FINAL

REMEDIAL INVESTIGATIONS AND REMEDIAL ACTIONS SUMMARY REPORT

U.S. EPA and GSA Area
(Area 1, Area 18A, Area 18B, Area 18C, Area 18E, Area 18F, and Area 18G)
Former Raritan Arsenal

FUDS Project Numbers C02NJ0084-15 and C02NJ0084-03

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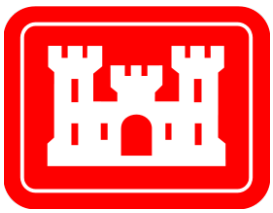

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ACRONYMS AND ABBREVIATIONS

ABS	dermal absorption factor
ABS_{GI}	fraction of contaminant absorbed in gastrointestinal tract
ADAF	Age-Dependent Adjustment Factor
ADD	average daily dose
AEHA	Army Environmental Hygiene Agency
AF	adherence factor
AOC	area of concern
ARAR	Applicable or Relevant and Appropriate Requirement
ASR	Archival Search Report
AST	above ground storage tank
AT	average time
AT_c	averaging time (cancer)
AT_{nc}	averaging time (noncancer)
ATSDR	Agency for Toxic Substances and Disease Registry
Avatar	Avatar Environmental, LLC
BERA	Baseline Ecological Risk Assessment
BTAG	Biological Technical Assistance Group
BTEX	benzene, toluene, ethylbenzene, xylene
bgs	below ground surface
BW	body weight
CA	Cost Analysis
CAH	chlorinated aliphatic hydrocarbons
CalEPA	California Environmental Protection Agency
CCA	chromate copper arsenate
CDI	chronic daily intake
CEA	Classification Exception Area
CEHNC	U.S. Army Engineering and Support Center, Huntsville, Alabama
CENAE	U.S. Army Corps of Engineers – New England District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm^2	squared centimeter
COC	contaminant of concern
COPC	contaminant of potential concern
COPEC	contaminant of potential ecological concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSF	cancer slope factor
CSF_o	oral cancer slope factor
CSF_d	dermal cancer slope factor
CSM	conceptual site model
CTE	central tendency exposure
CVOC	chlorinated volatile organic compound
cy	cubic yard
DCE	dichloroethylene

DDA	Drum Disposal Areas
DERP	Defense Environmental Restoration Program
DL	detection limit
DoD	Department of Defense
DSMOA	Defense Services Memorandum of Agreement
EA	exposure area
ED	exposure duration
EE/CA	Engineering Evaluation and Cost Analysis
EF	exposure frequency
EM	electromagnetic
EO	Executive Order
EODT	EOD Technology, Inc.
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERM	Ecological Risk Management
ET	exposure time
FOD	frequency of detection
ft	feet
ft^2	square feet
FI	fraction ingested
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FS	feasibility study
FUDS	Formerly Used Defense Sites
GPR	ground penetrating radar
GSA	General Services Administration
GWFS	Groundwater and Vapor Intrusion Feasibility Study
GWQS	Groundwater Quality Standards
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	hazard quotient
HTW	hazardous and/or toxic waste
HTRW	Hazardous Toxic Radioactive Waste
HQ	hazard quotient
IAQ	indoor air quality
IEUBK	Integrated Exposure Uptake Biokinetic
IGWSCC	Impact to Groundwater Soil Cleanup Criteria
IRIS	Integrated Risk Information System
IRS	soil ingestion rate
ISCO	in situ chemical oxidation
IT	International Technology Corporation
IUR	inhalation unit risk
kg	kilograms
kg/mg	kilograms per milligram
KM	Kaplan-Meier
LADD	limited average daily dose

Acronyms and Abbreviations, continued

LEAD	Letterkenny Army Depot
LOAEL	lowest observed adverse effect level
LOQ	limit of quantitation
m^3/kg	cubic meters per kilogram
MAG	magnetometer
MCC	Middlesex County College
MCL	Maximum Contaminant Level
MEC	munitions and explosives of concern
mg	milligram
mg/cm^2	milligrams per squared centimeter
mg/kg	milligram per kilogram
mg/m^3	milligrams per cubic meter
MMRP	Military Munitions Response Program
MNA	monitored natural attenuation
MRL	Minimal Risk Level
MTBE	methyl tert-butyl ether
MW	monitoring well
NCP	National Contingency Plan
ND	not detected
NFA	no further action
NHL	non-Hodgkin lymphoma
NJDEP	New Jersey Department of Environmental Protection
NOAEL	no observed adverse effect level
NPL	National Priorities List
NRDCSCC	Non-Residential Direct Contact Soil Cleanup Criteria
NTCRA	Non-time Critical Removal Action
NUS	Nuclear Utility Services Corporation
OBG	O'Brien & Gere
OE	ordnance and explosives
OEW	ordnance explosive waste
ORNL	Oak Ridge National Laboratory
OVM	organic vapor meter
PAHs	polycyclic aromatic hydrocarbons
PBT	persistent, bioaccumulative and toxic chemicals
PCBs	polychlorinated biphenyls
PCE	tetrachloroethylene
PCP	pentachlorophenol
PEF	particulate emission factor
PID	photoionization detector
POP	persistent organic pollutants
PPRTVs	Provisional Peer Review Toxicity Values
PRG	preliminary remediation goal
PRP	potentially responsible party
QA/QC	Quality Assurance/Quality Control
RA	remedial action

Acronyms and Abbreviations, continued

RAGS	Risk Assessment Guidance for Superfund
RAWP	Remedial Action Work Plan
RAO	removal action objective
RBA	relative bioavailability
RDCSCC	Residential Direct Contact Soil Cleanup Criteria
RfC	reference concentration
RfD	reference dose
RfD_o	oral reference dose
RfD_d	dermal reference dose
RI	Remedial Investigation
RMD	Remedial Management Decision
RME	reasonable maximum exposure
RSL	Regional Screening Level
SA	exposed skin surface area
SARA	Superfund Amendments and Reauthorization Act
SCC	soil cleanup criteria
SEL	severe effect level
SLERA	screening level ecological risk assessment
Shaw	Shaw Environmental, Inc
SOD	soil oxidant demand
SRS	soil remediation standard
SVOC	semivolatile organic compound
TAGA	Trace Atmospheric Gas Analyzer
TCE	trichloroethylene
TCL	target compound list
TCLP	toxicity characteristic leachate procedure
TEC	Threshold Effect Concentrations
TEP	Thomas Edison Park
THQ	target hazard quotient
TIC	tentatively identified compound
TNT	2,4,6-trinitrotoluene
TPH	total petroleum hydrocarbons
TR	target risk
UCL	upper-confidence limit
UE	unrestricted exposure
USACE	U.S. Army Corps of Engineers
USC	United States Code
UST	underground storage tank
UU	unrestricted use
UXO	unexploded ordnance
VC	vinyl chloride
VF	volatilization factor
VI	vapor intrusion
VOC	volatile organic compound
Weston	Weston Solutions, Inc.

WRA	well restriction area
WWI	World War I
WWII	World War II
XRF	x-ray fluorescence

EXECUTIVE SUMMARY

Avatar Environmental, LLC (Avatar) has prepared this *Remedial Investigations and Remedial Actions Summary Report for the U.S. Environmental Protection Agency/General Services Administration Area*, referred to as the EPA/GSA Area, at the former Raritan Arsenal (FUDS Project Number C02NJ0084-15) located in Edison, New Jersey. The former Raritan Arsenal has been divided into several Remedial Investigation (RI) Areas based on a combination of property ownership, land use, and historical Investigation Area boundaries. An additional project is being evaluated for site-wide groundwater contamination and potential vapor intrusion. This Report is specific to the EPA/GSA Area and presents the following information:

- Summaries of the previous RIs and interim response actions that have occurred at the EPA/GSA Area during the over 20-year investigation history of the site;
- An update of the human health risk assessment (HHRA) that was previously performed for the EPA/GSA Area (Watermark, 2009); and
- A summary of the analytical data of the affected media associated with the EPA/GSA Area and comparisons with Federal and State of New Jersey criteria for restricted and unrestricted land uses to determine the nature and extent of the contamination.

The USACE's Formerly Used Defense Site (FUDS) program conducts response activities at FUDS, such as the former Raritan Arsenal, in accordance with the Defense Environmental Restoration Program (DERP) statute (10 U.S. Code [USC] § 2701 et seq.), the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (42 USC § 9620 et seq.), Executive Orders (EOs) 12580 and 13016, and the National Oil and Hazardous Substances Pollution Contingency Plan, more commonly known as the National Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] Part 300). This *Remedial Investigations and Remedial Actions Summary Report* and the attendant risk assessments are in compliance with CERCLA and the NCP.

The following Investigation Areas are located within the EPA/GSA Area and are the focus of this report:

- Area 1 – Former Demolition Area;

- Area 18A – Former GSA/U.S. Army Pond Area;
- Area 18B – Former Firing Range;
- Area 18C – Former Landfill, Disposal, and Vehicle Processing Area;
- Area 18E – Former Maintenance Area;
- Area 18F – Former Warehouses; and
- Area 18G – Former Dump.

Investigations commenced in the early 1960s and continue to the present and have included:

- Archival searches based on historical operations to identify areas of potential contamination including munitions and explosives of concern (MEC);
- Geophysical and MEC surveys to search for subsurface anomalies that could in include historical disposal areas or buried MEC;
- Soil and groundwater investigations that delineated and characterized the levels of contamination throughout the EPA/GSA Area;
- UST removals;
- Response actions performed at Areas 18A, 18B, 18C (Building 256, Drum Disposal Areas 1 through 4), 18E, 18F, and 18G;
  - Area 18A: 1992 and 1998 soil removals
  - Area 18B: 2002 soil removals for lead and 2002 removal at Firing Range Backstop Area of ammunition debris consisting of expended bullets embedded in the backstop
  - Area 18C: UST removals, asbestos stabilization, 1998 and 2002 soil removals
  - Area18E: 2011 soil removals
  - Area 18F: none
  - Area 18G: UST removals
- Capping/covering of the asbestos landfill in Area 18C;
- Ongoing monitoring of the AOC 2, 4 and 8 groundwater plumes;

- A baseline HHRA that evaluated the degree of soil exposure within the EPA/GSA Area using health-protective assumptions on the current and future uses of the area; and

- A screening level and baseline ecological risk assessment (SLERA/BERA) that evaluated the potential exposure of ecological receptors to COPECs in specific habitat types including freshwater drainages, developed land, disturbed fields, and forested uplands. The consequent risk of that exposure was evaluated for a variety of aquatic and terrestrial receptors.

Hazardous and Toxic Waste Conclusions

The historical RIs and the current RI and HHRA evaluated all identified potential hazardous and toxic waste (HTW) contamination associated with the EPA/GSA Area and, in certain cases, resulted in the large-scale response actions of impacted soils.

As described in Section 4 (Nature and Extent of Contamination), the available soil and sediment data were compared against restricted and unrestricted use screening criteria from EPA and NJDEP. The results of the soil comparisons indicate that the residual contamination is isolated to a few areas that are a result of non-DoD sources. Further, when viewed from an area-wide perspective, the average soil concentrations are not a concern for any future use of the EPA/GSA Area. It is clear that contamination in the Area 18B Stream is present as demonstrated by the results of 2013 sediment sampling event (Avatar, 2013). However, as comprehensively described throughout this report, the sediment levels are the result of upgradient, non-DoD sources.

The CERCLA-compliant, site-specific baseline HHRA that was conducted resulted in unacceptable risk from hypothetical future resident exposure to soil/sediment; however, the total risks for this hypothetical exposure are driven primarily by PAHs from locations that USACE believes are not attributable to historical Army releases. When these non-Army sources are accounted for, the calculated risk levels based on exposure to DoD-related contamination are acceptable for unrestricted land use. USACE does not utilize state-promulgated remediation standards as a trigger to take an action. Rather, USACE uses a CERCLA-compliant HHRA, as was done for the EPA/GSA Area, to determine if there is risk to support the need for any remedial action.

For the majority of the evaluated ecological endpoints, there is little evidence of the potential for ecological risk as a result of historical DoD operations within the EPA/GSA Area. While concentrations of PAHs are present in the Area 18B Stream above ecological screening levels, the PAH levels are the result of upgradient drainage features and not DoD use of the former Raritan Arsenal.

No Further Action is required on behalf of USACE for the soil and sediment associated with the EPA/GSA Area.

Groundwater AOCs 2 and 8 both of which originate on the EPA/GSA Area are being addressed as a separate project for site wide groundwater and vapor intrusion.

MEC Conclusions

A number of geophysical and MEC surveys have been performed within the EPA/GSA Area with no MEC discoveries. Table ES-1 presents the investigations that have occurred to search for MEC at each Investigation Area. Based on the historical uses of the Investigation Areas, the EPA/GSA Area has only one area with a history of potential MEC (Investigation Area 1). Investigation Area 1 is a 0.57 acre (shown on Figure 2-1) that was defined based on the presence of a ground scar observed in a 1939 aerial photo and was interpreted as a former demolition area (Weston, 1996a). Investigation Area 1 has a reported history of destruction of adapter boosters, point and base detonating fuses, and 37 mm to 6-inch gun projectiles. Investigations were conducted at Investigation Area 1 in 1988 and 1992 that included both MEC surveys and intrusive investigations of anomalies using a shovel and backhoe. No MEC items were found. More recently, a supplemental records review for Investigation Area 1 was performed (CH2M HILL, 2013). It was concluded that no additional MEC investigation is warranted. MEC has not been identified in the surface or subsurface during previous inspections and investigations and is not a concern at Investigation Area 1.

Other areas were also investigated for MEC as shown on Table ES-1. A removal action completed in 2002 removed small arms ammunition debris consisting of expended bullets embedded in the

backstop of a small arms range target berm. The only additional munition related items found were incidental discoveries documented as: one 57-mm projectile (inert) and one empty machine shell.

The 57-mm projectile was recovered from Investigation Area 18E sometime between 1991 and 1994. The exact location of this discovery could not be determined. No other items were ever discovered within Investigation Area 18E even during MEC surveys, building demolition activities, and a large scale soil removal. This 57-mm projectile finding is considered to be an anomaly. One machine gun shell was discovered on the ground surface adjacent to the former rail bed in Investigation Area 18G. This is also considered an anomalous finding as there were no other items discovered and the historical use of the area does not involve ordnance or munitions.

The items found (expended bullets, inert projectile, and empty machine gun shell) are considered munition debris (MD) and not MEC. The lack of MEC finds even after all of the investigatory work is supported by the general historical use of the areas. Based on this information, USACE believes there are no remaining MEC issues associated with the EPA/GSA Area that require additional investigations or evaluation. Furthermore, the USACE recommends No Further Action for MEC within the EPA/GSA Area.

1. INTRODUCTION AND OBJECTIVES

Avatar Environmental, LLC (Avatar) has prepared this *Remedial Investigations and Remedial Actions Summary Report for the U.S. Environmental Protection Agency/General Services Administration Property Area*, referred to as the EPA/GSA Area, at the former Raritan Arsenal (FUDS Project Number C02NJ0084-15) located in Edison, New Jersey. For investigation purposes, the former Raritan Arsenal has been divided into several Remedial Investigation (RI) Areas based on a combination of property ownership, land use, and boundaries of historical Investigation Areas with another project for site-wide groundwater and vapor intrusion issues. The RI Areas are presented in Table 1-1. Other areas associated with the former Raritan Arsenal are presented on Table 1-2. The areas are subject to change as the remedial investigation process evolves for each area.

Groundwater and vapor intrusion (including indoor air quality) associated with the EPA/GSA Area and the entire former Raritan Arsenal is being addressed under a separate project. The groundwater and vapor intrusion project is currently in the Feasibility Study (FS) phase, which is being developed under a separate deliverable and contract.

The USACE's Formerly Used Defense Site (FUDS) program conducts response activities at FUDS, such as the former Raritan Arsenal, in accordance with the Defense Environmental Restoration Program (DERP) statute (10 U.S. Code [USC] § 2701 et seq.), the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (42 USC § 9620 et seq.), Executive Orders (EOs) 12580 and 13016, and the National Oil and Hazardous Substances Pollution Contingency Plan, more commonly known as the National Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] Part 300). This *Remedial Investigations and Remedial Actions Summary Report* and the attendant risk assessments are in compliance with CERCLA and the NCP.

This report summarizes the previous investigations including RIs and removal actions that have been conducted at the EPA/GSA Area. It also presents the nature and extent of the analytical data associated with these investigations, and updates the human health risk assessment (HHRA) and ecological risk evaluations that were previously prepared for the EPA/GSA Area. This report was

prepared for the USACE New York and New England Districts under USACE Contract W912WJ-11-D-0002, Delivery Order 0001.

This Report presents the following information:

1. Summaries of the previous investigations and interim response actions that have occurred at the EPA/GSA Area during the over 20-year investigation history of the site;

2. A summary of the analytical data of the affected media associated with the EPA/GSA Area and comparisons with Federal and NJDEP criteria for restricted and unrestricted land uses;

3. An update of the HHRA and ecological evaluations that were previously prepared for the EPA/GSA Area; and

4. Conclusions that discuss the significance and potential uncertainties of the findings of remedial investigations as well as suggested options to reduce the associated uncertainties, where applicable.

The previous investigations were funded and directed by USACE and documented in technical reports prepared by several consultants during the Phase I, Phase II, and Supplemental Phase II Remedial Investigations (RIs) and Remedial Action (RA) Reports. Human health and ecological risk assessments have also been performed at the Site. Under contract to Watermark Environmental, Inc., Avatar conducted a HHRA (Watermark, 2009). An updated HHRA is included in this report due to new or updated toxicity values from the United States Environmental Protection Agency (EPA), an updated protocol from EPA for calculating cancer risks for constituents (e.g., polycyclic aromatic hydrocarbons) that exhibit carcinogenicity through a mutagenic mode of action, a completed interim response action at Investigation Area 18E that resulted in the removal of contaminated soil, and the inclusion of recently collected soil and sediment data from Investigation Areas 18A and Area 18B Stream. Weston Solutions, Inc. (Weston) performed a Screening Level Ecological Risk Assessment (SLERA) and a Baseline Ecological Risk Assessment (BERA) (Weston, 2004a and 2008a, respectively). The risk assessments were performed to provide the USACE the information necessary for making risk management decisions for the EPA/GSA Area. The reports associated with the previous investigations performed at the EPA/GSA Area are included on a CD in Appendix A and listed in the References Section (Section 8).

1.1 REGULATORY REQUIREMENTS AND AGENCY COORDINATION

Activities at the former Raritan Arsenal site are being administered by the USACE under the Defense Environmental Restoration Program/Formerly Used Defense Sites (DERP/FUDS) program. The Army is the executive agent on behalf of the Department of Defense (DoD) charged with meeting all applicable environmental restoration requirements at FUDS, regardless of which DoD component previously owned or used the property. The Secretary of the Army further delegated the program management and execution responsibility for FUDS to the USACE.

In carrying out its responsibilities, USACE must comply with the DERP statute (10 USC 2701 et seq.), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, 42 USC § 9601 *et seq.*), Executive Orders (EOs) 12580 and 13016, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and all applicable DoD (e.g., DoD Management Guidance for the DERP) and Army policies in managing and executing the FUDS program.

