with the excavation of 1.5 m-wide x 5 m-long x 3 m-deep trench.

Chemical of Potential Concern	C_i Soil Concentration mg/kg	X_i Soil Concentration mg/mg	E PM Emissions g	ER PM ₁₀ Emission Rate g/s	C Maximum 1-Hour Average PM ₁₀ Concentration ug/m ³
Aluminum	1.2E+04	1.2E-02	3.7E+00	8.2E-05	1.7E+01
Arsenic	1.3E+00	1.3E-06	3.7E+00	8.8E-09	1.8E-03
Iron	1.6E+04	1.6E-02	3.7E+00	1.1E-04	2.2E+01
Vanadium	5.8E+01	5.8E-05	3.7E+00	3.9E-07	8.0E-02

<u>Parameter</u>	<u>Value</u>	<u>Source</u>
(1) Particle size multiplier (k, unitless) =	0.35	Default for PM ₁₀
(2) Empirical constant (0.0016, g/kg) =	0.0016	
(3) Mass of soil handled (M, kg) =	33,750	Based on the volume of soil excavated (22.5 m ³) and default bulk density (1.5 g/
(4) Mean wind speed (U, m/s) =	3.53	for Richmond, VA
(5) Empirical constant (2.2, g/kg) =	2.2	
(6) Percent moisture (X _{H2O} , %) =	10	Default (USEPA, 1995b)
(7) Fraction of chemical in PM ₁₀ (X _i , unitless) =	chemical-specific	Concentration in soil converted to mg/mg
(8) Time to excavate (t _{vsoil} , s)	540	Calculated
(9) Maximum 1-hour unitized impact (μg/m ³ per g/s) =	2.04E+05	Predicted from SCREEN3, for rural land use

USEPA RAGS PART D
DERMAL WORKSHEETS

TABLE E-13
DERMAL WORKSHEET
INTERMEDIATE VARIABLES FOR CALCULATING DA_{event}
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA

Scenario Timeframe:	Future
Receptor Population:	Construction/Utility Worker
Exposure Medium:	Subsurface Soil

Chemical of Potential Concern	Dermal Absorption Fraction (soil)
Aluminum	0.01 ^a
Arsenic	0.03 ^b
Benzene	0.05 ^a
Iron	0.01 ^a
Vanadium	0.01 ^a
Ethylbenzene	0.03 ^a
Naphthalene	0.13 ^b
2-Methylnaphthalene	0.13 ^b

Notes

a = USEPA, 2003a, 1995a

b = USEPA, 2004

TABLE E-14
DERMAL WORKSHEET
INTERMEDIATE VARIABLES FOR CALCULATING Daevent
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA

Scenario Timeframe:	Future
Receptor Population:	Construction/Utility Worker
Exposure Medium:	Groundwater

Chemical of Potential Concern	FA	Kp		t-event		Tau (event)		T*		B
	Value	Value	Units	Value	Units	Value	Units	Value	Units	Value
Benzene	1	1.5E-02	cm/hr	8	hr/event	0.29	hr/event	0.7	hr	0.1
Cobalt	1	2.0E-03	cm/hr	8	hr/event	N/A	hr/event	N/A	hr	N/A
Ethylbenzene	1	4.9E-02	cm/hr	8	hr/event	0.42	hr/event	1.01	hr	0.2
Iron	1	1.0E-03	cm/hr	8	hr/event	N/A	hr/event	N/A	hr	N/A
Manganese	1	1.0E-03	cm/hr	8	hr/event	N/A	hr/event	N/A	hr	N/A
Methylcyclohexane	1	1.8E-01	cm/hr	8	hr/event	0.38	hr/event	1.48	hr	0.7
Naphthalene	1	4.7E-02	cm/hr	8	hr/event	0.56	hr/event	1.34	hr	0.2
1-Methylnaphthalene	1	1.5E-01	cm/hr	8	hr/event	0.67	hr/event	2.61	hr	0.7
2-Methylnaphthalene	1	9.2E-02	cm/hr	8	hr/event	0.67	hr/event	1.6	hr	0.4
Phenanthrene	1	1.4E-01	cm/hr	8	hr/event	1.06	hr/event	4.11	hr	0.7
Xylenes	1	5.3E-02	cm/hr	8	hr/event	0.42	hr/event	1.01	hr	0.2
2,3,7,8-TCDD TEQ	0.5	8.1E-01	cm/hr	8	hr/event	6.82	hr/event	30.09	hr	5.6

Notes

FA = Fraction absorbed water (USEPA, 2004)

Kp = Dermal permeability coefficient of chemical in water (USEPA, 2004)

t-event = Event duration

Tau = Lag time (USEPA, 2004)

T* = Time to reach steady-state (USEPA, 2004)

B = Dimensionless ratio of the permeability coefficient of a chemical through the stratum corneum relative to its permeability coefficient across the viable epidermis (USEPA, 2004)

N/A = Not applicable

COPEC SCREENING TABLE

**TABLE E-15
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - SUBSURFACE SOIL
INACTIVE FIRE FIGHTING TRAINING PIT, FORT LEE, VIRGINIA**

Exposure Medium	CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (1)	Ecological Screening Value (2)	Source	COPEC Flag [Y/N]	Rationale for Selection or Deletion	
Subsurface Soil	Total TAL Metals														
	7429-90-5	Aluminum	7,625	13,000	mg/kg	WSW1	12 / 12	--	13,000	1,350 - 8,200	10	b	Y	1, 7	
	7440-36-0	Antimony	0.33 B	0.98 B	mg/kg	SSW3 & WSW2	12 / 12	--	0.98	1.2	0.27	a	Y	1, 6	
	7440-38-2	Arsenic	0.26	2.0	mg/kg	SSW3	12 / 12	--	2.0	0.9 - 10.9	18	a	N	2, 6	
	7440-39-3	Barium	12.4 B	20.3 B	mg/kg	SSW1	12 / 12	--	20.3	6.1 - 31.1	330	a	N	2, 6	
	7440-41-7	Beryllium	0.07 B	0.155 B	mg/kg	Bott	4 / 12	0.00005	0.155	0.14 - 2.5	21	a	N	2, 6	
	7440-43-9	Cadmium	0.11 B	0.46 B	mg/kg	ESW1	5 / 12	0.00007 - 0.00008	0.46	0.08 - 1.9	0.36	a	Y	1, 6	
	7440-70-2	Calcium*	19.6 B	51.9 B	mg/kg	NSW2	12 / 12	--	51.9	183 - 1,240	NA	N	N	3, 5, 6	
	18540-29-9	Chromium	10.05	37.6	mg/kg	SSW3	12 / 12	--	37.6	1.2 - 4.8	26	a	Y	1, 7	
	7440-50-8	Copper	6	11	mg/kg	NSW3	12 / 12	--	11	1.6 - 7.4	28	a	N	2, 7	
	7439-89-6	Iron	9,630	23,000	mg/kg	ESW1	12 / 12	--	23,000	759 - 3,850	3,260	b	Y	1, 7	
	7439-92-1	Lead	8.3	13.5	mg/kg	ESW1 & WSW2	12 / 12	--	13.5	8.8 - 21.7	11	a	Y	1, 6	
	7439-95-4	Magnesium*	122 B	174 B	mg/kg	SSW2	12 / 12	--	174	63.5 - 275	0.00044	b	N	1, 5, 6	
	7439-96-5	Manganese	4	16.5	mg/kg	Bott	12 / 12	--	16.5	6.2 - 41.9	220	a	N	2, 6	
	7439-97-6	Mercury	0.022 B	0.049	mg/kg	WSW2	7 / 12	0.00002	0.049	0.08	0.058	b	N	2, 6	
	7440-02-0	Nickel	1.2 B	2.6 B	mg/kg	Bott	12 / 12	--	2.6	0.7 - 1.6	38	a	N	2, 7	
	7440-09-27	Potassium*	236 BE	371 BE	mg/kg	ESW1	12 / 12	--	371	94.4 - 267	NA	N	N	3, 5, 7	
	7782-49-2	Selenium	0.67	2.2	mg/kg	SSW3	12 / 12	--	2.2	0.39 - 4.3	0.52	a	Y	1, 6	
	7681-49-4	Sodium*	97 B	177 B	mg/kg	Bott	12 / 12	--	177	314 - 450	NA	N	N	3, 5, 6	
	7440-62-2	Vanadium	23.4	72	mg/kg	SSW3	12 / 12	--	72	6.3 - 17.2	8	a	Y	1, 7	
	7440-66-6	Zinc	2.8	10.25	mg/kg	Bott	12 / 12	--	10.25	7.3 - 32.9	46	a	N	2, 6	
	TCL Volatile Organic Compounds														
	67-64-1	Acetone	0.011 J	0.610 J	mg/kg	C2	12 / 12	--	0.61	N/A	2.5	c	N	2	
	75-09-2	Methylene chloride	0.0018 JB	0.0043 JB	mg/kg	Bott	9 / 12	0.310 - 0.430	0.0043	N/A	0.3	b	N	2	
	75-34-3	1,1-Dichloroethane	--	0.0031 J	mg/kg	Bott	1 / 12	0.310 - 0.430	0.0031	N/A	0.3	b	N	2	
	78-93-3	2-Butanone	0.010 J	0.016	mg/kg	SSW1	5 / 12	0.77 - 1.1	0.016	N/A	89.6	c	N	2	
	71-55-6	1,1,1-Trichloroethane	0.027	0.34 J	mg/kg	C2	2 / 12	0.0063 - 0.310	0.34	N/A	29.8	b	N	2	
	71-43-2	Benzene	0.0575 J	0.8	mg/kg	C2	2 / 12	0.0061 - 0.310	0.8	N/A	0.1	b	Y	1	
	108-88-3	Toluene	0.0015 J	0.280 J	mg/kg	C2	8 / 12	0.0061 - 0.310	0.28	N/A	0.1	b	Y	1	
	100-41-4	Ethylbenzene	0.0027 J	6.2	mg/kg	C2	10 / 12	0.0061 - 0.0063	6.2	N/A	0.1	b	Y	1	
	98-82-8	Isopropylbenzene	0.0088	2.2	mg/kg	C2	9 / 12	0.0062 - 0.0063	2.2	N/A	NA	c	Y	5	
	120-82-1	1,2,4-Trichlorobenzene	--	0.290 J	mg/kg	SSW2	1 / 12	0.0062 - 0.430	0.29	N/A	11.1	c	N	2	
	1330-20-7	Xylenes (total)	0.0017 J	15	mg/kg	C2	12 / 12	--	15	N/A	0.1	b	Y	1	
	108-87-2	Methylcyclohexane	0.0017 J	4.1	mg/kg	C2	8 / 12	0.0061 - 0.0063	4.1	N/A	NA	c	Y	5	
	TCL Polycyclic Aromatic Hydrocarbons														
	83-32-9	Acenaphthene	0.160 J	0.73	mg/kg	NSW1	7 / 12	0.210 - 1.5	0.73	N/A	29	a	N	2	
	86-73-7	Fluorene	0.190 J	1.4	mg/kg	NSW1	8 / 12	0.210 - 1.5	1.4	N/A	29	a	N	2	
	91-57-6	2-Methylnaphthalene	0.130 J	45	mg/kg	C2	12 / 12	0.21	45	N/A	29	a	Y	1	
	90-12-0	1-Methylnaphthalene	0.099 J	17	mg/kg	C2	11 / 12	0.21	17	N/A	29	a	N	2	
	91-20-3	Naphthalene	0.180 J	11	mg/kg	C2	9 / 12	0.21	11	N/A	29	a	N	2	
	85-01-8	Phenanthrene	0.110 J	6.2	mg/kg	C2	11 / 12	0.21	6.2	N/A	29	a	N	2	
	129-00-0	Pyrene	0.0955	0.120 J	mg/kg	NSW1	2 / 12	0.210 - 1.5	0.12	N/A	1.1	a	N	2	
Dioxin/Furans															
1746-01-6	2,3,7,8-TCDD TEQ**	0.00000215	0.00000451	mg/kg	A2	2 / 2	--	4.51E-07	N/A	4.50E-06	a	N	2		