For FUDS properties not included on the National Priorities List (NPL), the DERP statute requires that response actions addressing DoD hazardous substances, pollutants, and contaminants be conducted in accordance with CERCLA. In all other cases, CERCLA is DoD's preferred framework for environmental restoration. States or tribes are generally the lead regulators for environmental investigations and responses at non-NPL FUDS. DoD maintains lead agency authority at non-NPL FUDS, coordinates project activities with the lead regulatory agency, and provides notice and opportunity for comment to the appropriate state, tribal, and local authorities.

The former Raritan Arsenal property was identified as eligible for action under the FUDS program. The property is not on the NPL. Therefore, the New Jersey Department of Environmental Protection (NJDEP) is the lead regulatory agency. Under the DERP-FUDS program, only known or potential contamination or hazards on the former Raritan Arsenal attributable to former DoD activities (prior to October 17, 1986) can be addressed.

1.2 FORMER RARITAN ARSENAL BACKGROUND AND SETTING

The former Raritan Arsenal is located in Edison and Woodbridge Townships, Middlesex County, New Jersey. The site is bordered to the north and northwest by Woodbridge Avenue, to the

southwest by Mill Road and the Industrial Land Reclamation Landfill, and to the south and east by the Raritan River (Figure 1-1).

Prior to construction of the Raritan Arsenal, the area consisted of tidal marsh, clay and sand pit quarries, and farmland with several residences. The former Raritan Arsenal was used by the U.S. Army from 1917 to 1963. Operations at the site included the receipt, storage, shipment, and decommissioning of ordnance, arms, and machinery. During this period, some waste material, including ordnance and chemical agents, were reportedly buried on site. It has also been reported that explosive materials were routinely destroyed by surface burning or burning in chambers or pits. Accidental explosions in magazine buildings and outdoor storage areas reportedly scattered materials over large areas, and drove ordnance fragments into the ground.

Site operations were phased out between 1961 and 1963. In 1964, the U.S. government sold 2,000 acres of the former Raritan Arsenal to the Visceglia family which formed the Federal Storage Warehouses Company. In 1975, Federal Storage Warehouses split into two companies (Federal Business Centers and Summit Associates, Inc.) and built the Raritan Center, a major commercial and industrial complex.

The U.S. government also sold a parcel of land, located in the western part of the site, to Middlesex County. The county developed the area into Thomas Edison Park (TEP) and Middlesex County College (MCC). Another section of U.S. government property bordering Woodbridge Avenue is managed by General Services Administration (GSA) and occupied by the EPA, which maintains office, warehouse, and laboratory space on site (Figure 1-2).

The southern half of the site has remained primarily a wetland area with limited development since the closing of the Raritan Arsenal in 1963. The Industrial Land Reclamation Landfill, which operated in the 1970s and was closed by court order in 1985, is located adjacent to the southwest border of the former Raritan Arsenal. A more detailed description of the site history can be found in the *Management Action Plan for the Former Raritan Arsenal* (Weston, 2007).

1.3 AREA OF FOCUS – U.S. EPA AND GSA PROPERTY AREA

The focus of this Report is the area owned and managed by the EPA Region 2 and GSA in the northern portion of the former Raritan Arsenal. The EPA and various contractors maintain office and general operations space within this area. The EPA Region 2 Laboratory, Emergency Response Team, Research and Development staff, and Removal and Emergency Response staff occupy this area. There are also unused buildings and a wooded area in the southern portion of the area.

Given the overall size of the EPA/GSA Area, it was necessary to prioritize the investigations to areas where known or suspected DoD activities could have resulted in impacts to soil and groundwater. Impacts in this context could include the release of hazardous and/or toxic waste (HTW) and MEC. The areas selected for investigation were identified during closure activities as well as searches of various archives.

1.3.1 U.S. EPA and GSA Property Area Site History

This section briefly describes the DoD-related activities that occurred at the EPA/GSA Area since the creation of the Raritan Arsenal. Much of the information presented in the following subsections was obtained from an Archival Search Report (ASR) and the accompanying Map Annex that was produced for the former Raritan Arsenal (Dames and Moore, 1993a).

1.3.2 Review of Site Plans

A 1918 site plan (Dames and Moore, 1993a) indicated that the northern portion of the EPA/GSA Area contained a number of buildings, some of which are present today. The majority of the buildings were in Investigation Area 18F. Approximately five rail lines that terminated at some of the buildings in Investigation Area 18F were also depicted on the 1918 site plan. The building area was identified as “Motor Assembly” on the 1918 site plan. There was a fire station, a boiler house, and various other structures that were not labeled located within Investigation Area 18G. There were two structures in Investigation Area 18E with rail lines terminating next to each building.

Between 1918 and 1925, miscellaneous, un-labeled buildings were constructed in Investigation Area 18E, minor roadways were added, and a rail spur was run to the boiler house in Investigation Area 18G that was identified on the 1918 site plan. A cluster of what appeared to be various structures including the firehouse, located in Investigation Area 18G adjacent to the rail line, were removed between 1918 and 1925. In addition, one of the rail lines running to Investigation Area 18F was removed between 1918 and 1925. There were few buildings constructed within the EPA/GSA Area between 1925 and 1934.

The period between 1934 and 1943 saw the construction of multiple buildings in Investigation Area 18D. Loading docks appear to have been added between 1934 and 1943 to the existing buildings in Investigation Area 18F. Additional buildings were also added in Investigation Area 18G. New rail spurs were run to the new buildings in Investigation Area 18D and to some of the existing buildings in Investigation Area 18F. Additional roads were added between 1934 and 1943. Buildings in Investigation Area 18E associated with the "Shop" area were removed between 1934 and 1943.

One building was added in Investigation Area 18G between 1943 and 1949. It appears that buildings were added and removed in Investigation Area 18E between 1943 and 1949. Two small, unknown structures are observed in Investigation Area 18B during this same time period.

Buildings 245 and 246 were constructed in Investigation Area 18D between 1949 and 1963. A rail spur was run between Buildings 245 and 246. These buildings were nearly being demolished as of January 2015. Buildings 255 and 256 were constructed in Investigation Area 18C during the same time period. Building 255 and 256 were demolished in August 2014. Only the slab foundations remain.

1.3.3 Summary of Archival Search Report Findings

Suspicion of MEC began at the time of the former Raritan Arsenal's closing. The first investigation performed at the former Raritan Arsenal was a report prepared in 1963 by the Letterkenny Army Depot (LEAD) that discussed the results of a decontamination (explosive residue only) effort performed by the Army during the closure of the former Raritan Arsenal

(LEAD, 1963). Seventeen soil Investigation Areas were identified by LEAD between 1961 and 1963 during closure activities. The LEAD Report identified one MEC suspect area at the EPA/GSA Area: Investigation Area 1 (referred to as the Former Demolition Area).

The purpose of the Dames and Moore ASR (1993a) was to identify historical land uses and to find locations where disposal of ordnance and explosive waste, hazardous, toxic, and radiological waste, and chemical agents could have occurred on the land area that was a part of the former Raritan Arsenal during its history. The following subsections present the areas of concern identified in the ASR.

1.3.3.1 Investigation Area 1

Investigation Area 1 was not specifically identified as a post-World War I demolition ground in the documents reviewed. The aerial photographs show nothing unusual in the boundary defining Area 1. However, the circa 1930 aerial photographs show two possible burning ground locations: one about 100 yards west and one about 200 yards east, both of which lie within Investigation Area 18B. These appear as clearings and scarred areas in later photographs, and activities continued into later years at the site to the east. In 1963, Area 1 was surface searched for ordnance as part of the LEAD decontamination operation. There is no record of any discovered ordnance. In 1988, UXB International conducted another search for ordnance. No ordnance was found. MEC surveys were also conducted. They revealed no anomalies that could be interpreted as buried ordnance.

1.3.3.2 Trench South of Casad Road and Nearby Former Dump (Part of Investigation Areas 18D and 18G)

The area was first discovered during the summer of 1990 when ground subsidence exposed buried artillery casings, which appeared to have been stacked in a trench. The trench was located in Investigation Area 18D, south of Casad Road and west of Meadow Road (see Figure 2-1). A former dump, located nearby, was identified through an accident report of a fire at a dump. This dump, used by Columbia Salvage Company in the early years of the former Raritan Arsenal, was located north of and across Casad Road from the trench and is part of both Investigation Areas 18D and 18G. Investigation Area 18D is being evaluated as a separate RI Area and is being addressed under

a separate USACE task order contract. Its site history is included for comprehensiveness and because it could potentially affect other Investigation Areas that are being evaluated in this Report such as 18G.

Dames and Moore, in their ASR (1993a), report that the trench was viewed by Metcalf & Eddy personnel in 1991, finding it to be about 150 feet long and stacked about 8 feet high with artillery casings and projectiles. Most of the projectiles and casings appeared to be 37-mm and 110-mm. The Engineering Evaluation/Cost Analysis (EE/CA) (FWENC, 2000) reports that the trench was approximately 150 feet long and contained 33,673 MEC items and/or munitions debris (MD), including 20-mm to 105-mm cartridge casings and 23-mm to 57-mm filled projectiles. Demilitarization was required for 10,773 of the items. Visual surface checks and visual and magnetometer subsurface checks of five percent of the remediated area yielded negative results. An additional magnetometer survey of 10,000 square feet performed by EODT in 1993 yielded 64 anomalies. MEC were not located upon further investigation of 19 of the anomalies. Additional site walks and exploratory digs in the vicinity of the trench did not result in any additional MEC discoveries.

1.3.3.3 Former Firing Range (Part of Investigation Area 18B)

The former firing range was located between Building 246 and the Conrail-Lehigh Valley Railroad. Several discoveries of pieces of old rifles and guns have been reported by employees of Federal Business Centers and Middlesex County College. Nuclear Utility Services Corporation (NUS) collected soil samples from this area in 1985 during the Site Investigation (NUS, 1985) and in 1990 during the Listing Site Inspection (NUS, 1990), but no significant contamination was detected.

1.3.3.4 Parcel 5 (Investigation Area 18C)

This marshy area located in the southeastern corner of the EPA/GSA Area is reported to have stored 55-gallon drums of unknown origin and contents. No known ordnance discoveries have been made at this location. In 1992, the EPA performed an investigation to assess whether contamination from these drums was affecting a nearby daycare center. Nine surface soil samples

were collected from the eastern boundary of Parcel 5. The results of these samples revealed no contamination. In 1985, NUS collected several samples from what Metcalf & Eddy (1991) later identified as Parcel 5. Two of these samples contained elevated lead concentrations. In addition, one of these samples contained elevated arsenic. In 1990, NUS collected an additional 15 samples from a 40- by 40-foot area within Parcel 5. Based on analysis by x-ray fluorescence (XRF) performed in the field, eight samples were reported to contain elevated lead and arsenic.

1.3.3.5 Tar Pit (Investigation Area 18A)

A "tar" pit or pond was located immediately southeast of Avenue D. Metcalf & Eddy observed that it contained several barrels full of a tar-like substance (Metcalf & Eddy, 1991). The pit does not appear on aerial photographs until 1954. Apparently, it was a disposal site for waste solvents, degreasers, and Cosmoline – a heavy, Vaseline-like grease used to coat stored weapons. A surface water sample from the pit collected in 1985 by NUS contained high levels of several volatile organic compounds (VOCs). In 1990, NUS installed two monitoring wells near the tar pit (one downgradient and one cross-gradient, to the south). Groundwater samples were collected from these wells, and surface water and sediment samples were collected from the pond. One VOC was detected in the downgradient well. No contamination was detected in the cross-gradient well. A single surface water sample was collected that contained elevated VOCs.

1.3.4 Investigation Areas Evaluated in this Report

Based on what is known about the historical uses of the EPA/GSA Area, the Investigation Areas listed below are the focus of this report:

- Area 1 – Former Demolition Area;
- Area 18A – Former GSA/U.S. Army Pond Area;
- Area 18B – Former Firing Range;
- Area 18C – Former Landfill, Disposal, and Vehicle Processing Area;
- Area 18E – Former Maintenance Area;
- Area 18F – Former Warehouses; and

- Area 18G – Former Dump.

A significant portion of Investigation Area 18D is within the EPA/GSA Area. However, based on ongoing concerns at Investigation Area 18D associated with MEC, a separate RI report specifically for Investigation Area 18D is being developed under a separate USACE task order contract.

In addition to the Investigation Areas listed above, there are groundwater plumes associated with the EPA/GSA Area: Groundwater AOCs 2, 4, and 8. The groundwater is being evaluated as a separate project. The issues related to the groundwater plumes, including the vapor intrusion pathway and indoor air quality (IAQ), are generally discussed in this report for completeness only.

The previous investigations and interim response actions that have occurred at the EPA/GSA Investigation Areas listed above are summarized in Section 2. The reader is referred to Appendix A to review the full documents. The list that follows presents the investigation and interim response action reports that have been produced for the EPA/GSA Area in chronological order:

- *Decontamination of the Ammunition Area at Raritan Arsenal* (LEAD, 1963);
- *Final Draft Site Inspection Report and Hazard Ranking System Model* (NUS, 1985);
- *Final Engineering Report, Contamination Evaluation* (O'Brien & Gere [OBG], 1989);
- *Listing Site Inspection* (NUS, 1990);
- *Archives Search Report for Middlesex County College and Thomas Edison Park,* (Metcalf and Eddy, 1991);
- Ordnance and explosive wastes location and removal (International Technology Corporation [IT], 1992);
- UXO Remediation Support Services (EOD Technology, Inc. [EODT], 1992);
- *Archival Search Report* (Dames and Moore, 1993a);
- *Phase I Remedial Investigation of Selected Areas* (Dames and Moore, 1993b);
- *Final Report for the Geophysical Mapping and Sampling of Areas 2, 3, 4, 6, 8, 9, 10, 11, 13, 14, 15, 16, 16A, 18B, 18C, 18D, 19, and MCC* (EODT, 1993);
- *Remediation of Area 18A Pond, Area 18B, Area 18C* (IT, 1993);

- *Final Report of Investigation, Area 1 Investigation* (Weston, 1996a);
- *Final Report of Investigation, Area 18A Investigation* (Weston, 1996b);
- *Geophysical Investigation Report, Area 18C Investigation* (Weston, 1996c);
- *Phase II Supplemental Record Review/Site Inspection Report* (Weston, 1997);
- *Supplemental Investigation, Areas 2, 3, 7, 9, 11, 16, 18A, 19, Inland Container, and W* (Weston, 1999a);
- *Final Supplemental Report of Investigation, Areas 18B, 18C, 18D, 18F, and 18G Investigations* (Weston, 1999b);
- *Engineering Evaluation/Cost Analysis, Former Raritan Arsenal* (FWENC, 2000);
- *Supplement 2 Phase II Remedial Investigation Report* (Weston, 2000);
- *Remedial Action Report, Remedial Construction – Areas 11, 12, 18A, 18C, and W* (Weston, 2002);
- *Final Groundwater Natural Attenuation Report* (Weston, 2003);
- *Final Screening-Level Ecological Risk Assessment, Former Raritan Arsenal* (Weston, 2004a);
- *Remedial Action Report, Remedial Construction – Areas 12, 18B, 18C, and Building 256* (Weston, 2004b);
- *Supplemental Remedial Investigation Report, Area 18C – Ramp Area and Buildings 151/165* (Weston, 2005a);
- *Groundwater AOC 8, EPA Buildings Investigation* (Weston, 2005b);
- *Final Supplemental Groundwater Data Report, Groundwater AOCs 2, 3, 4, 6, 7, 8, and 10* (Weston, 2006);
- *Management Action Plan for the Former Raritan Arsenal* (Weston, 2007);
- *Final Baseline Ecological Risk Assessment, Former Raritan Arsenal* (Weston, 2008a);
- *Human Health Risk Assessment, Former Raritan Arsenal* (Watermark, 2009);
- *Final Remedial Action Report, Building 165 and Area 18C Groundwater Treatment Pilot Systems* (Shaw Environmental, Inc. [Shaw], 2010);
- *Final Supplemental Remedial Investigation Report, Area 18E* (Weston, 2011);

- *Engineering Evaluation/Cost Analysis for Area 18E Removal Actions* (H&S Environmental, 2011);
- *Final Removal Action Completion Report, Area 18E Removal Action* (H&S, 2013);
- *2013 Supplemental Sampling at Investigation Area 18A and Area 18B Stream* (Avatar, 2013);
- Final Ecological Risk Management Report (Weston, 2013);
- *Draft Final Groundwater and Vapor Intrusion Feasibility Study* (Weston, 2015); and
- Various Indoor Air Quality Reports (most recent is the *Indoor Air Quality Report #10*, [Avatar, 2015]).

2. SUMMARY OF PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS

This section summarizes the previous investigations and interim response actions that have taken place at the Investigation Areas within the EPA/GSA Area. The intent of this section is to present and discuss all previous environmental investigations that have occurred within the EPA/GSA Area in general terms to provide the reader a sense of the amount of work that has taken place since the mid-1980s. Results from samples collected during the previous investigations were compared against New Jersey criteria that were current at the time of the investigation. The results of the comparisons with the New Jersey criteria were used to determine nature and extent of contamination, and guide additional sample collection and, in some cases, interim removal actions. This current RI Report for the EPA/GSA Area is following the CERCLA process as stated in Section 1.1.

Table 2-1 presents a general summary of the investigations and removal actions that have occurred at each Investigation Area. Figure 2-1 presents the locations of the Investigation Areas, soil and sediment sampling locations, locations of groundwater monitoring wells, and boundaries of the groundwater plumes.

2.1 AREA 1 – FORMER DEMOLITION AREA

Area 1 is a 0.57-acre site that was used as a former demolition ground after World War I (WWI) and into the early 1930s for the destruction of adapter boosters, point and base detonating fuses, and 37 mm to 6-inch gun projectiles. Sections 2.1.1 through 2.1.7 list all investigations associated with Area 1 in chronological order.

2.1.1 LEAD Report

In the early 1960s, a surface search as part of a decontamination operation of the former Raritan Arsenal was conducted. There is no record of any discovered ordnance. It was recommended that the use of Area 1 be limited to surface use only (LEAD, 1963).

2.1.2 Contamination Evaluation

The objective of the evaluation was to perform field investigations and to make a preliminary determination of whether chemical and/or ordnance contamination, which may have been caused by DoD related activities, were present at Area 1 (OBG, 1989). The potential hazards identified by OBG at Area 1 included surficial and subsurface MEC as well as potential contamination from VOCs and heavy metals.

Area 1 was first searched by UXB International (under contract to OBG) during the initial site inspection in January 1988. A brief visual inspection revealed no apparent ordnance on the ground surface. Checks with the ordnance locator instrument (reported to be a MK 26 Ferrous Ordnance Locator) identified numerous small ferrous objects 0.5 to 1 foot below ground surface (bgs). Hand excavation of several locations revealed pieces of wire and steel reinforcing bars and half of a small can. MEC was not found.

A second ordnance search of the area was conducted in June 1988 prior to site clearing and the MEC (geophysical) survey. The search focused along each of the proposed MEC survey lines. Visual inspection revealed no ordnance on the surface. Ordnance locators identified eight metal objects below grade. Each item was excavated. None of the excavated items were MEC.

Magnetometer (MAG) and ground penetrating radar (GPR) surveys were conducted in September and October 1988. The surveys were completed on a 25-ft square grid over a 200-ft square area. The grid was established such that the stream which bisects the site did not interfere with data collection. The MAG survey showed no magnetic anomalies that could be associated with subsurface objects. The GPR survey identified no detectable subsurface anomalies which indicated buried objects or evidence of previous excavations.

OBG drilled three soil borings in Area 1. Soil samples were collected from each soil boring and submitted for laboratory analysis. Four monitoring wells (MWs) (MW-7, MW-8, MW-9, and MW-31) were installed in Area 1 by OBG. Samples were collected from each of the wells installed by OBG. The MWs were installed to address the northern section of Area 1. Possible contamination in the southern section was not addressed.

Soil samples were analyzed for VOCs, explosives, and metals. Groundwater samples were analyzed for VOCs, total petroleum hydrocarbons (TPH), explosives, and metals. Soil sample results showed that metals were detected in shallow and deep soil. Explosives were not detected (ND) in soil. VOCs were not detected in the shallow soil but were found at low concentrations in the deeper soil samples. VOCs and metals were detected in the groundwater samples. Explosives were not detected in groundwater samples.

2.1.3 MEC Investigation

Another ordnance investigation was performed at Area 1 by IT (1992) as a result of the LEAD and Contamination Evaluation investigations. The entire area was surveyed with a GA-52B magnetometer. Hits were marked with red flagging and excavated using a shovel and/or backhoe. Only metallic scraps were found. No MEC related items were found.

2.1.3.1 Engineering Evaluation/Cost Analysis

No MEC was discovered, despite two separate MEC investigations that included both visual inspections and MEC (i.e., geophysical) surveys of the entire area. The density of ordnance and explosives (OE) was determined to be minimal at all depths in this area. Investigation Area 1 is presently unused, and the EPA, who currently owns the land, has no formal plans for future use of the area. Given the current use (or non-use) and control by a federal agency, combined with the restricted access and the negative results of all MEC investigations to date, the risk of OE exposure in this area for current use was considered to be low.

2.1.4 Archival Search Report

Dames and Moore (1993a) conducted an archival search of the former Raritan Arsenal. The ASR indicated that the Area 1 was used as a demolition ground after World War I until the early 1930s. Ammunition destroyed included adapter boosters, fuzes, and projectiles.

2.1.5 Phase I Remedial Investigation

The objective of the Phase I RI was to begin the assessment of the presence and extent of soil and groundwater contamination attributable to operations and activities historically conducted at the former Raritan Arsenal (Dames and Moore, 1993b).

Groundwater samples were collected from the MWs installed during the Contamination Evaluation (MW-7, MW-8, MW-9, and MW-31). These samples were analyzed for VOCs, base/neutral and acid extractable organic compounds, metals, explosives, and pesticides. Concentrations of trichloroethylene (TCE), arsenic, and lead exceeded the NJDEP groundwater criteria that existed at the time.

2.1.6 Phase II Remedial Investigation

Following the Phase I RI, Weston Solutions (Weston) performed Phase II RI field activities between July and December 1994 (Weston, 1996a). Specific field activities included:

- Advancement of four soil borings targeting the suspected former demolition ground identified by a ground scar on a 1939 aerial photograph;
- Collection of soil samples (surface and subsurface) from the soil borings;
- Installation of three overburden and three bedrock MWs (MW-87A/C, MW-88A/C, MW-89A/C);
- Groundwater sampling of the four existing MWs installed during the Contamination Evaluation (MW-7, MW-8, MW-9, and MW-31) and the six new MWs (MW-87A/C, MW-88A/C, MW-89A/C); and
- Collection of four surface water and sediment samples from the stream that bisects Area 1.

The soil samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), 2,4,6-trinitrotolune (TNT) screening using the Jenkins method, and metals. The groundwater samples were analyzed for VOCs, SVOCs, pesticides/PCBs, explosives, and metals. All surface water and sediment samples were analyzed for VOCs, SVOCs, and metals. The surface water samples were also analyzed for explosives. All sediment samples were screened for TNT.

The soil, surface water, and sediment sample results collected during the Phase II RI showed that the analytes were either not detected or were found at concentrations less than the most stringent NJDEP criteria for the respective media that were available at the time. Based on the full soil, sediment, and surface water sampling results, it was concluded that past DoD activities had not

significantly impacted soils at Area 1. No further action related to soil was recommended for Area 1. No further action for Area 1 surface water or sediment was also recommended.

VOCs including TCE, 1,2-dichloroethylene (1,2-DCE), and tetrachloroethylene (PCE) were detected in groundwater at concentrations exceeding the NJDEP Groundwater Quality Standards (GWQS). The results of previous sampling events and the Phase II RI groundwater sampling events, as well as groundwater flow directions in the vicinity of Area 1, indicated that the VOCs detected in MWs associated with Area 1 were attributed to the Groundwater AOC 4 plume. The results of the Phase II RI soil sampling indicated that sources of contamination related to historical DoD activities in Area 1 no longer exist, but did not rule out the possibility that past DoD activities in Area 1 could have contributed to the Groundwater AOC 4 plume. Further evaluation of the Groundwater AOC 4 plume was recommended. It was subsequently determined that the groundwater at Area 1 is part of Groundwater AOC 8, not Groundwater AOC 4 as previously concluded.

2.1.7 Supplemental MEC Evaluation

The USACE's Munitions Center of Expertise (Huntsville District) re-evaluated the historic DoD uses and USACE-led investigations at the former Raritan Arsenal to determine if MEC concerns could still exist at the Investigation Areas. It was concluded that Investigation Area 1 may require further evaluation for MEC. USACE's contractor, CH2M Hill, performed a records review and developed a Conceptual Site Model for Investigation Area 1 as presented in the Remedial Investigation/Feasibility Study Work Plan (CH2M Hill, 2013).

It was concluded that the existing data are sufficient to complete an RI for Area 1. Further, MEC has not been identified in the surface or subsurface during previous inspections and investigations and is not a concern at Investigation Area 1. Therefore, no additional MEC investigation is warranted. There are no documented releases of MC and HTW associated with former DoD activities at Area 1, and previous investigation data do not provide any evidence that the former DoD activities have affected this area (CH2M Hill, 2013).

2.2 AREA 18A – FORMER GSA/U.S. ARMY POND AREA

Area 18A is three acres and was formerly a man-made pond, first appearing in a 1951 aerial photograph. It was identified as a "tar pit" during an archival investigation in 1991. The appearance of the tar pit in 1951 coincided with the appearance of two oil tanks. Information on the time frame of disposal and specific disposal practices was not provided in archival reports. Sections 2.2.1 through 2.2.8 list all investigations/response actions associated with Area 18A in chronological order.

2.2.1 Site Listing Investigation

In 1990, NUS installed two MWs (MW-EPA-1A, MW-EPA-2A) and collected one surface water and three sediment samples from the man-made pond. The Site Listing Investigation report (NUS, 1990) was not available for review. However, for the purposes of this subsection, it has been presumed that the samples were analyzed for VOCs. Contaminants were not detected in MW-EPA-1A. Trans-1,2-dichloroethene (trans-1,2-DCE) was detected in MW-EPA-2A. The surface water and sediment samples had elevated concentrations of TCE and TCE breakdown products.

2.2.2 Remediation of Area 18A Pond

As a result of the Site Listing investigation, IT (1993) conducted an investigation and interim response activities in 1992 at two former disposal areas within Area 18A (Figure 2-1). The first area was the man-made pond measuring approximately 60 feet (ft) by 30 ft. The second area was located within the western border and encompassed approximately 2,500 square feet (ft^2). Specific activities included the following:

- Removed and disposed of 15,300 gallons of contaminated surface water from the pond.
- Excavated and disposed of approximately 176 tons of tar-based material from the pond. Approximately 2 ft of tar-based material was excavated. Following the removal of the tar-based material, all visibly contaminated soil was removed.
- Crushed, staged, and incinerated approximately 46 empty drum carcasses and additional debris from the pond.
- Excavated and disposed of approximately 527 cubic yards (cy) of soil, product, and debris from the second disposal area. Excavations were to an average depth of 1.5 ft bgs with isolated depths to 4 ft bgs.

- Residual levels of contamination remained in the soil at the pond. Five post-excavation samples from the former pond contained TCE, TPH, and other VOCs exceeding NJDEP criteria.
- Three post-excavation samples at the second disposal area indicated metals concentrations were less than NJDEP criteria.
- The two areas were not backfilled. They were contoured to blend in with the natural terrain.

2.2.3 Archival Search Report

Dames and Moore (1993a) conducted an archival search of the former Raritan Arsenal. The ASR indicated that the Area 18A pond was used for dumping a variety of waste products. Drums containing various waste products were rolled down the hillside slope from Avenue D and scattered at the base of the hill and/or into the pond. Wastes could have included solvents, degreasers, and Cosmoline, which is a heavy grease used to coat stored weapons.

2.2.4 Phase II Remedial Investigation

An expedited Phase II RI was performed by Weston (1996b) from April to May 1994. Specific field activities included:

- Drilling of 26 soil borings targeting areas within and surrounding the former disposal areas;
- Collection of surface and subsurface samples for laboratory analysis;
- Installation of one bedrock monitoring well (MW-71C);
- Collection of groundwater samples from six existing wells (MW-7, MW-8, MW-9, MW-31, MW-46A, and MW-EPA-2A) and three newly installed wells (MW-71C, MW-89A, and MW-89C); and
- Collection of six surface water samples and six sediment samples from a stream identified as the Area 18B Stream to evaluate possible impacts to surface water drainage within and adjacent to Area 18A.

All soil samples collected were analyzed for VOCs, SVOCs, metals, and screened for TNT. Eight of the soil samples submitted for TNT screening were also submitted for laboratory explosives analysis. Forty soil samples were analyzed for pesticides/PCBs. The groundwater samples were

analyzed for VOCs, SVOCs, pesticides/PCBs, explosives, and metals. All surface water and sediment samples were analyzed for VOCs, SVOCs, pesticides/PCBs, and metals. The surface water samples were also analyzed for explosives. All sediment samples were screened for TNT. Two sediment samples were submitted for laboratory explosives analysis.

The results of the Phase II RI soil investigation indicated that the NJDEP Residential Direct Contact Soil Cleanup Criteria (RDCSCC) for PAHs, cadmium, and/or lead were exceeded within the 0 to 0.5 ft bgs depth interval at four of the 26 soil boring locations advanced along the southern edge of Avenue D. Additional delineation of the soil contamination in Area 18A was recommended.

The analytical results of bedrock wells MW-71C, MW-87C, MW-88C, and MW-89C indicated that the bedrock aquifer was uncontaminated. VOCs including benzene, 1,2-DCE, TCE, vinyl chloride (VC), and metals were detected at concentrations exceeding the GWQS in several overburden wells associated with Area 18A.

Groundwater plume AOC 4 (Figure 2-1) contained VOCs that have been attributed to a combination of non-DOD upgradient and DoD sources (i.e., the former Area 18A pond). The analytical soil results within Area 18A indicated that there does not appear to be a major continuing discharge to groundwater from the former disposal areas. The absence of a point source can be attributed to the successful USACE interim response activities that were performed to address the former disposal areas.

PAHs were present at concentrations exceeding the ecologically-based Ontario Severe Effect Level (SEL) guidelines in four of the six sediment samples collected from the Area 18B Stream that is thought to be associated with Area 18A. These results, as well as detections of pesticides and explosives, indicated that the concentration and number of contaminants increased while moving upstream in the Area 18B Stream. The Area 18B Stream is fed by two underground concrete pipes (i.e., storm drains) which appear to collect stormwater runoff from upgradient Investigation Areas 18D and 18F and possibly other upgradient locations.

A review of the Map Annex that accompanies the ASR (Dames and Moore, 1993a) shows that an aboveground storm drain appears at the general location of the Area 18B Stream in the 1963 site plan. The map presenting the location of the aboveground storm drain shows a network of upgradient, belowground storm drains that may discharge to the aboveground drain depicted on the map. However, since as-built diagrams were not available, the exact source of water emanating from the discharge pipe was undetermined. The results of groundwater, soil, surface water, and sediment sampling in Area 18A indicated that most of the contamination identified within the Area 18B Stream (with the exception of VOCs) cannot be attributed to Area 18A and may be the result of an upgradient source area.

2.2.5 Supplemental Phase II Remedial Investigation

Weston performed a Supplemental Phase II RI from April to June 1996 (Weston, 1999a). Field activities included:

- Drilling nine soil borings along Avenue D;
- Excavating 14 test pits around previous soil borings (18A08 and 18A11) with elevated contamination levels and two subsurface, metallic anomalies. The locations of subsurface metallic anomalies were observed during a MEC avoidance magnetometer survey on the south slope of Avenue D. The anomalies, typical of buried drums, were identified at 3 feet bgs; and
- Collection of surface and subsurface soil samples.

All soil samples collected from the soil borings were analyzed for cadmium. Eleven of the samples collected from the soil borings were analyzed for lead and PAHs. The soil sample collected from the test pits at previous soil boring 18A08 was analyzed for VOCs, SVOCs, and metals. The soil samples collected from the test pits at previous soil boring 18A11 were analyzed for TPH, PAHs, VOCs, and metals. Samples collected from the test pits excavated to explore the subsurface anomalies were analyzed for VOCs, SVOCs, pesticides/PCBs, explosives, TPH (one sample), and metals.

The cadmium concentrations from the soil samples collected from soil borings along Avenue D did not exceed the NJDEP cadmium criterion. As a result, no further action (NFA) was proposed for cadmium within this area. NFA was proposed for PAHs in the vicinity of Avenue D due to

paved roadways nearby and nearly complete contaminant delineation. Lead was adequately delineated (horizontally and vertically) in the Avenue D soil borings. A future response action for lead in this area was determined to be required.

Analytical results for soil samples collected at previous soil boring 18A08 showed that VOCs (1,2-DCE and xylenes) exceeded NJDEP Impact-to-Groundwater Soil Cleanup Criteria (IGWSCC). The horizontal and vertical extent of the VOC contamination was delineated. NFA was proposed due to the limited vertical extent of the VOC contamination, the soil contamination was not a significant source of groundwater contamination, the contamination was at depth (limiting exposure), and the horizontal extent was delineated.

Sample results and visual observation in the area of previous soil boring 18A11 and the surrounding test pits showed that the lateral extent of the visually contaminated soil around 18A11 was approximately 3,860 ft^2 with an average thickness of 2 ft (overall volume of about 285 cy). The sample results for VOCs (TCE and 1,2-DCE), benzo(a)pyrene, and TPH exceeded NJDEP criteria. Based on visual observations and geophysical surveys, the lateral extent of buried material/contamination at the location of the subsurface, metallic anomalies was approximately 1,460 ft^2 with an average thickness of 4 ft (overall volume of about 220 cy). The sample results for VOCs (TCE, 1,2-DCE, VC, and xylenes), lead, and TPH exceeded NJDEP criteria. This information resulted in the conclusion that a future interim response action was required for this area.

2.2.6 Engineering Evaluation/Cost Analysis

OE was not identified during a site visit in 1991 or during the removal actions that were completed in 1992 and 1998. The likelihood that undiscovered OE remains buried in 18A is considered minimal. The OE density is considered to be minimal for all depths in this area. The risk of OE exposure in this area is considered low. Based on the available data for this area, which demonstrate no evidence of OE present, the risk of OE exposure for future activities is also considered low.

2.2.7 Interim Response Action

Based on the RIs that were conducted at Area 18A, two areas of contamination were identified as requiring additional interim response actions: 18A-1 and 18A-2. Area 18A-1 was located along Avenue D. Area 18A-2 was located in the vicinity of the former pond. Excavation activities at 18A-1 and 18A-2 were conducted in April and May of 1998 (Weston, 2002). The total volume of soil removed from both Area 18A excavations was 2,485 cy. Figure 2-1 shows the location of the 1998 Area 18A removals.

2.2.7.1 Removal Area 18A-1

Visibly impacted soils and soils with elevated photoionization detector (PID) readings were removed to a depth of approximately 5 to 6 ft bgs at 18A-1. A total of 1,288 cy of black, stained soil and black, viscous material were removed from 18A-1. Groundwater was encountered at this depth and no further soil was removed. Drums or containers were not encountered during excavation activities.

Post excavation samples from 18A-1 included eight sidewall and five excavation floor samples. Samples were analyzed for TPH and VOCs. PAHs were analyzed on 25% of the samples with TPH concentrations greater than 100 mg/kg. VOCs exceeded the NJDEP criteria in two of the samples. However, additional material was not removed due to the presence of groundwater in the excavation and no visible contamination in the sidewall. NJDEP agreed with this and with the USACE recommendation that any residual contamination would be addressed as part of the site-wide groundwater monitoring program (Groundwater AOC 4). The excavation was backfilled.

2.2.7.2 Removal Area 18A-2

A total of 141 drums containing a black, tar-like material were encountered during the 18A-2 removal. The 18A-2 excavation consisted of four areas having varying excavation depths. The first excavation contained visibly stained soils removed to a depth of 4 ft bgs located between areas 18A-1 and 18A-2. The second excavation extended to a depth of 6 ft bgs. The largest excavation extended to a depth of 8 to 9 ft bgs and included the area with the drums. A majority of the visibly impacted soil and free product was removed from this excavation. The fourth excavation extended

to a depth of approximately 6 ft bgs. A total of 1,197 cy of visibly impacted soil was removed from 18A-2. Post excavation samples were collected, including:

- First excavation – three sidewall samples and one floor sample were collected. PID readings were zero.
- Second excavation – two sidewall samples and one floor sample were collected. PID readings were zero, 27, and 50 units, respectively.
- Third excavation – six sidewall samples and two floor samples were collected. PID readings were zero to 410 units for sidewall and 233 and 780 units for the floor.
- Fourth excavation: two sidewall samples and one floor sample were collected. PID readings were zero.

TPH results were greater than 100 mg/kg in six post excavation samples. VOCs exceeded the NJDEP criteria in three of the post excavation samples. Additional material was not removed due to groundwater in the excavation and no visible contamination in the sidewall. NJDEP agreed with this and with the USACE recommendation that any residual contamination would be addressed as part of the site-wide groundwater monitoring program (Groundwater AOC 4) (NJDEP, 2000). The excavation was backfilled.

2.2.8 2013 Supplemental Sampling

NJDEP expressed concern that historical PAH contamination associated with Investigation Area 18A could be a continuing source of PAH contamination to the Area 18B Stream through surface runoff during and following precipitation events. Observations made during a site visit in August 2013 and review of area topographic maps indicated that it is unlikely surface runoff from Area 18A would reach the upstream portions of the Area 18B Stream where the highest levels of PAH contamination have been observed. However, to address NJDEP's concern, surface (0-0.5 ft bgs) and subsurface (2-3 ft bgs) soil samples were collected at Investigation Area 18A in a previously un-sampled area that appears to be down slope of the areas that were remediated in 1992 and 1998 by USACE (see location 18A44 on Figure 2-1). The samples were analyzed for PAHs by Method SW8270C SIM. PAHs in the surface sample were detected at levels less than NJDEP residential and industrial criteria. No PAHs were detected in the subsurface sample. These sample results, in concert with historical soil sampling results indicating PAHs analyzed from the surrounding area

were either not detected or were detected at low levels, indicate that surface migration is likely not a source of PAH contamination to the Area 18B Stream. No further investigation of the overland flow of PAHs to the Area 18B Stream is proposed. Section 2.3.8 and Appendix B discusses samples collected from within the Area 18B Stream.