Notes

COPEC = Chemical of Potential Ecological Concern
 *Chemical is an essential nutrient and was therefore categorically eliminated as a COPEC
 J = Estimated concentration
 B = Detected in associated QC blank
 E = High bias
 NA = Not available
 mg/kg - milligrams per kilogram

**The dioxin/furan data were reduced to 2,3,7,8-TCDD TEQ using the 2005 WHO TEF scheme for mammals (Van den Berg et al., 2006) and evaluated as 2,3,7,8-TCDD. While a 1998 WHO TEF scheme for birds also exists (Van den Berg et al., 1998), the ESV used in this SLERA for 2,3,7,8-TCDD is the USEPA EcoSSL for mammals.

(1) Background represents the range of detected metals concentrations in surface soil at Fort Lee, VA (Fluor Daniel, 1999)

(2) The following hierarchy of sources of Ecological Screening Values was used:

- a - USEPA (2009) Ecological Soil Screening Levels (EcoSSLs); the lowest available EcoSSL was used as the screening value.
- b - USEPA (1995) Region 3 BTAG Table for Soil
- c - USEPA (2003) Region 5 Ecological Screening Levels (ESL) for soil

Reason Codes:

- 1 = Maximum detected concentration exceeds Ecological Screening Value
- 2 = Maximum detected concentration does not exceed Ecological Screening Value
- 3 = Chemical is an essential nutrient
- 4 = Frequency of detection is less than 5%
- 5 = No Ecological Screening Value available

Additional Descriptive Codes:

- 6 = Maximum detected concentration is less than or within the range of detected background concentrations
- 7 = Maximum detected concentration is greater than detected background concentrations