2.3 AREA 18B – FORMER FIRING RANGE

Area 18B is approximately 50 acres, surrounds Area 18A, and includes the former location of a firing range. Little information regarding specific operations at the firing range was available, but it appears that only small arms firing occurred. The extent of the former firing range was roughly delineated by historical ground scars noted while reviewing historical aerial photographs. Four AOCs have been identified for Area 18B: AOC 1 – former firing range and ground scars; AOCs 2 and 3 – sediment/surface water and groundwater, respectively; and, AOC 4 – locations previously sampled by NUS. Sections 2.3.1 through 2.3.8 list all investigations/response actions associated with Area 18B in chronological order.

2.3.1 Site Inspection

A Site Inspection was conducted by NUS in 1985. Surface soil samples were collected within and nearby the former firing range (identified as AOC 1). Results indicated that arsenic, barium, and lead concentrations exceeded NJDEP criteria.

2.3.2 Site Listing

A Site Listing inspection by NUS in 1990 included the collection of additional surface soil samples. Metals concentrations exceeded NJDEP criteria.

2.3.3 MEC Investigation

A geophysical mapping and sampling investigation for MEC was performed at four areas in Area 18B during July 1993 (EODT, 1993). A number of anomalies were identified and sampled as summarized below. MEC was not found at these areas.

Area 1: 2,500 ft^2, Anomalies = 18, Anomalies Sampled = 18, MEC found = none

Area 2: 11,250 ft^2, Anomalies = 55, Anomalies Sampled = 21, MEC found = none

Area 3: 10,000 ft^2, Anomalies = 56, Anomalies Sampled = 14, MEC found = none

Area 4: 625 ft^2, Anomalies = 4, Anomalies Sampled = 4, MEC found = none

Figure 2-1 presents the areas where the geophysical investigations were performed.

2.3.4 Supplemental Phase II Remedial Investigation

The Supplemental Phase II RI report presents the results of the field activities performed from April to July 1996 and also includes work conducted as part of the 1994 Phase II RI (groundwater, sediment, and surface water sampling) (Weston, 1999b).

The Supplemental Phase II RI effort included drilling 38 soil borings and excavating one test pit. The test pit was excavated to investigate a suspicious change in lithologic conditions observed during the drilling of soil boring 18B08. Three soil samples were collected from each of the 17 soil borings at AOC 1. Analyses included SVOCs, pesticides/PCBs, metals, TNT screening, VOCs (18 samples), and confirmatory explosives (5 samples). VOCs and pesticides/PCBs were not a concern at the former firing range AOC (either not detected or less than NJDEP criteria). PAHs at two locations (soil borings 18B04A and 18B07A) exceeded NJDEP Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC). TNT screening found TNT but paired laboratory samples were not detected. Additional lead delineation with four soil borings was proposed around soil boring 18B04A.

Two soil samples were collected from each of the 20 soil borings advanced around previous NUS sampling locations (AOC 4). Every sample was analyzed for TNT screening, 10 samples were analyzed for metals, and four samples were submitted for laboratory explosives analyses. Arsenic and lead concentrations exceeded NJDEP NRDCSCC in two samples. TNT screening indicated TNT but in paired laboratory samples, TNT was not detected. Additional lead delineation with two additional soil borings was proposed around soil boring 18B36. Additional lead delineation also was proposed around NUS sample location S-18. In addition, at the request of Edison Health Department, a series of tests pits were planned to be excavated at the former target range backstop area.

2.3.5 Engineering Evaluation/Cost Analysis

Surface searches and magnetometer surveys at select locations in Area 18B with investigation of anomalies have not resulted in the identification of any OE in Area 18B. In addition, OE was not discovered during investigations at adjacent Investigation Areas 1 and 18A. Due to the reported historical uses of this area, and the lack of OE discoveries within this area, there is little reason to suspect the presence of OE. The OE density was determined to be minimal for all depths in this area. The risk of OE exposure in this area for both current and future use is considered low.

2.3.6 Supplement 2 Phase II Remedial Investigation

Weston performed an additional Supplemental Phase II RI (Weston, 2000) in August 1999 to fill the data gaps identified in the 1999 Supplemental RI (see Section 2.3.4). Results of the additional sampling indicated that the lateral extent of lead contamination around previously sampled locations 18B04, S-18, and 18B36 was delineated. The test pit investigation at the backstop area indicated that firing was directed toward the center of the backstop. Four of the 30 samples collected from the test pits had lead levels above the NJDEP NRDCSCC.

2.3.7 Interim Response Action

Upon completion of the previous RIs, the USACE proposed NFA and no cap for Area 18B. The NJDEP stated in its review of the NFA proposal that, although delineation had been adequately defined, future interim response actions and/or capping would be required. The NJDEP also specified that all small arms ammunition debris (i.e., expended bullets) should be removed and all soil areas containing lead in excess of 600 mg/kg must be either treated, removed, or capped, and a deed notice acceptable to the current property owner instituted. Additionally, NJDEP requested that groundwater downgradient of this area be evaluated for the presence of lead.

As a result, a soil removal was conducted in 2002 at Area 18B to remediate the lead-contaminated soil identified at the former firing range and at three areas associated with anomalous lead detections identified at sample locations 18B41/S-18, 18B04, and 18B36/S25 (Weston, 2004b). An area of soil with an elevated detection of arsenic at former sample location 18B41/S-18 was also removed concurrent with the soil excavated to remediate the lead exceedances.

Soil and small arms ammunition debris consisting of expended bullets were excavated from the backstop area. Lead concentrations in post excavation samples at the backstop were below NJDEP lead standards; nevertheless, additional removal was performed due to the presence of additional small arms ammunition debris. The excavation area for the firing range area was 4,125 ft^2 to a depth of 2 ft bgs. Additionally, hot spots were removed at locations 18B41/S-18, 18B04, and 18B36/S25 to a depth of one ft bgs. Lead concentrations in post excavation samples collected at locations 18B41/S-18, 18B04, and 18B36/S25 were below NJDEP criteria. MW-148 was installed and sampled in April 2008 to evaluate the impact to groundwater from lead in soil. Sample results showed no groundwater impacts. NJDEP agreed that the response action adequately addressed the lead contamination (NJDEP, 2004). Figure 2-1 shows the location of the Area 18B 2002 removals.

2.3.8 2013 Supplemental Sediment Sampling

Additional sediment samples were collected from the Area 18B Stream to further define the extent of PAH contamination in stream sediments. A memorandum presenting and interpreting the results was submitted to NJDEP on 26 February 2014 (USACE, 2014a). The following paragraphs summarize the information that was presented in the memorandum.

Although identified as a stream, the Area 18B Stream is actually an intermittent storm water drainageway constructed by DoD when the Raritan Arsenal was active. During the sediment sampling conducted in October 2013, all of the sediment sampling locations were dry except for location SD1819, the farthest downstream location. Based on field observations, the stream substrate is sand. In fact, sand is present in the top foot and deeper of the substrate throughout much of the drainageway. During the October 2013 field effort, pooled water was present at a few locations and had apparently been there for some time; moreover there was no surface water flow in the stream. Groundwater flow in the Area 18B vicinity is generally to the southeast based on the March 2005 Site-Wide Groundwater Contour Map. The upper portion of the stream is likely a losing stream and not hydraulically connected to groundwater.

During the sediment sampling, a sample was collected from the surface (0-0.5 ft bgs) at each location. At the upstream locations, a subsurface sample was also collected at the request of NJDEP. The subsurface depth interval selected for sampling was determined based on PID meter

readings, odors, or staining. If none of these were present, the first 6 inches of non-sand soil/sediment below the surface sand layer was sampled. All samples were analyzed for PAHs by Method SW8270C SIM. The PAH results exceeded NJDEP criteria and ecological screening standards in nearly all samples.

The 2013 PAH sample results as well as historical results indicate that PAH concentrations tend to decrease with distance downstream of the storm sewer outfall. The Area 18B Stream is fed by two 48-inch diameter storm drains that appear to collect stormwater runoff from upgradient locations including rooftops and paved areas around Buildings 245, 246 and possibly 229. Note that Buildings 245 and 246 were demolished in the early 2015.

A review of the Map Annex that accompanies the Dames and Moore ASR (1993a) shows that an aboveground storm drain appears at the general location of the Area 18B Stream in the 1963 site plan. The map presenting the location of the aboveground storm drain shows a network of upgradient, belowground storm drains that discharge to the Area 18B drainage ditch. This map also shows storm drains adjacent to former Buildings 245 and 246 (the two large buildings located west of Areas 18A and 18B) discharging to the Area 18B drainage ditch. Likewise, a 1958 (revised 1960) storm drain map prepared by the Army shows the same drainage configuration.

Meaningful comparisons of the 2013 results with the previous sample results from the Area 18B Stream are difficult based on the dynamic nature of the stream's sand substrate. Over time, the stream substrate and the associated PAH levels are likely to change and are impacted by major storm events that likely scour older substrate and replaces it with levels from upgradient locations. Any comparisons of the 2013 results with results from 1994 and even 2005 are of limited utility other than to illustrate the changing stream conditions. For simplicity, the total PAH concentrations represented by the sum of the individual PAHs were compared.

- Location SD-1820 was sampled in July 2005 (location SD-1812) as part of the sample collection effort for the ERA. The total PAH concentration in 2005 at this location was 120 mg/kg. The 2013 total PAH concentration is 531 mg/kg, an approximately four-fold increase.
- Location SD-1821 was sampled in July 2005 (location SD-1813) and August 1994 (SD-1803). The total PAH concentration in 1994 was 4,934 mg/kg. The 2005

sample results showed a significant decrease to 49 mg/kg. The 2013 total PAH result increased to 2,742 mg/kg.

- Location SD-1822 was sampled in July 2005 (previous location SD-1814 plus a field duplicate) and August 1994 (SD-1804). The 1994 total PAH concentration was 5,436 mg/kg. The 2005 concentration (average of the primary and field duplicate) was 316 mg/kg. The 2013 sample results exhibited a modest increase from 2005 to 902 mg/kg.

- Location SD-1823 was sampled in July 2005 (previous location SD-1815). The 2005 total PAH concentration was 552 mg/kg. The 2013 PAHs results were mostly non-detect, with a total PAH concentration approximately 0.1 mg/kg.

- Location SD-1824 was sampled in August 1994 (previous location SD-1805). The total PAHs detected in 1994 were relatively similar to the 2013 result.

- Location SD-1827 was sampled in July 2005 (location SD-1811) and August 1994 (SD-1806). The total PAH concentrations, less than 50 mg/kg, from this location remained relatively consistent in the 1994, 2005, and 2013 sampling results

As outlined in the previous bullets, there is no temporal trend apparent with regards to the total PAH concentrations within the Area 18B Stream. Likewise, there is not a clear trend with depth. The lack of a clear contamination pattern could be related to the sandy substrate and the likely source of the PAHs. These results, especially at the upstream sampling locations, are indicative of an intermittent source of contamination to the Area 18B Stream that is heavily dependent on storm events, such as periodic discharge from the two 48-inch stormwater discharge pipes located at the headwater of the Area 18B Stream. One would expect relative consistency in PAH concentrations over time if the source was from the previously remediated areas at Investigation Area 18A. In addition, data from historical soil samples collected at the water table between the Area 18B stream and the Area 18A remediation areas did not detect PAHs. The results of the 2013 sample collection effort indicate that the contamination identified within the Area 18B Stream most likely is the result of storm water discharge from upgradient areas. Therefore, total PAH concentrations associated with the Area 18B Stream are not considered for any future decisions on remediation of the EPA/GSA Area.

The reader is referred to Appendix B for more information on this topic. Appendix B contains the memorandum (USACE, 2014a) that presents and discusses the results that was sent to NJDEP on 26 February 2014, comments on the memorandum received from NJDEP on 23 May 2014, and

additional information that addresses NJDEP comments including a geologic cross-section, a groundwater contour map, and a map showing borehole locations.

2.4 AREA 18C – FORMER LANDFILL, DISPOSAL, AND VEHICLE PROCESSING AREA

Area 18C is 58 acres and includes the foundations of two former buildings (Buildings 255 and 256) that were demolished in August 2014, asphalt and railroad areas, and undeveloped land. A portion of the site was historically used as a dumping ground for building debris. The extent of dumping/landfill area is not clear. However, some of the debris that was dumped was known to contain asbestos. The area containing asbestos is approximately 0.25 acre within the larger total landfill area and is referred to as the Asbestos Landfill (see Figure 2-1). The total landfill area is much larger than the area containing asbestos as indicated by the large amount of building debris throughout the area surrounding the Asbestos Landfill. This landfill is a result of GSA-directed demolitions conducted in the early 1990s. Contamination (asbestos and non-asbestos related) associated with the Asbestos Landfill is not quantitatively evaluated in this RI.

Area 18C contains a large paved area adjacent to former Buildings 255 and 256 that has been "washed out". There were considerable depressions and changes in elevation across the lot. The cause of these conditions is not known, but may be the result of differential settling of potentially contaminated fill material below the asphalt. Former Buildings 255 and 256 were historically used for vehicle storage, assembly, repair, and painting. Sections 2.4.1 through 2.4.16 list all investigations/response actions associated with Area 18C in chronological order.

2.4.1 Site Inspection

A Site Inspection was conducted by NUS in 1985. Surface soil samples were collected at five locations within Area 18C. Results of these samples indicated that levels of arsenic, cadmium, copper, and lead exceeded NJDEP criteria.

2.4.2 Site Listing

A Site Listing inspection by NUS in 1990 included the collection of additional surface soil samples for XRF field screening of metals and subsequent laboratory analysis. There were no exceedances of NJDEP criteria in the laboratory samples.

2.4.3 UST Removals

Four USTs were historically located adjacent to Building 256. Three of the USTs were located to the north of Building 256 and one UST was located to the west. The former USTs included a 25,000-gallon UST and a 15,000-gallon UST that contained No. 6 fuel oil, a 2,500-gallon UST that contained No. 2 fuel oil, and one 5,000-gallon UST that was reportedly used to store fuel and engine oil drained from newly painted tanks prior to shipping them overseas. Figure 2-1 presents the locations of former USTs.

The EPA removed the four USTs (identified as A10, A11, A12, and A13), obtained post excavation soil samples, and installed and sampled one monitoring well. The EPA submitted closure plans and closure reports (NJDEP UST Closure Report Approval Nos. C-90-0390 and C-90-0391) to the NJDEP Bureau of Underground Storage Tanks in August 1991. The soil samples obtained indicated that there were no contaminants of concern in the soil. The groundwater sample collected from the monitoring well (MW-EPA-4A) adjacent to UST A13 contained chlorinated VOCs (CVOCs).

2.4.4 Rapid Response Action

A Rapid Response Action was carried out in the early 1990s by the USACE-Huntsville District at the Asbestos Landfill to stabilize/encapsulate suspected asbestos material found at the site. This was accomplished by spraying the material with a copolymer. Figure 2-1 presents the approximate location of the Asbestos Landfill.

2.4.5 Archival Search Report

Dames and Moore (1993a) conducted an archival search of the former Raritan Arsenal. The ASR noted that the section of Area 18C south of the railroad tracks represents a portion of the old borrow

pit that predates the former Raritan Arsenal. The ASR also stated that the borrow pit area was filled beginning in the mid-1940s.

2.4.6 MEC Investigation

A geophysical mapping and sampling investigation for MEC was performed at one location (150 ft^2) in Area 18C during July 1993 (EODT, 1993). No anomalies or MEC were identified. Figure 2-1 presents the area were the 1993 MEC survey was performed.

2.4.7 Geophysical Investigation

A geophysical investigation was performed by Weston using a complement of electromagnetic (EM) terrain conductivity and MAG surveys (Weston, 1996c). The objective of the investigation was to locate and delineate suspected buried drum areas. Twenty-five subsurface anomalies were investigated by test trenches. No MEC items were found. The location of the 1996 geophysical investigation is depicted on Figure 2-1.

2.4.8 Phase II Supplemental Record Review/Site Inspection

A Phase II Supplemental Record Review/Site Inspection (Weston, 1997) was conducted to confirm the exact usage and waste practices associated with historical Building 256. A site inspection was conducted of the interior of Building 256 to determine if old DoD systems such as floor drains, holding tanks, sumps, etc. existed. A site inspection around building exteriors to identify potential evidence of dumping or stained soils was also performed. Lastly, a review of soil and groundwater contamination results for locations in close proximity (downgradient) of the area being investigated was conducted. The subsections that follow present the overall conclusions of the Phase II Supplemental Record Review/Site Inspection.

2.4.8.1 Building 256

Soil borings/samples were recommended at the sand-filled concrete sumps under the pneumatic lift located within Building 256. Soil borings/samples were also recommended at the location of standing water below the grating in the grit blast room to determine the potential for the discharge of contaminated liquid to soil/groundwater underlying the building. The transformer pads north of Building 256 were a concern due to the potential for PCB/TPH contamination from leaking

transformers. The contamination associated with and in the vicinity of the tanks and leach field east of Building 256 was planned to be addressed as part of a future interim response action.

2.4.8.2 Area AS-16 (Gas and Oil Dump)

Soil borings/samples were recommended to the north of the historical railroad tracks, but south of an area identified as AS-16. This area was suspected to be the location of a gas and/or oil dumping ground. The proposed sampling would identify any potential contamination associated with historical DoD-related activities.

2.4.9 Supplemental Phase II Remedial Investigation

The Supplemental Phase II RI report presents the results of the Supplemental Phase II RI performed from April to July 1996 (Weston, 1999b). Five AOCs at Area 18C were investigated including: the Asbestos Landfill, the Buried Drum Area, the Wash-Out Area, the Building 256 Leach Field, and Surface Soil Contamination. Activities included a geophysical investigation (see Section 2.4.7), drilling 45 soil borings, and excavating 53 test pits and the collection of soil samples for laboratory analysis. Specific activities associated with each AOC are discussed in Subsections 2.4.9.1 through 2.4.9.5.

2.4.9.1 Asbestos Landfill

Ten soil borings were planned to be advanced within or just outside of the Asbestos Landfill. The majority of the soil borings were not completed to the planned depth due to the presence of numerous magnetic anomalies and/or auger refusal. Four soil borings were drilled at the perimeter of the Landfill. The six remaining soil borings within the Asbestos Landfill area were completed as test pits. All soil samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and TNT screening. Two samples were submitted for laboratory explosives analysis. All but the deeper sample intervals collected from the perimeter of the Asbestos Landfill were submitted for asbestos analysis.

VOCs were not detected at levels exceeding either the NJDEP NRDCSCC or IGWSCC that were current at the time. PAHs were detected at levels exceeding the NJDEP NRDCSCC and/or IGWSCC in 18 samples. Arsenic, lead, and zinc were detected in one or more soil samples at

concentrations exceeding the NJDEP NRDCSCC (arsenic – 1 sample, lead – 3 samples, and zinc – 2 samples). DDT exceeded its NRDCSCC in 1 of 28 samples. PCBs (Aroclor 1254) were detected at concentrations exceeding the NRDCSCC in 2 of 28 samples. Screening analysis detected TNT in approximately 35% of the test kits. However, laboratory explosives analysis did not detect explosives. Thirteen samples contained detectable levels of asbestos (chrysotile) ranging from 1% to 8%. It did not appear that the contamination present within the Asbestos Landfill AOC has impacted the groundwater.

2.4.9.2 Buried Drum Area

A total of 31 test pits were excavated and 10 soil borings were advanced to investigate potential impacts to soil from areas observed to contain drum carcasses and from suspect areas identified during the geophysical survey. Four soil borings were advanced in attempts to install MWs. Only one of the four soil borings was suitable for installing a MW (MW-106A). One to three soil samples were collected from each test pit at areas with visual contamination or elevated PID readings. Fifty-four soil samples were collected and analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and TNT screening. Eight samples were submitted for laboratory explosives analysis. Four samples of solid material from within four separate drum carcasses, and two liquid samples from separate drum carcasses were also collected. These samples were analyzed for VOCs, SVOCs, pesticides/PCBs, and metals. Following the test pit program, 10 investigatory soil borings were drilled at areas suspected to be downgradient or adjacent to contamination observed during the test pit program. Samples from these soil borings were collected from three intervals (surface, intermediate depth, and just above the clay layer).

Xylenes exceeded the IGWSCC in 2 of 88 samples (both from TP-27). Concentrations of benzo(a)pyrene exceeded the NRDCSCC in three soil samples from three different test pits (TP-55, TP-63, and TP-65). Lead exceeded the NRDCSCC in one sample from TP-18. The excavation at TP-6 revealed 300 to 400 buried cans labeled “waterless hand cleaner.” A number of test pits (TP-2, -3, -5, -7, -8, and -29) revealed buried 55-gallon drums, 30-gallon galvanized trash cans, paint cans and buckets, paint-stained soils, and building debris extending to 9.5 ft bgs.

Due to grossly contaminated soil, areas within this AOC were recommended for remediation. Four distinct areas of contamination were identified as Drum Disposal Areas-1 through -4.

Additional areas were investigated because geophysical anomalies and/or surface debris were noted during site walkthroughs. One surface soil sample contained pentachlorophenol exceeding the NRDCSCC. PAHs exceeded the NRDCSCC from samples collected at TP-22, TP-24, and TP-26. Dieldrin exceeded its NRDCSCC at TP-22. Waste containers were not observed in TP-22 and TP-26. Beryllium exceeded its NRDCSCC at TP-19 and TP-31.

2.4.9.3 Wash-Out Area

Three soil borings were advanced in the Wash-Out Area west of Building 255. Three soil samples were collected from each boring. Each sample was analyzed for SVOCs, pesticides/PCBs, metals, and TNT screening. One sample was analyzed for VOCs and explosives.

Benzo(a)pyrene exceeded its NRDCSCC in one sample. TNT was detected in one field screening sample but was not detected in the laboratory sample. All other constituents were either not detected or detected at levels below the NRDCSCC. No Further Action was proposed for benzo(a)pyrene as the observed levels are related to surface water runoff from railroad tracks (actively used) or the surrounding asphalt.

2.4.9.4 Building 256 Leach Field

Fourteen test pits were excavated in the vicinity of the northeast corner of Building 256 to investigate a former drainage field and suspected USTs. Prior to the test pit excavations, four samples (2 tank sediment samples and 2 water samples) were collected at two pipe stickups believed to be connected to two separate USTs. These samples were analyzed for VOCs, SVOCs, pesticides/PCBs, and metals. The tests pits excavated around the stickups discovered one large UST (approximately 3,000 gallons). Samples were collected from the other test pits from various depths. Twelve samples were collected and analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and TNT screening. Two of the samples were also submitted for laboratory explosives analysis.

VOCs (TCE, PCE, 1,2-DCE, and xylenes) were detected at concentrations exceeding the NRDCSCC and/or IGWSCC in four soil samples. Benzo(a)pyrene exceeded its NRDCSCC in

one sample. Other analyzed constituents were either not detected or less than the NRDCSCC. This area is believed to be one of the source areas for groundwater contamination in Groundwater AOC 2 (see Figure 2-1). An interim response action was determined to be needed for the leach field. A geophysical investigation and the collection of additional soil samples were recommended.

2.4.9.5 Surface Soil Contamination

Eighteen shallow soil borings were advanced where previous NUS sample results had indicated surface soil contamination. Two samples were collected from each soil boring. Four soil borings were drilled near NUS location S-9 (analyzed for metals and TNT screening). Four soil borings were drilled near NUS location S-1 (analyzed for PAHs, metals, TNT screening, and one was submitted for laboratory explosives analysis). Four soil borings were drilled near NUS location S-49 (analyzed for metals, TNT screening, and one was submitted for laboratory explosives analysis). Six were advanced near NUS locations S-13, S-14, S-15, and S-18 (analyzed for metals, TNT screening, and two were submitted for laboratory explosives analysis).

Arsenic concentrations exceeded the NRDCSCC in three soil samples from two soil borings. TNT was detected in the screening but was not detected in the laboratory samples. All other constituents were either not detected or less than NRDCSCCs. Further delineation of the arsenic contamination detected in two soil borings was required. Four additional soil borings were proposed with two samples collected from each soil boring.

2.4.10 Engineering Evaluation/Cost Analysis

Historical use of Investigation Area 18C for dumping of oil and gas does not suggest a high probability of OE contamination. Further, a MAG survey of a small suspect area on the eastern edge of Area 18C yielded no magnetic anomalies. The OE density was determined to be minimal for all depths in this area. The risk of OE exposure in this area for both current and future use was considered low.

2.4.11 Interim Response Action – 1998

Based on the observations and analytical results in the Supplemental Phase II RI (see Section 2.4.9 and Weston, 1999b), interim response actions were conducted at the Building 256 Leach Field

Area and the Drum Disposal Areas (DDAs) (Weston, 2002). The first interim response activities occurred in 1998. It is noted that MEC items were not observed during any of the response activities.

2.4.11.1 Building 256 Leach Field Removal

Three vertical, cylindrical concrete tanks were removed along with the soil around the tanks. The tanks were structurally sound and did not appear to have leaked. Following the concrete tanks removal, a 6,000-gallon steel settling tank was uncovered and removed. This tank was in good condition and did not appear to have leaked. Debris, crushed drums, and black-stained soil were removed from the area north of the steel tank excavation. Stained soil was observed beneath the concrete tanks. The source of this stained soil was unknown because the tanks appeared to be intact. Additional soil was removed from the excavation.

Piping removed included 4-inch clay pipe between each tank within the tank system, and up to the end of the eastern extent of the excavation adjacent to the leach field. A 6-inch clay pipe entering the 6,000-gallon tank was flush cut and capped. A 2-foot diameter storm sewer pipe was present in the excavation. After discussion with the property owner, the pipe was cut at both ends of the excavation and sealed with brick and mortar on the east end. The western end of the pipe was not capped due to the contamination encountered on the ramp in this portion of the excavation.

A ramp was constructed along the northwestern side of the excavation for access due to the depth of the excavation. A limited test pit investigation was conducted on the ramp leading out of the excavation when it was noted that the tracks of the excavator were displacing soil that appeared stained. Due to funding limitations and the unknown extent of contamination, no further remediation was conducted. It was determined that an additional investigation should be conducted prior to any additional interim response action.

At the time the removal activities halted, 2,450 cy of soil had been removed. Post excavation samples were analyzed for TPH and VOCs, with PAH and PCB analyses on 25% of the samples. PAH and PCB analyses were conducted on the samples with the highest TPH results. PCE, TCE, cis-1,2-DCE, xylenes, and TPH exceeded the IGWSCCs in a subset of the post excavation samples. NJDEP agreed with the USACE recommendation that any residual contamination in the

Building 256 excavation would be addressed in the site-wide groundwater monitoring program. However, the ramp area soil contamination would have to be addressed. The excavation was backfilled.

2.4.11.2 DDA-1 Removal

A total of 329 cy of soil was excavated from DDA-1 when activities ceased due to water in the excavation. Water was encountered at an unanticipated shallow depth of 2 to 3 ft bgs. The expected depth of excavation had been 10 to 12 ft bgs. Additional remediation of DDA-1 was planned to be addressed under a future interim response action.

2.4.11.3 DDA-2 Removal

Excavation of DDA-2 was attempted in April 1998 when hundreds of 1-pint containers labeled "waterless hand cleaner" were discovered. As with DDA-1, water was present in the initial excavation at 1 to 2 ft bgs. It was decided to wait 2 weeks to see if the water would recede and allow for the excavation to continue. The water did not recede and the excavation was closed pending additional design and investigation.

2.4.11.4 DDA-3 Removal

A total of 1,248 cy of soil were removed from DDA-3. All post excavation samples were analyzed for VOCs. One of the post excavation samples was analyzed for SVOCs and metals. Sample results were less than NJDEP NRDCSCC and/or IGWSCC. The USACE recommended a NFA at DDA-3 that was agreed to by NJDEP as there was only a single marginal exceedance.

2.4.11.5 DDA-4 Removal

A total of 238 cy of soil were removed. All post excavation samples were analyzed for PAHs and lead. One of the post excavation samples was analyzed for metals at the request of NJDEP. Benzo(a)pyrene marginally exceeded the NRDCSCC in one sample. The USACE recommendation for NFA at DDA-4 was agreed to by NJDEP as there was only a single marginal exceedance.

2.4.12 Supplement 2 Phase II Remedial Investigation

Weston performed an additional Supplemental Phase II RI (Weston, 2000) in August 1999 to fill the data gaps that remained following the 1999 Supplemental RI (see Section 2.4.9) and the 1998 interim response action (see Section 2.4.11). Sampling was performed at six areas: DDA-1, DDA-2, Building 256 Interior, Building 256 Fill Area, Surface Soil Contamination, and Area AS-16 (Gas and Oil Dump).

2.4.12.1 Drum Disposal Areas

Based on their proximity, DDA-1 and DDA-2 were combined into one area for the additional investigation. The additional investigation (including a geophysical survey) of the area was conducted to better quantify the volume of contaminated material and to measure the depth of groundwater to assist in potential interim response action dewatering planning. A total of 27 test pits were excavated within and around areas based on the results of the geophysical survey. Test pits were extended below the water table (to the extent possible) if contamination or buried materials were present.

Three large, irregular anomalies were located along with several small “single station” anomalies during the geophysical survey. Fill materials in the test pits correlated well with the geophysical data. No samples were collected for laboratory analysis. Soil from each test pit was screened with an OVM (Organic Vapor Meter – a PID) and visually observed. Material encountered included metal debris, drums, paint residue, vehicle parts, a refrigerator, glass bottle, and other miscellaneous debris. Based on the field observations, the subsurface material in DDA-1 and DDA-2 has been visually delineated. DDA-1 and DDA-2 were estimated to contain approximately 2,500 and 750 cy, respectively, of impacted soil. These areas were planned to be remediated in a future interim response action.

2.4.12.2 Building 256 Interior

AOCs within Building 256 included pneumatic lift pits and a pit containing standing water. Sand in the lift pits and the standing water were sampled to determine if residual contamination was present. Four soil borings were drilled within the sumps with two samples collected from intermediate depths and two samples collected near the sump bottoms. Each sample was analyzed

for VOCs, TPH, and metals with one sample from each sump analyzed for PCBs. Two water samples were collected from the sump in the Grit Blast Room (analyzed for VOCs and metals). Sediment was not present in the Grit Blast Room sump.

Samples collected from the interior of Building 256 indicate that none of the detected contaminants exceeded their respective NRDCSCC. The USACE recommended NFA for the interior of Building 256. Note that Building 256 was demolished in 2014.

2.4.12.3 Building 256 Fill Area

A geophysical survey, a soil boring investigation, and a test pit investigation were conducted in the area where unanticipated buried construction debris was encountered beneath the asphalt, northeast of Building 256 and west of the 1998 interim response action.

A total of 16 soil borings were drilled with two samples collected from each soil boring. Soil samples were analyzed for VOCs, metals, and PCBs. Eight samples were also analyzed for SVOCs. These parameters were based on the findings of the previous interim response action (see Section 2.4.11). Based on the results of the soil boring effort and historical information, test pits were excavated to a depth of 10 ft bgs to aid in the determination of the nature of the buried debris/contamination. Five soil borings were also advanced outside the suspected fill area to confirm the boundary.

The geophysical survey concluded that the historical fill boundary was approximately the same as that depicted in the Dames and Moore ASR (1993a). One large metallic anomaly was detected in the area to the east of Building 256. To verify the geophysical survey results, soil borings were drilled throughout the area. Select VOCs exceeded the NRDCSCC and/or IGWSCC in 4 of 32 soil samples located near the metallic anomaly. Test pits were then excavated to verify the results found during the soil boring program. No samples were collected for laboratory analysis. Each test pit was screened with an organic vapor meter (OVM) and visually observed. Observations made during the test pit activities indicated that the metallic anomaly was not a solid metallic object; rather, it was buried metal drums and debris along with heavily stained soil. Based on the field observations, the subsurface material has been visually delineated. Approximately 20 cy of stained soil and debris were estimated to be present.

2.4.12.4 Surface Soil Contamination

Additional soil samples were collected around previous sampling locations SS-18C28A and SS-18C29A to delineate the extent of arsenic contamination. All samples were analyzed for arsenic. The delineation samples did not contain arsenic concentrations above the NRDCSCC. The estimated areal extent of arsenic concentrations above the NRDCSCC is approximately 750 ft^2. Thus, arsenic has been delineated at this area. USACE recommended NFA based on the *de minimus* quantity of arsenic.

2.4.12.5 Area AS-16

Soil borings were advanced to determine if oil and/or gas dumping occurred in this area. One sample was collected from each soil boring and analyzed for VOCs and TPH with one sample also analyzed for SVOCs. Sample results indicated that no contaminants were detected above the NRDCSCC and/or IGWSCC. USACE recommended NFA for this area.

2.4.13 Interim Response Action – 2002

An additional interim response action at Area 18C was performed by Weston in 2002 (2004b). It focused on the residual contamination associated with the previous excavation and leach field (referred to as the Ramp Area), Building 256 Interior, and DDA-1 and DDA-2. Like the previous interim response action, it is noted that MEC items were not observed during the response activities.

2.4.13.1 Ramp Area

Previous sampling investigations and excavation activities have shown that the soil associated with the Ramp Area contains chlorinated VOCs (specifically TCE and PCE). Four phases of excavation were conducted during the 2002 interim response action. During the early phases, delineation sample results exceeded IGWSCC. The area of excavation was subsequently expanded and re-sampled each time. Groundwater was encountered during the excavation at approximately 20 ft bgs. The maximum depth of excavation was approximately 21 ft bgs. A total of 5,275 tons of soil was removed. Post excavation samples were collected from the final limits of excavation. During the final phase of excavation, residual soil with visual contamination was not removed from the

central floor of the excavation due to the presence of groundwater and the inability of the excavator to reach to the excavation floor.

Final post excavation samples and visual observations indicated that residual VOC contamination remains at depths great than 20 ft bgs. The results were reviewed by NJDEP who concurred with USACE's recommendation that the remaining contamination would be addressed at a later time.

2.4.13.2 Building 256 Interior

The two sand-filled hydraulic lift sumps that were identified during a previous investigation were remediated through one excavation. The existing analytical data indicated concentrations of oils and PCBs that were less than NJDEP criteria. About 27 tons of solids and concrete were removed from the former lift sumps. Two post excavation sidewall samples and one post excavation bottom sample were collected and analyzed for VOCs and PAHs. There were no analytes that exceeded criteria in any of the post excavation samples.

The interim response action in the Grit Blast Room consisted of pumping out the water, demolishing and removing equipment, cleaning the residual sludge, and performing a visual inspection. Post excavation sampling was not required. As specified by NJDEP, the decontaminated Grit Blast Room was visually inspected for integrity, screened with a PID, and photo-documented. USACE recommended NFA for the Building 256 Interior. Building 254 was demolished in 2014.

2.4.13.3 DDA-1 and DDA-2

Groundwater was not encountered in the DDA-1 excavation. Pocketed (perched) groundwater was observed in the excavation of DDA-2. The groundwater did not impede the interim response activities. During the removal, test pits were excavated throughout the central portion of the DDA-1/DDA-2 excavation under the direction of NJDEP to confirm that all debris had been identified and removed.

Approximately 2,483 tons of contaminated soil and debris were removed from DDA-1. Post excavation samples were collected and analyzed for VOCs. Twenty-five percent of the samples

were analyzed for PAHs, PCBs, and metals. Results for these samples did not exceed any NJDEP standard.

Approximately 1,440 tons of contaminated soil mixed with waterless hand cleaner cans was removed from DDA-2. All post excavation samples were analyzed for VOCs. A subset of the samples was analyzed for PAHs, PCBs, and metals. Results for these samples did not exceed any NJDEP standard. The USACE recommended NFA for DDA-1 and DDA-2.

2.4.14 Ramp Area – Supplemental Remedial Investigation

Weston (2005a) conducted a Supplemental RI for the Ramp Area. The Ramp Area contained three major potential contamination source areas requiring further delineation: (1) the previous 2002 excavation area, (2) the previous 1998 excavation area, and (3) the former leach field. Twenty soil borings were completed in the Ramp Area. All soil borings were advanced to the depth where the semi-confining clay/sand layer was encountered.

Four soil borings were completed in the area of the 2002 excavation. Soil samples were collected at depths ranging from 14 to 29.5 ft bgs. One sample (collected from 29 to 29.5 ft bgs, below the water table) contained PCE and TCE concentrations above the IGWSCC. This was the deepest sample collected during this investigation. Thus, vertical delineation was not completed in this area.

Three soil borings were completed in the area of the 1998 excavation. Soil samples were collected at depths ranging from 15.5 to 32 ft bgs. Groundwater was encountered 16 ft bgs in the soil borings. Two samples at/below the water table contained CVOCs (cis-1,2-DCE, TCE, and VC) concentrations exceeding the NJDEP IGWSCC. Concentrations of these CVOCs in the deeper soil samples were less than the IGWSCC. Therefore, the vertical delineation was completed. However, it appeared that the 1998 excavation, which extended to a depth of 15 to 17 ft bgs, did not remove all of the soil contamination.

VOC concentrations measured in samples collected from the three soil borings in the former Leach Field did not exceed NJDEP IGWSCC. Of the 10 soil borings drilled along the perimeter of the two excavated areas, two soil borings contained TCE concentrations that exceeded the NJDEP

IGWSCC. Concentrations of TCE in deeper soil samples at both of these locations were below IGWSCC. Therefore, the horizontal extent of the contamination was not fully delineated. The vertical extent of contamination was delineated.

The recommendations from the Supplemental RI stated:

- The groundwater remedial action work plan (RAWP) for Groundwater AOC 2 was planned to be revised to include a treatability study;
- Use of in-situ treatment to remediate soil contamination at the Ramp Area and 1998 Excavation Area concurrently with groundwater was planned; and
- NFA was recommended for the former Leach Field.

2.4.15 Treatability Studies

Shaw conducted two groundwater treatment pilot studies for Groundwater AOC 2 (Shaw, 2008 and 2010). Two areas were evaluated: Area 1 (MW-114 which includes the Investigation Area 18C - Ramp Area) and Area 2 (MW-165-1 which is adjacent to 165 Fieldcrest Avenue and downgradient of the AOC 2 source area).

The first treatment was injection of an in situ chemical oxidation (ISCO) compound, focused at Area 2. The second pilot study consisted of biostimulation/bioaugmentation at Area 1. The results of the bench-scale treatability studies have shown that:

- ISCO is a viable in situ groundwater treatment option to pilot test for Area 2, but soil oxidant demand (SOD) in the Area 1 source area is too high for ISCO to be applied.
- SOD data for Area 2 is limited and variability is not known.
- Anaerobic biostimulation is not a viable in situ groundwater treatment option to pilot test for either Area 1 or Area 2.
- Anaerobic bioaugmentation is a viable in situ groundwater treatment option for Areas 1 and 2.
- Aerobic biostimulation is a potentially viable in situ groundwater treatment option for the site if adequate time is allowed for a sufficient population of methanotrophic bacteria to develop.

- Aerobic bioaugmentation is not a viable in situ groundwater treatment option to pilot test for either Area 1 or Area 2.

2.4.16 Asbestos Landfill Focus Informational Paper

A Focus Informational Paper was developed as a means to determine a clear understanding of the party responsible for the Asbestos Landfill Area and the contamination present therein (USACE, 2014b). Based on the historical documents and aerial photographs, testimony from EPA personnel, memoranda from USACE, geophysical surveys, and RI reports, the contamination (asbestos and chemical contamination) associated with the Asbestos Landfill is not the result of activities managed or conducted by the DoD on the former Raritan Arsenal. This landfill is a result of GSA-directed demolition conducted in the late 1970s and early 1980s. Contamination (asbestos and non-asbestos related) associated with the Asbestos Landfill is not quantitatively evaluated in this RI and is not considered in future decisions on remediation of the EPA/GSA Area.

Appendix C contains the Asbestos Landfill Focus Informational Paper submitted to NJDEP on 27 February 2014, NJDEP comments on the paper dated 17 July 2014, and a revised paper based on the NJDEP comments dated January 2015.

2.5 AREA 18E – FORMER MAINTENANCE AREA

Area 18E includes three former Army buildings that were demolished by EPA in 1997: Buildings 14, 15, and 19 (Figure 2-1 includes the outline of the demolished buildings). Based on the ASR (Dames and Moore, 1993a), Building 14 served as a small arms shop; Building 15 served as a machine shop; and Building 19 was referred to as a vehicle rebuild assembly shop. Review of historical aerial photography indicated that the three buildings were joined together as of 1940. Sections 2.5.1 through 2.5.8 list all investigations/response actions associated with Area 18E in chronological order.

2.5.1 Phase II Supplemental Record Review/Site Inspection

A Phase II Supplemental Record Review/Site Inspection (Weston, 1997) was conducted by Weston to confirm the exact usage and waste practices associated with former Buildings 14, 15, and 19.

Weston conducted physical on-site inspections of the interior and exterior of Buildings 14, 15, and 19 prior to the demolition of these buildings. During the 1997 demolition activities, the AOCs identified during the inspections as well as additional AOCs identified by Weston during demolition activities (based on OVM field screening/observations) were characterized through a soil sampling program. This soil sampling program was conducted in conjunction with demolition activities. The results of the characterization indicated that soil within Area 18E had detected concentrations above the most stringent NJDEP criteria for the following compounds:

- TCE within the area encompassing former Buildings 14, 15, and 19;
- PCE within the area encompassing former Building 14;
- Chloroform within the area encompassing former Building 19; and
- Metals (antimony, arsenic, beryllium, copper, lead, and zinc) within the area of former Building 19.

2.5.2 Supplement 2 Phase II Remedial Investigation

During the Supplement 2 Phase II RI (Weston, 2000), a geophysical investigation, consisting of EM, GPR, and MAG surveys, was conducted in the vicinity of a suspected former UST location in Building 14 and at a suspected former UST location west of Building 14. Additionally, 24 soil borings were advanced in the areas that were not investigated during the October 1997 investigation. Two of these soil borings were sampled at 0 to 0.5 ft bgs and 1.5 to 2.0 ft bgs. All other soil borings were sampled at 1.5 to 2 ft bgs only. The samples collected from three soil borings were analyzed for VOCs and PCBs. The sample collected from one soil boring was analyzed for VOCs, PCBs, and metals. Samples collected from all other soil borings were analyzed for VOCs only.

The geophysical survey covered two separate areas believed to contain former USTs. The data collected indicated that USTs or other subsurface anomalies suggestive of MEC were not present at either location. A number of miscellaneous sources of metal debris (buried utility lines, reinforced concrete, etc.) were detected in both areas.

The analytical results of the soil samples indicated that PCE and TCE were present at several locations at concentrations above the IGWSCC, but below the RDCSCC and NRDCSCC within the footprints of the former buildings. TCE and PCE were detected in the samples collected from the former Building 14 TCE tank vent locations. TCE was detected between former Buildings 14 and 15 near the former drain lines. TCE was detected in the northeast corner of former Building 15 near the former degreaser and still. TCE was detected in soil below the floor slab of the former Artillery Annex Shop. TCE and chloroform were detected in subsurface soils along the former railroad track bed adjacent to Building 19. Chloroform was detected at one location at a concentration above the IGWSCC, but below the RDCSCC and NRDCSCC. Chloroform was delineated to the southeast only and was not delineated vertically. PCE was detected above the NRDCSCC and IGWSCC at one location. PCE was delineated to the north, but was not delineated to the south, east, west, or at depth.

Metals were also detected above their NRDCSCC at four of the locations sampled. These metals included arsenic, beryllium, copper, lead, and zinc in soil samples collected from gray-stained soil near former Building 19, arsenic in a soil sample collected from soil below the floor slab of the former Artillery Annex Shop, and arsenic and lead in subsurface soils along the former railroad track bed, adjacent to former Building 19, at concentrations similar to those seen in rail bed at other locations within the former Raritan Arsenal. Zinc and beryllium were detected in samples collected from one boring with concentrations only slightly exceeding the NRDCSCC. This suggested that these analytes (metals) were present in *de minimus* quantities at these locations and required no further action. PCBs were not detected above their NRDCSCC in any of the samples collected in Area 18E.

Additional sampling was planned to be conducted in Area 18E during a future action to delineate the extent of TCE in soil. This sampling would allow for evaluation of TCE concentrations at depth and determination of the contribution, if any, of former activities in Area 18E on groundwater AOCs. The results of this sampling was planned to be used to indicate whether additional action is required at Area 18E.

2.5.3 Engineering Evaluation/Cost Analysis

The reported use of this area for small arms maintenance and the historically developed nature of the area, consisting of some of the original Raritan Arsenal buildings, suggests a low probability of OE contamination. However, one item (a 57-mm projectile) considered to be MD was discovered in this area. No items were identified during 1999 geophysical surveys and a soil removal action performed in 2013. Area 18E was historically developed and the area surrounding Area 18E is almost completely developed. The OE density was considered to be minimal for all depths in this area. The risk of OE exposure in this area for both current and future use was considered low.

2.5.4 Final Supplemental Remedial Investigation – First Phase

The Final Supplemental RI presents the results of the first phase of the 2-phase Supplemental RI (Weston, 2011). The first phase of the supplemental investigation was conducted from October 2004 through March 2005 to address soil impacted with VOCs and metals, with a specific focus on determining if the soil contamination previously identified represented a source of contamination to groundwater. The field activities included MEC clearance for sampling locations, soil sampling, shallow groundwater sampling, and MW installation and groundwater sampling. The following soil AOCs were investigated: TCE Tank Pit Vent Area, Tile Drain and Vault/Transformer Pit Area, Artillery Annex Shop and Degreaser/Still Area, Former Railroad Track Bed Area, Former Gasoline Tank Areas, Former Transformer/Vault Pit Areas, and Former Sample Locations 18E19 and 18E20. No anomalies were identified in the soil borings that were screened for MEC. Following MEC clearance, soil borings were completed and discrete soil samples were collected. The table below summarizes the soil samples collected from each soil AOC.

Soil AOC	Number of Soil Borings	Number of Soil Samples	Analyses
TCE Tank Pit Vent Area	5	10	VOCs
Tile Drain and Vault/Transformer Pit Area	7	14	VOCs
Artillery Annex Shop and Degreaser/Still Area	8	21	17 - VOCs 4 - metals
Former Railroad Track Bed Area	7	11	7 - metals 1 – VOCs

Soil AOC	Number of Soil Borings	Number of Soil Samples	Analyses
			3 - VOCs and metals
Former Gasoline Tank Areas	2	4	VOCs
Former Transformer/Vault Pit Areas	6	12	VOCs and PCBs
Former Sample Locations 18E19 and 18E20	2	4	VOCs

TCE and arsenic were the only compounds detected in soil during the supplemental investigation exceeding their respective NJDEP criteria. TCE exceeded its most restrictive NJDEP criteria in three of the 65 samples analyzed for VOCs and arsenic exceeded in one of the 14 samples analyzed for metals. The soil results did not indicate any new sources of contamination or indicate the need for an immediate interim response action. Furthermore, soil VOC concentrations in samples collected immediately above the groundwater table did not indicate any exceedances of the NJDEP criteria.

Delineation (both horizontal and vertical) has been completed for three of the soil AOCs: TCE Tank Pit Vent Area, Tile Drain and Vault/Transformer Pit Area, and Former Sample Location 18E19 and 18E20 Areas. Delineation has not been completed for the Artillery Annex Shop and Degreaser/Still Area and the Former Railroad Track Bed Area.

Two of the soil AOCs were investigated for the first time: Former Gasoline Tank Areas and Former Transformer/Vault Pit Areas. At one of the six former Transformer/Vault Pit Areas, TCE was detected at one soil boring location at a concentration exceeding the NJDEP IGWSCC and RDCSCC. This TCE exceedance has been horizontally and vertically delineated. PCBs were not detected in the samples collected from the Former Transformer/Vault Pit Areas.

Following completion of the soil sampling, the preliminary analytical results were reviewed to select locations for the collection of shallow groundwater grab samples collected using Geoprobe®. It was determined that 11 locations would be proposed to NJDEP for the collection of a groundwater grab sample. The NJDEP agreed with the proposed locations. The samples were collected in November 2004 and analyzed for VOCs.

MW locations were selected based on the grab sample results from the November 2004 event and the July 2004 sampling round that collected samples from existing MWs in the northern portion of the groundwater AOC 8 plume. The new MWs (MW-133 through -137) were installed in November 2004 and sampled in March 2005. The samples were submitted for VOC analysis.

TCE was detected in the groundwater throughout Area 18E at concentrations exceeding the NJDEP GWQS. The highest concentrations of TCE in groundwater were detected in the northeastern portion of Area 18E, adjacent to the parking lot. The next highest TCE concentration was detected north of Building 18. These areas are located within or hydraulically downgradient of areas where TCE was detected in soil at the highest concentrations.

In the areas where TCE was detected in soil and groundwater at its greatest concentrations, a 3.5 to 4 ft bgs soil sample was collected to vertically delineate the TCE concentrations previously detected in the 1.5 to 2 ft bgs interval. The analytical results from the 3.5 to 4 ft bgs soil samples indicated that TCE concentrations remained approximately the same at depth at one soil boring location and increased with depth at another soil boring location.

Area 18E is situated within Groundwater AOC 8, which is being addressed as part of the site-wide groundwater investigation. The groundwater data collected as part of this supplemental investigation were planned to be incorporated and further evaluated as part of the site-wide groundwater evaluation. Additionally, in areas where soil and groundwater data were collected within 100 ft of an existing building, these data were planned to be evaluated and included as part of the evaluation of potential vapor intrusion pathways at the former Raritan Arsenal.

2.5.5 EPA Building Inspection

As described in the Final Supplemental RI for Area 18E (Weston, 2011), EPA conducted subslab soil gas (December 2004) and indoor air (January 2005) investigations under and within selected buildings on their property to evaluate the potential for vapor intrusion (VI) into the buildings. USACE conducted a follow-up investigation from January through March 2005. The primary objectives of the USACE investigation were to confirm the EPA subslab soil gas results and to identify potential sources of the elevated VOC concentrations detected during EPA's December 2004/January 2005 investigations. Based on EPA's findings, the USACE investigation focused on

Buildings 10, 200, 205, and the old Guard Shack with subslab soil gas samples collected at the listed buildings and soil and groundwater samples collected beneath or near Buildings 200, 205, and the Guard Shack. Subslab soil gas was not re-sampled at Building 18 because the selected EPA-installed monitoring point had been abandoned and filled with clay.

The results of USACE investigation confirmed the EPA subslab soil gas results. TCE concentrations detected in the subslab soil gas results were significantly greater than those detected in the EPA indoor air investigation. The Groundwater AOC 8 - EPA Buildings Investigation Report (Weston, 2005b) noted that the highest TCE concentrations in subslab soil gas and in groundwater were detected at the old Guard Shack.

TCE was detected in groundwater in the vicinity of Buildings 200, 205, and the old Guard Shack and in soil beneath Buildings 200 and 205 at concentrations in groundwater and soil exceeding their respective NJDEP criteria. TCE was detected in groundwater at concentrations exceeding the NJDEP GWQS and EPA's Generic Vapor Intrusion Screening Levels for Groundwater. TCE was detected in soil exceeding the NJDEP IGWSCC, but below the NJDEP RDCSCC and NRDCSCC.

The results of this investigation indicated that a potentially complete VI pathway for soil gas to indoor air existed for Buildings 10, 200, 205, and the old Guard Shack. For Building 200 and the old Guard Shack, the sources of TCE detected in soil and groundwater were unknown. For Building 205, the TCE detected in soil and groundwater may be related to the historical use of this building for degreasing activities. Subslab soil gas concentrations cannot be explained by the maximum TCE concentrations detected in groundwater alone. It is likely that the TCE concentration detected in soil as well as unidentified potential sources in the vicinity of old Guard Shack and former structures associated with the historical use of Building 205 are responsible for the significant levels of the TCE detected in subslab soil gas. Further discussion of the indoor air quality is presented in Section 2.9.

2.5.6 Final Supplemental Remedial Investigation – Second Phase

Based on the field investigation conducted in 2004, the second phase of the investigation included a soil delineation investigation performed in August 2009 and a groundwater investigation in

September 2009 (Weston, 2011). Additional soil and groundwater sampling was conducted in December 2009 to complete contaminant delineation in Area 18E. The various field activities included MEC clearance for the proposed sampling locations, a utility survey, soil sampling activities, MW installation, and groundwater sampling activities.

The soil boring program was completed in August 2009. A total of 47 soil borings were advanced to adequately delineate the VOCs and metals contamination within Area 18E. The December 2009 effort included drilling 16 soil borings, which were added to complete the delineation at Area 18E. The soil samples were analyzed for VOCs, PCBs (subset of samples), and metals.

MW locations were selected based on groundwater analytical results from the previous supplemental RI as well as other historical data. The newly installed MWs (MW-154 through -157) were sampled in September 2009 and analyzed for VOCs.

The analytical results fully delineated (horizontally and vertically) soil contamination for arsenic and TCE identified during prior investigations at Area 18E. The results of this investigation indicated that the TCE-contaminated soil previously identified at Area 18E has impacted groundwater within Groundwater AOC 8A/B and the new MWs have adequately delineated the extent of AOC 8A/B. The results of this investigation have further delineated groundwater contamination in the vicinity of Building 200 and the former Guard Shack. Soil in two sub-areas in the northern portion of Area 18E near former Building 15 is potentially a residual source of TCE to the groundwater. It is likely that the groundwater concentrations are contributing to soil gas beneath buildings.

The extent of arsenic contamination along the former railroad tracks has been delineated horizontally and vertically. However, the contamination along the railroad tracks is most likely due to the installation, operation, and maintenance of the tracks. Per the FUDS program, the DoD is responsible to investigate and remediate CERCLA releases. The areas along the former rail lines do not have a history of a CERCLA release nor does the DoD bear the legal burden to produce such evidence. The contamination levels are attributed to the fill and material that were used to construct the rail beds and the application of herbicides and insecticides and not the result of CERCLA release. CERCLA expressly states that no person may recover under CERCLA 107 (42

U.S.C 9607) for any response costs or damages resulting from the application of a registered pesticide. FIFRA defines pesticides to include herbicides (see 7 U.S.C. 136). This means that the arsenic is not considered hazardous substances under CERCLA, and that there is no CERCLA release. If there is no CERCLA release, then there is no authority to act under the FUDS program. For the foregoing reasons, USACE cannot and will not take any further samples along rail beds and the DoD should not be responsible for contaminated fill that may have been used to construct these areas.

2.5.7 Engineering Evaluation/Cost Analysis

Under contract to the USACE, H&S Environmental developed an EE/CA to support a non-time critical removal action (NTCRA) for soils at Area 18E (H&S Environmental, 2011). The objectives of the EE/CA were to identify the removal action objectives (RAOs) and evaluate the removal alternatives that might be used to fulfill these objectives based on effectiveness, implementability, and cost.

Excavation and off-site disposal was identified as the interim response action that best satisfies the evaluation criteria based on the comparative analysis. This determination was based on the proven effectiveness of the action, the ease of implementation, and the relative cost. The preferred alternative would excavate and remove approximately 1,850 cy of TCE, PCE, and arsenic contaminated soil from Area 18E. This remedial alternative had the lowest cost of all the other removal alternatives except for the no-action alternative, compares favorably with the other alternatives, and provides a proportionately higher level of protection of human health and the environment. In addition, the excavation and off-site disposal of the contaminated soils were expected to result in a permanent solution that requires no additional long-term oversight, operation and maintenance, or monitoring.

2.5.8 Non-Time Critical Removal Action (NTCRA) – 2011

H&S Environmental conducted a NTCRA at Area 18E in late 2011 (H&S, 2013). The RAOs and cleanup goals for the NTCRA are provided in the *Final Engineering Evaluation/Cost Analysis (EE/CA) – Revision 1* (H&S, 2011). To define the RAOs for the site, the results of the site characterization and streamlined risk evaluation were examined in an effort to construct removal

goals that comply with the ARARs and are protective of human health and the environment. Based on this process, the following RAOs were identified:

- Reduce human exposure to TCE, PCE, and arsenic in the contaminated soil found in the vadose zone to acceptable levels as defined by the NJDEP Remediation Standards, and by doing so, remove the source of TCE contamination to groundwater.
- Reduce ecological exposure to TCE, PCE, and arsenic in the contaminated soil to acceptable levels.
- Reduce off-site transport of TCE, PCE, and arsenic via surface runoff, migration to groundwater, and wind dispersion.

To ensure achievement of the RAOs, the USACE requested that H&S conduct removal actions to achieve concentrations equal to or less than 1 mg/kg for TCE and PCE and 19 mg/kg for arsenic.

Excavations were performed at five areas to remove elevated concentrations of TCE and other VOCs. The excavation areas are shown on Figure 2-1. It is noted that MEC items were not observed during any of the response activities. Approximately 2,960 tons of soil was excavated and transported to Middlesex County Landfill for disposal. Ninety-three soil confirmatory samples were collected and analyzed by an off-site USACE-approved laboratory for VOCs and metals by EPA Method 8260B and EPA Method 6010B and 7471A, respectively. Results of all soil samples were below the cleanup goal of 1 mg/kg for PCE, 84 of the 93 TCE samples were below the cleanup goal of 1 mg/kg, and 82 of the 93 total arsenic confirmation samples were below the cleanup goal of 19 mg/kg. Eight total arsenic confirmation samples exceeded the remediation goal in Removal Area 1, which was located along former railroad tracks.

Upon completion of the excavation activities, the site was restored back to natural grade with general soil backfill and topsoil and then seeded. All equipment was demobilized. Representatives from USACE, EPA, and H&S conducted the final visual inspection of the sites and there were no outstanding issues (H&S, 2013).

2.6 AREA 18F – FORMER WAREHOUSES

Area 18F is approximately 43 acres and historically contained a small arms packing operation and several warehouses. The Archives Search Report indicated Building 202, located within Area 18F,

was used for parts storage and truck storage in 1918 and 1919. A fire occurred in Building 202 in 1929. Inert ordnance materials including fuses, bomb casings, wooden containers, and cartridge cases were stored in Building 202 in 1935. A reproduction office including blueprint machines, dark rooms, and sinks was located at an unspecified location within Building 202. However, this building was referred to as the packing and shipping shed in 1943. Wrenches, ordnance tools, and shovels were stored in Building 202 in 1946. The GSA owned Building 202 from 1963 until the early 1970s when the EPA acquired the property. Building 202 was demolished in 1994.

Inert ordnance materials including fuses, bomb casings, wooden containers, and cartridge cases were stored in Building 203 (located within Investigation Area 18F) in 1935. A pit of unspecified size was located along a steam pipe trench at an unknown location within Building 203. The GSA owned Building 203 from 1963 until the early 1970s, when it was transferred to the EPA. Building 203 was demolished by EPA in 1994.

The area between former Buildings 202 and 203 has been filled with brick, concrete, and other building demolition debris by EPA. A former railroad line ran between former Buildings 202 and 203 (see Figure 2-1). A 15 to 20 foot long excavation was observed in the fill material between Building 202 and Building 203 during a site inspection conducted by Weston in April 1996 (Weston, 1997). A 6-inch to 8-inch diameter metal pipe was observed traversing the excavation. A 1-foot diameter PVC pipe was observed entering the excavation from the north, potentially discharging in this area. The excavation was an intentional void left within the construction debris backfill between the foundations of Buildings 202 and 203 by EPA to allow for the drainage of local storm sewers. EPA indicated that the 6- to 8-inch diameter pipe was a steam pipe, no longer in use, that was historically used for heating Buildings 202 and 203.

Reported historical use in former Building 202 for small arms packing suggest the possibility of MEC. However, the area was surface cleared prior to closure of the arsenal in 1963. No subsequent MEC investigations have been conducted, but since the area is almost entirely covered by original Raritan Arsenal structures, the likelihood of subsurface MEC is small.

As depicted on Figure 2-1, Investigation Area 18F includes the area owned by the EPA as well as area not owned by the EPA including the Beechwood Development area and the area around

former Building 216. The portion of Investigation Area 18F that is owned by the EPA was evaluated in this report. Sections 2.6.1 through 2.6.5 list all investigations associated with Area 18F in chronological order.

2.6.1 Site Inspection

One surface soil sample was collected in the area between former Buildings 202 and 203 along the abandoned railroad tracks during the Site Inspection in 1985. The sample contained concentrations of arsenic, copper, lead, and DDT exceeding the NJDEP RDCSCC. Arsenic, copper, and lead concentrations also exceeded the NRDCSCC in this sample.

2.6.2 Site Listing

Eleven surface soil samples were collected during the Site Listing investigation in 1990 to further investigate the extent of potential metals contamination. The samples were analyzed for select metals (arsenic, chromium, copper, and lead) using a field portable XRF instrument. The analytical results indicated that concentrations of arsenic, copper, and lead exceeded the NJDEP RDCSCC and NRDCSCC. Confirmatory analysis performed on five of the samples indicated that antimony, arsenic, beryllium, cadmium, chromium, copper, lead, and zinc concentrations exceeded the RDCSCC. Arsenic, beryllium, chromium, copper, lead, and zinc concentrations also exceeded the NRDCSCC.

2.6.3 Supplemental Phase II Remedial Investigation

The Supplemental Phase II RI report presents the results of the sampling activities performed from April through July 1996 (Weston, 1999b). Sampling focused on the area between former Buildings 202 and 203 to further investigate the elevated concentrations of metals detected previously. A total of 38 soil samples were collected from 18 soil borings for laboratory analysis. In general, two surface soil samples were collected from the top 2 ft of soil, below the construction debris (e.g., bricks) that was placed in this area by EPA. One sample was collected from the 0 to 0.5 ft bgs (upper surface soil sample), and the second sample was collected from 1.5 to 2 .0 ft bgs (lower surface soil). The soil samples were analyzed for metals. One well (MW-108A) was installed.

The analytical results indicated that several metals were present at concentrations exceeding the NJDEP NRDCSCC throughout the portion of Area 18F that was sampled. The samples were collected along a transect where an abandoned set of railroad tracks was located between Buildings 202 and 203. Arsenic was detected above the NJDEP NRDCSCC in 20 samples. Chromium, copper, and zinc were detected in one sample at concentrations that exceeded the NRDCSCC. Lead was detected above the NRDCSCC in 12 samples. All other metals were either not detected, or were detected at concentrations below the NRDCSCC.

A review of Army files revealed that historical activities and items stored in Buildings 202 and 203, including inert fuses, bomb casings, cartridge casings, tools, and vehicles, may have contributed to the metals contamination observed. A more likely source for most of the metals present is the abandoned set of railroad tracks that existed between the two buildings. EPA has filled the area with building demolition debris to raise the grade to that of the adjacent building foundations and may have plans to further develop the site.

Groundwater sample results from monitoring wells MW-EPA-6A and MWEPA-10A, which are located southeast and slightly side gradient, have indicated that the elevated metals found within this portion of Area 18F have not significantly impacted the local groundwater. In order to determine whether contamination was confined to the filled railroad loading/unloading area, additional sampling (four soil borings) was proposed to the north and south of the fill area. All four soil borings were planned to be located in areas containing soil, and most likely to receive surface water runoff from the filled railroad loading/unloading area. Two samples were planned to be collected from each boring at the northern end (0 to 0.5 and 1.5 to 2 ft bgs) and analyzed for arsenic and lead to further delineate the extent of these analytes. The two borings at the southern end of the filled area were planned to be advanced across the road from the building foundations. It was necessary to sample across the road because the entire area is paved south of the existing soil borings. Two samples were planned to be collected from each of these borings and analyzed for arsenic and lead to further delineate the extent of these contaminants at this end of the AOC. Each of the sampling locations also potentially receives runoff from roadways and parking areas actively used by EPA. These samples were collected as part of the Supplement 2 Phase II RI.

2.6.4 Supplement 2 Phase II Remedial Investigation

During the Supplement 2 Phase II RI (Weston, 2000), the samples that were proposed in the Supplemental Phase II Report were collected. The results of the samples indicated that the NRDCSCC for arsenic was exceeded in seven of the eight samples collected. The arsenic in the northwestern portion of the study area has been delineated vertically. Lead was detected in all eight samples collected during the Supplement 2 Phase II RI. However, only two samples collected from one soil boring contained lead concentrations above the NRDCSCC. Therefore, lead has been delineated horizontally to the northwest, southwest, and southeast. Lead has not been delineated vertically. The USACE recommended NFA (no capping required). In a comment letter dated August 2, 2002, NJDEP indicated that the following issues needed to be addressed by USACE: (1) address how the potential extent of metals (arsenic and lead) beneath the former buildings will be determined for remedial decisions and deed notices, (2) complete the vertical delineation of arsenic and lead contamination, and (3) evaluate the potential extent of groundwater impact.

2.6.5 Engineering Evaluation/Cost Analysis

Investigation Area 18F is a developed area owned by EPA. Reported historical uses of this area suggest the possibility of ordnance contamination; however, the area was surface cleared prior to closure of the arsenal in 1963. No subsequent OE investigations of this area have been conducted, but since the area is almost entirely covered by original Raritan Arsenal structures, the likelihood of subsurface OE contamination is very small. It was determined the OE density to be minimal for all depths in this area. The risk of OE exposure in this area for both current and future use was considered low.

2.7 AREA 18G – FORMER DUMP

Area 18G is approximately 21 acres and was historically used for equipment storage, as a gasoline station and automotive shop, and as a dump. Information reported in the Dames and Moore Archive Search Report (1993a) indicated that a dump was historically located in this area and had been covered over with concrete (Figure 2-1). The dump was reportedly used by Columbia Salvage Company to dispose of scrap material generated during the ammunition salvage

operations. The timeframe associated with dumping activities is not known. In 1919, the former Arsenal was assigned the task of salvaging "...ammunition that was either so old that it was considered obsolete or so deteriorated that its continued presence within the former Arsenal might prove hazardous." Columbia Salvage Company was one of three salvage companies that began conducting ordnance salvage operations in 1919 directly on or near the former Arsenal grounds under the direction of the Arsenal military personnel.

A gasoline station storage building and automotive shop were historically located near the northern corner of Area 18G, where it borders Area 18F. The exact dates for when the station was constructed and when the station was removed are unknown. However, the station was actively utilized by GSA/EPA into the 1980s. The two USTs (identified as A1 and A2) previously located there were removed by the EPA in 1991. Tank Al was a 5,000-gallon unleaded gasoline UST and Tank A2 was a 2,000-gallon diesel fuel UST.

Sections 2.7.1 through 2.7.6 list all investigations/response actions associated with Area 18G in chronological order.

2.7.1 Site Inspection

Surface soil samples collected in the open portion of Area 18G as part of the 1985 NUS Site Investigation contained concentrations of PAH compounds exceeding the RDCSCC and NRDCSCC.

2.7.2 UST Removals

The EPA removed USTs A1 (unleaded gasoline) and A2 (diesel fuel) at the former gasoline station, obtained post-excavation soil samples, and installed and sampled two MWs (MW-EPA-6A and MW-EPA-7A). The EPA submitted closure plans and closure reports (NJDEP UST Closure Report Approval No. C-90-0267) to the NJDEP BUST in October 1992. The soil samples contained no contaminants of concern and the groundwater samples did not contain contaminants related to the fuel stored in the tanks. The groundwater samples obtained from MW-EPA-6A and MW-EPA-7A contained chlorinated VOCs. The well located near the gasoline pump island (MW-EPA-6A) also contained lead at a concentration exceeding the NJDEP GWQS.

2.7.3 Phase II Supplemental Record Review/Site Inspection

A Phase II Supplemental Record Review/Site Inspection (Weston, 1997) was conducted by Weston to confirm the exact usage and waste practices associated with former Building 241 which was located within Area 18G. GSA owned Building 241 from 1963 until 1988, when it was transferred to the EPA. Building 241 was demolished by EPA.

Physical on-site inspections of former location of Building 241 were conducted in April 1996 and September 1997. A concrete pad that had connected the southern end of Building 241 with Bonhamtown Road remained on-site at the time of the inspections. A lack of vegetation was observed in the vicinity of Building 241, attributed to the recent demolition of the building. Debris including pieces of bricks were scattered around the former location of Building 241. The EPA facilities representative that accompanied the personnel from Weston performing the inspection stated that the GSA had stored paint, asbestos roofing tar, and drums of paint and oil in Building 241. However, the EPA hired a contractor to remove the stored material prior to the demolition of the building.

The EPA representative stated that a 22-foot by 13-foot concrete lined sand pit had been located in Building 241. A drain was located at the bottom of the pit. The EPA representative indicated that the drain discharged into a manhole that was connected with the sanitary sewer line. Although the sand pit location was not evident due to the building demolition, the location of the former pit was marked on Bonhamtown Road as being 65 feet east of the road marking.

The EPA representative stated that PCB-containing transformers had been drained into the pit; but could not provide documentation of this activity, including whether it was done by GSA or the Army. PCBs have been detected by EPA in samples collected from the sand pit, a "nearby manhole", and the "downgradient manhole". EPA has requested that the USACE conduct an additional investigation into the possible migration of contaminants from the sand pit and the sanitary sewer lines. It should be noted that the sand pit was not located on any historical plans for Building 241. The EPA representative believed that the sand pit was built when Building 241 was constructed in the 1940s. Since the building was constructed by the DoD and it was their common practice at that time to discharge onto the ground and adjacent to the railroad tracks, the EPA

representative indicated that he believed that the DoD and GSA spilled PCB contaminated oil into the sand pit.

No documentation other than the EPA sampling results was offered by EPA or discovered by Weston that corroborates this theory. Information related to past operations in Building 241 is unavailable from GSA. The sand pit has been covered with a geotextile layer. No stained soil was observed in the vicinity of Building 241 during the inspection.

It was recommended in the Phase II Supplemental Record Review/Site Inspection (Weston, 1997) that the source of PCBs identified in the sand pit and sanitary sewer be investigated. The investigation of this area was planned to be pursued under a separate potentially responsible party contract by the USACE.

2.7.4 Supplemental Phase II Remedial Investigation

The Supplemental Phase II RI report presents the results of the sampling activities performed from April to July 1996 (Weston, 1999b). Four AOCs were identified in Area 18G, including the former dump, a former automotive shop (Building 241), groundwater (AOC 3), and surface soil contamination previously identified by NUS. The former dump, groundwater, and surface soil contamination identified by NUS were investigated during the Supplemental Phase II RI. The soil sampling program included drilling soil borings to investigate the former dump and potential surface soil contamination near locations previously sampled by NUS. A total of 48 soil samples were collected for laboratory analysis.

Six soil borings were advanced in the former dump area to assess whether the material could be a potential source area for groundwater contamination. Two soil borings were drilled to depths of 6 ft each, but samples were not collected because it was determined that they were not located within the boundaries of the former dump. The remaining 16 soil borings were advanced to further investigate areas where previous NUS sampling indicated that concentrations of PAH compounds exceeded the NJDEP criteria.

In general, samples were collected at three intervals from the four soil borings in the former dump. These intervals consisted of an upper surface soil sample, an intermediate sample representative

of the fill material, and a sample either 6 inches above groundwater or 9.5 to 10 ft below the fill material. All 12 samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and TNT screening. One sample was also submitted for laboratory explosives analysis.

The remaining 16 soil borings (advanced around previous NUS sample locations where PAH results exceeded RDCSCC) were sampled from 0.0 to 0.5 foot bgs and 1.5 to 2.0 ft bgs (the upper and lower surface soil intervals). These samples were analyzed for PAHs. One soil boring was sampled at a third interval (1.0 to 1.5 ft bgs) due to the presence of a naphthalene-like odor. This sample and was analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and explosives.

The analytical results for soil samples indicated that PAHs and metals were present at concentrations exceeding the most stringent NJDEP criteria. It should be noted that the majority of this area is covered with crushed, weathered asphalt, which was reportedly difficult to avoid (or sift out) when collecting the 0.0 to 0.5-foot interval samples.

Four of the 13 samples from the former dump area contained concentrations of PAHs that exceeded the NRDCSCC. Two of these samples were surface soil samples that contained marginal benzo(a)pyrene exceedances, while the exceedances detected in the two other samples were in subsurface samples where multiple PAH compounds were detected. The highest concentrations of PAHs in the former dump area were detected in the subsurface soil samples. This is not unusual considering that this area is a former dump and the subsurface borings logs indicated that railroad tie wood, slag, ash, and coal were present (which all typically contain PAHs).

Copper, lead, and zinc were also detected at concentrations exceeding the NJDEP NRDCSCC in the former dump. Two of the 13 soil samples exhibited exceedances. Copper was detected above the NRDCSCC in one subsurface sample. The extent of elevated copper appears to be limited to this boring. Lead was detected above the NRDCSCC in two subsurface samples. The extent of lead appears to be limited to these two soil boring locations. Zinc was detected above its NRDCSCC in one subsurface sample. It appeared that elevated zinc concentrations were limited to this boring.

PAH exceedances were randomly distributed within this AOC and are mainly attributed to the fill material encountered. However, other potential sources of PAHs, including asphalt paving associated with the active EPA heliport and nearby roads may also have contributed to the presence of PAHs. Due to the fact that the highest concentrations of PAHs were in subsurface samples (the surface soil PAH exceedances were marginal), there is little potential for direct contact exposure to these compounds. The copper, lead, and zinc exceedances were detected in two subsurface samples collected at two soil borings. As with the PAH contamination, the elevated concentrations of metals were believed to be directly related to the nature of the fill material present (including slag, cinders, wood, metal fragments, asphalt, brick, and pieces of coal). Based on the 1994 groundwater sampling results for MW-87A (located approximately 600 ft downgradient), PAH compounds and metals have not impacted the groundwater. Therefore, due to a lack of direct contact exposure and evidence suggesting that groundwater has not been impacted by the contaminants, NFA was recommended for PAHs and metals for Area 18G. The NJDEP agreed with this approach in a comment letter dated October 9, 1997, but recommended that the physical extent of the dump be delineated to ensure that it was adequately capped. The physical extent of the former dump was planned to be defined using geophysical methods, such as an EM and/or ground penetrating radar (GPR) survey. Exploratory soil borings were planned to verify the limit of the former dump as interpreted from the geophysical investigation results. Eight soil borings were planned to be advanced to a maximum depth of 24 ft bgs. The borings were planned to be stopped once they have been advanced a minimum of two ft into natural soil. Four of the borings were planned to be advanced at the edge of the dump limits and four borings were planned to be advanced just beyond the predicted edge of the dump limits.

The analytical results for soil samples collected around the previous NUS locations indicated that PAH compounds and arsenic were present at concentrations exceeding the NJDEP NRDCSCC. A total of 35 soil samples were collected from 16 soil borings. Concentrations of one or more PAH compounds above the NRDCSCC were detected at 10 of the 16 soil boring locations. A total of 13 of the 35 samples contained PAH compound concentrations exceeding the NRDCSCC. Of these 13 samples, 10 were surface soil samples collected from 0 to 0.5 foot bgs, one was collected from 1.0 to 1.5 ft bgs, and two were collected between 1.5 to 2.0 ft bgs.

Eight soil borings were advanced in the central portion of Area 18G around two previous NUS samples (S-54 and S-56). Of the 17 samples collected, two upper surface soil samples collected from 0 to 0.5 ft bgs contained concentrations of benzo(a)pyrene above the NRDCSCC. Soil borings were advanced in the vicinity of previous NUS borings S-63, S-64, and S-65. Eight surface soil samples were collected and all four upper surface samples contained concentrations of PAHs that marginally exceeded the NRDCSCC. The samples collected from soil borings advanced around the previous NUS sample location S-44 also contained concentrations of benzo(a)pyrene that marginally exceeded the NRDCSCC. At one soil boring (18G18), an extra unplanned soil sample was collected from 1.0 to 1.5 ft bgs due to the presence of an odor similar to naphthalene. This sample contained PAH compounds at concentrations exceeding the NRDCSCC.

The PAHs detected in the soil samples collected as part of the surface soil investigation were present at a majority of the sample locations, but primarily only in the upper soil sample interval (0 to 0.5 ft bgs). A review of historical aerial photographs and the Dames and Moore ASR (1993a) transparencies indicated that Area 18G appeared to consist of "hard stand" material as early as 1947. Later photographs from 1951, 1958, and 1963 also indicated that an engineered surface existed that may have been used for vehicle parking and general storage. The analysis of the 1963 photograph confirmed that Area 18G was paved at that time. The source of the PAHs in this AOC was the remaining crushed/weathered asphalt in the soil that was a remnant of the hard stand material from the area historically used as a parking area.

No further action was recommended because the source of contamination is the remaining surficial crushed asphalt and storm water runoff from the nearby roads and abandoned railroad tracks. Observations from July 1999 indicated that the EPA removed much of the weathered asphalt pieces from the ground surface in this area and raked the ground surface.

Arsenic was detected at a concentration exceeding the NRDCSCC in one soil sample. This sample was collected where a naphthalene odor was noted in the soil while drilling a soil boring. The soil boring log also noted that coal fragments were observed. The arsenic concentration only marginally exceeded the NRDCSCC. No further action for arsenic was recommended based on the marginal exceedance observed at this location.

2.7.5 Supplement 2 Phase II Remedial Investigation

During the Supplement 2 Phase II RI (Weston, 2000), the samples that were proposed in the Supplemental Phase II RI were collected. The physical extent of the former dump was defined using geophysical methods, including EM and GPR surveys. Exploratory soil borings were then advanced to verify the limit of the former dump as interpreted from the geophysical investigation data.

The geophysical survey indicated that fill material was detected in the area previously described. The interpreted boundary was irregularly shaped and the greatest volume appeared to be located to the northeast of Meadow Road. Two lobes of the dump appeared to extend to the north and south of the helipad and fill materials also extended below the helipad. Geophysical data indicated that the western edge of the dump parallels the roadway and a small amount of material may also be present in the southwestern corner of the survey area. The steel reinforced structure of the roadway and the helipad caused anomalous readings in these areas. However, these interferences were not believed to affect the overall delineation of the fill area. Visual observations of the soil from the boring logs indicated the exact extent of the dump was not fully delineated, but the dramatic decrease in fill-type materials in the outer borings clearly established that locations were near the dump edge. The extent of the dump was just beyond the outer borings as an extrapolation of the decreasing fill trend. The information obtained from the geophysical survey and the borings were adequate to estimate the approximate extent of the fill material. The dump was estimated to contain approximately 21,000 cy of material. NFA was recommended for Area 18G.

2.7.6 Engineering Evaluation/Cost Analysis

The dump area used by Columbia Salvage extends into Area 18G, and a single machine gun shell (considered to be MD) was discovered on the surface during a cultural resources survey, suggesting the possibility of OE contamination in this area. However, surface debris has recently been cleared from part of this area with no reported discoveries of OE. The OE density was determined to be minimal for all depths in this area. The risk of OE exposure in this area for both current and future use was considered low.

2.8 GROUNDWATER

The following groundwater AOCs either originate within or have a significant portion that lay beneath the EPA/GSA Area: AOC 2, AOC 4, and AOC 8 (Figure 2-1). Groundwater and vapor intrusion are being evaluated as a separate project. This section discusses the status of the groundwater AOCs in general terms.

Groundwater AOC 2 is located within the north central portion of the former Raritan Arsenal, beginning near former Building 256 in Investigation Area 18C and extending southeast, underlying the physical boundaries of Investigation Areas 2 and 3 and Building 151 in the Raritan Center Industrial Park. The main source of contamination, the Building 256 UST system and buried waste, was remediated (see Sections 2.4.11 and 2.4.13).

Groundwater AOC 4 is located in the north central portion of the former Raritan Arsenal. The plume extends in a southeasterly and easterly direction from Investigation Area 18A, encompassing portions of Investigation Areas 1, 18B, 18C, and further extending into the Raritan Center Industrial Park (Figure 2-1). The source of the AOC 4 plume is related to the former pond and buried drums at Area 18A, which have been remediated (see Sections 2.2.2 and 2.2.7).

Groundwater AOC 8 is located in the upper northwestern portion of the former Raritan Arsenal. Potential DoD sources of the contamination are the former TCE degreasing operations and associated piping located within and nearby former Buildings 14, 15, and 19 in Investigation Area 18E. An interim response action was recently completed in the vicinity of former Buildings 14, 15, and 19 (see Section 2.5.8).

2.9 INDOOR AIR QUALITY AND VAPOR INTRUSION

Vapor intrusion has been investigated since 2003 to fulfill the condition approval requirement of the NJDEP for monitored natural attenuation (MNA) as a remedy for contaminated groundwater. As presented in Section 1, vapor intrusion issues including indoor air quality at the former Raritan Arsenal are being addressed and evaluated as a separate project under a separate USACE task order contract. This subsection provides a general summary of the indoor air quality issues associated with the VI pathway.

There have been a series of investigations related to IAQ at the former Raritan Arsenal that have included sampling to evaluate potential IAQ impacts related to the vapor intrusion pathway for VOCs associated with groundwater AOCs 2 and 8A/B. There have been several IAQ reports developed for the former Raritan Arsenal. This section focuses on the results of the most recent report (Indoor Air Quality Report #10) (Avatar, 2015). The 2015 report presents results of indoor air and subslab soil gas sampling for groundwater AOC 2 and AOC 8A/B completed during September 2013, October 2013 (165 Fieldcrest only), and February 2014, and summarizes results relative to prior sampling events.

AOC 2

Based on past analytical results from groundwater, subslab soil gas and indoor air sampling, three buildings (165 Fieldcrest, 160 Fieldcrest, and Campus Plaza 4) required sampling within groundwater AOC 2 as part of an ongoing monitoring program (Avatar, 2015). Other buildings located within groundwater AOC 2 were sampled previously and it was determined that no further investigation or action was required including Building 150, Building 151, Campus Plaza 1, Campus Plaza 2, and Campus Plaza 3.

- **165 Fieldcrest** – Elevated levels of PCE were observed in the September 2013 indoor air results. The September 2013 PCE exceedances prompted the October 2013 sample event. Prior to the October 2013 sampling, Avatar along with representatives from USACE and Federal Business Center (FBC) performed a targeted inspection of the warehouse space that appeared to be the source of the PCE. A PCE-containing degreasing/parts cleaner product was observed in the targeted warehouse space. This product was not observed during the initial building survey performed in September 2013. The tenant was instructed to remove the product immediately and use a non-PCE-containing product in the future. The building's fresh air intakes were increased to facilitate building ventilation. The October 2013 sampling occurred approximately two weeks after the PCE containing product was removed. The October 2013 IA samples targeted the locations with the most elevated PCE in September. The PCE results for the October 2013 IA samples were less than the screening levels indicating that the source of PCE was removed.

  USACE recommended continued semi-annual monitoring to evaluate the operation of the system over the next year (September 2014 and February 2015). USACE conducted a partial shutdown of the SSD system in August 2014 in advance of the planned September 2014 sampling event. Upon completion of the September 2014 sampling event, the system was turned back on. USACE and NJDEP are discussing the conditions for system termination. If the data collected in September 2014 and February 2015 indicated that

operation of the SSD is necessary, it was recommended to replace the current SSD blowers with radon fans. These fans operate at flow rates similar to those obtained by the 10 fold reduction in baseline system flow rates, are much more efficient and could reduce annual electricity costs.

- **160 Fieldcrest** – This building had a passive subslab vapor mitigation system installed in June 2008. Subsequent sampling has shown VOC concentrations in VR samples above the NJDEP Vapor Intrusion Guidance (VIG) and site-specific soil gas screening levels. All indoor air VOC results were nondetect. The available analytical results illustrate that the VR system at 160 Fieldcrest is operating as designed. USACE performs an annual inspection of the subslab vapor mitigation system to ensure that the system is operating properly. It is recommended that system inspections continue on an annual basis to ensure the VR system continues to operate properly. The next analytical sampling round is scheduled for 2017.

- **Campus Plaza 4** –The SSSG analytical results from September 2013 and February 2014 sampling events for Campus Plaza 4 continue to show concentrations of TCE above site-specific screening levels for soil gas. The indoor air analytical results also had TCE concentrations above the screening levels. Since TCE was detected in both soil gas and indoor air, a potentially complete VI pathway exists at Campus Plaza 4. However, a report by GSI Environmental titled, *Use of Compound-Specific Stable Isotope Analysis to Distinguish between Vapor Intrusion and Indoor Sources of VOCs* (2013), indicated that the most likely source of TCE in indoor air is tenant activities based on an isotope analysis. Continued monitoring is recommended while the source of contaminants is further evaluated.

AOC 8A/B

Four EPA buildings (Buildings 10, 200, 205, and 209) were sampled within Groundwater AOC 8 during September 2013 and February 2014. Buildings 10, 200, and 205 have a subslab vapor mitigation system in place. Other buildings are located within the footprint of AOC 8A/B but were not sampled because of NJDEP's agreement with USACE's NFA recommendation based on the results of previous sampling efforts.

- **EPA Building 10** – VOCs have not been migrating into the indoor air at concentrations of concern. This is due to the effectiveness of the subslab mitigation system. Semi-annual monitoring of the remedial system has proven that the system is operating properly. USACE recommends continuing semi-annual monitoring for another year (summer 2014 and winter 2015) at which time the data will be evaluated to determine the need for further sampling, frequency of sampling, and operation of the mitigation system. USACE will also perform an optimization study of the mitigation system to determine the proper flow-rate and operation of the mitigation system and need for future sampling.

- **EPA Building 200** – The two locations sampled in February 2014 had TCE concentrations that marginally exceeded the residential site-specific screening level (0.43 µg/m^3) but the levels were less than the site-specific nonresidential level (3 µg/m^3). The TCE concentrations were less than the NJDEP VIG level for residential and nonresidential use of 3 µg/m^3. None of the other VOCs had concentrations detected above the residential and nonresidential site-specific or the NJDEP VIG screening levels at the indoor air locations. During September 2013 and February 2014, TCE concentrations were detected in soil gas above the residential and nonresidential site-specific screening levels. No other VOCs were detected above their screening levels for subslab soil gas.

  Based on the analytical data from September 2013 and February 2014, it appears that the VI pathway is incomplete due to the subslab mitigation system. It is recommended that the monitoring continue at the same semi-annual frequency for the next year. USACE will evaluate the data to determine the proper flow-rate and operation of the mitigation system and need for future sampling. This optimization study is scheduled to be performed in the spring of 2015 following the sampling scheduled for February 2015. An optimization study work plan will be prepared and provided for review prior to beginning the study.

- **EPA Building 205** – PCE and TCE were either not detected in indoor air or were detected at insignificant levels that were less than the residential and nonresidential screening criteria. The VI exposure pathway is incomplete as demonstrated by the non-detect and low level detections observed in the IA samples relative to the SSSG concentrations. Further, the subslab mitigation system at Building 205 has successfully addressed the potential for VI. The low level detections of PCE and TCE in indoor air are likely due to an interior source. Continued semi-annual subslab and indoor air sampling of this building is recommended for the next year. USACE will evaluate the data to determine future sampling needs.

- **EPA Building 209** – The recommendation in *IAQ Report #9* for Building 209 was that no further sampling is needed due to a lack of VOC concentrations greater than nonresidential screening levels. However, another two rounds of samples were collected from Building 209 in September 2013 and February 2014. PCE and TCE concentrations in both soil gas and indoor air continue to remain below site-specific and NJDEP VIG screening levels in the most recent sampling results. Building 209 does not have a subslab vapor mitigation system installed. Based on the historical and most recent sampling results, USACE recommends no further sampling at Building 209 based on an incomplete pathway from groundwater to SSSG.

2.10 ECOLOGICAL RISK ASSESSMENT

A SLERA and a BERA were prepared for the Former Raritan Arsenal (Weston Solutions, 2004a and 2008a, respectively). The SLERA informed the conducting of the BERA; the objective of which was to determine whether contaminated soils and sediments at the former Raritan Arsenal pose ecological risks. The BERA focused on several areas within eight drainages that comprise

parts of the former Arsenal. The EPA/GSA Area lies within the Red Root Creek Drainage (also referred to as Drainage Area 3).

As noted in Section 2.1.5, the soil, surface water, and sediment sample results collected during the Phase II RI showed that the constituents were either ND or were found at concentrations less than the most stringent NJDEP criteria that were available at the time. Based on the full soil, sediment, and surface water sampling results, past activities have not significantly impacted soils at Investigation Area 1. No further action related to soil was recommended for Investigation Area 1. No further action for Investigation Area 1 surface water or sediment was also recommended. Therefore, Investigation Area 1 was not addressed in the BERA.

Three primary habitats of concern investigated in the BERA were freshwater, estuarine, and terrestrial. The habitats found within Area 18 are developed land, old field, disturbed oldfield, or deciduous forested upland. The old field is dominated by little bluestem (*Schizachyrium scoparium*), the disturbed oldfield is dominated by Indian grass (*Sorghastrum nutans*), staghorn sumac (*Rhus typhina*), and gray birch (*Betula populifolia*), and the forested upland is dominated by oaks (*Quercus spp.*) and pitch pine (*Pinus rigida*). Waterbody features are limited to drainage ditches containing freshwater.

2.10.1 Aquatic Habitats

Potential ecological risks in the aquatic habitats in Area 18 were evaluated through sediment-mediated exposures, using tools including: comparisons of sediment concentrations to sediment benchmarks; benthic macroinvertebrate community analysis; *Hyalella azteca* bioassay; and comparisons of site-related frog tissue concentrations to reference concentrations; and food chain exposure modeling using the great blue heron as the target receptor.

Comparisons of sediment chemistry to sediment benchmarks indicated that concentrations of PAHs, 4,4-DDD, 4,4-DDE, 4,4-DDT, endosulfan II, copper, cyanide, and lead were higher than their respective lowest ecological benchmark. In addition, the benthic macroinvertebrate community primarily consisted of pollution-tolerant chironomids. Results of the *H. azteca* bioassay indicated that survival and growth in sediment collected from Area 18 (n = 3) was not significantly different from the reference location sediment. Although high mortality in the

reference samples invalidated the *C. tentans* test, results of the bioassay for sediments collected from Area 18 (n = 5) are of interest given that location SD1810 exhibited 100% mortality; whereas, location SD1811 exhibited 82.5% survival and was the only location (site or reference) that exhibited survival above 34%. Although all benthic macroinvertebrate taxomony locations had organisms from the Chironomidae family, only location SD1811 had individuals from the *Chironomus* species. It is suggested that confounding factors, other than chemical toxicity affected the test.

Tissue concentrations from frogs collected from Area 18 had concentrations of metals that were relatively consistent with those found in the reference locations. Frogs appeared to be abundant in the area and there were no gross abnormalities observed in individuals that were captured.

Great blue heron food chain modeling was based on the heron consuming frogs exclusively (no fiddler crabs or fish were collected from Area 18) and the incidental ingestion of sediment. No observed adverse effect level (NOAEL)-based hazard quotients (HQs) exceeded 1.0 for only 4,4-DDE (1.2). Lowest observed adverse effect level (LOAEL)-based HQs did not exceed 1.0. Lastly using NOAEL-based values, the reference area HQ for 4,4-DDE (1.15) was essentially the same as the site HQ. Therefore, potential risks to upper-trophic level birds are likely indicative of regional conditions.

2.10.2 Terrestrial Habitats

Terrestrial habitats in Area 18 were evaluated through soil-mediated exposures, using tools including: comparisons of soil concentrations to phytotoxicity and soil invertebrate benchmarks; *Lumbricus terrestris* bioassay; comparisons of site-related earthworm and small mammal tissue concentrations to reference concentrations; small mammal histology; and food chain exposure modeling using the American robin, red-tailed hawk, and red fox as the target receptors.

Comparisons of soil chemistry from samples to the lower of phytotoxicity and soil invertebrate/microbe benchmarks indicated that concentrations of several metals (aluminum, cadmium, chromium, copper, iron, lead, mercury, and vanadium) were higher than their respective benchmark. Dieldrin was detected in earthworm tissues, as were many metals. However, results

of the *L. terrestris* bioassay indicated that survival in soil collected from within Area 18 (sample SS18D23) was not significantly different from either reference soil location.

Tissue concentrations from small mammals collected from Area 18 had pesticides detected that were not detected in the reference location samples. However, concentrations of detected metals were relatively consistent with those collected from the reference area. No lesions or dermal impacts were observed during field collection or gross necropsy; and no abnormalities associated with contaminant exposure were observed in the histopathological analyses.

American robin food chain modeling was based on the robin's diet consisting of earthworms exclusively and the incidental ingestion of soil. NOAEL-based HQs exceeded 1.0 for aluminum, cadmium, chromium, lead, selenium, and zinc. However, LOAEL HQs exceeded 1.0 for only aluminum, lead, and selenium. Of these, only selenium had a site HQ (2.82) greater than the reference HQ (2.64). The residual risk would be 0.18. Given that many soils at the former Arsenal are sandy and do not provide adequate habitat for earthworms and that soil litter invertebrates are not as exposed to contaminated soil as earthworms are, the use of earthworm concentrations is likely conservative. Coupled with the other conservative assumptions incorporated into the risk estimate (e.g., an area use factor of 1), calculated risks are considered to be not of concern.

Red-tailed hawk food chain modeling was based on the hawk's diet consisting of small mammals exclusively; whereas the red fox food chain modeling was based on the fox's diet consisting of small mammals exclusively and the incidental ingestion of soil. The only HQs exceeding 1.0 were for the red-tailed hawk from exposure to 4,4-DDT and for the red fox from exposure to aluminum. The hawk 4,4-DDT NOAEL-based HQ was 1.29 and the LOAEL-based HQ was 1.2. The fox aluminum NOAEL-based HQ was 5.10, but the reference area HQ was 10.04. (LOAEL HQ was <1.0). Coupled with the other conservative assumptions incorporated into the risk estimate (e.g., an area use factor of 1), calculated risks are considered to be not of concern.

2.10.3 Ecological Risk Management Report

An Ecological Risk Management Report (ERM) was prepared for the former Raritan Arsenal (Weston, 2013). The ERM focused on the proposed risk management strategy for addressing ecological risks, with particular emphasis on the recommendations made in the BERA. As noted

previously, three primary areas of concern investigated at the former Raritan Arsenal included aquatic (freshwater and estuarine) and terrestrial habitats. The habitats found within Area 18 are freshwater drainage ditches and terrestrial.

Overall, the results of the BERA indicated low level risks are found site-wide in both the aquatic and terrestrial habitats when compared to the site reference. However, additional investigations within a few areas (including Area 18) were underway when the document was written. When necessary, ecological risk-based preliminary remediation goals (PRGs) were calculated based on risks identified from modeling uptake of contaminants to ecological receptors. It should be noted that the ultimate risk management decision (RMD) would take into account factors other than the PRG, such as attribution, risk reduction and habitat destruction, preservation and restoration, and technical feasibility.

The following is a summary of the conclusions of the investigation with respect to potential ecological risks and remaining uncertainties and data gaps that need to be factored into RMDs for Area 18.

Surface Water

- Data collected did not indicate any impacts from groundwater or migration of surface soils. No further action proposed.

Freshwater Sediment

- Potential impacts noted not associated with historical DoD operations or activities within Area 18. No further action proposed.

Terrestrial Soils

- Concentrations of PAHs within Areas 18A, 18D, and 18F may warrant further delineation and evaluation of remedial alternatives. A PRG for PAHs was not calculated because sediment toxicity or impairment of the benthic community was not observed attributable to PAHs. The primary concern regarding PAHs in Area 18 is overland runoff of soil PAHs into streams where these compounds could eventually impact sediment. PAHs in soils will be further evaluated by DoD within this area as a means of source control to ensure that this exposure pathway is not complete.

- Concentrations of lead within Area 18D soils may warrant further delineation and evaluation of remedial alternatives. Although it is clear that additional delineation of lead in soil is required within Area 18, the ultimate remedial goal from the perspective of ecological risks remains subject to a number of considerations, including the high degree of uncertainty surrounding the original BERA assessment based on bioaccumulation into earthworms.

The recommended soil PRG for zinc of 47.9 mg/kg is based on the mean concentration detected at the Ireland Brook reference area. The exceedances of the PRG within Area 18 coincide with the areas of lead-contaminated soils in Areas 18A and 18C.

2.10.4 Ecological Risk Assessment Conclusions

For the majority of the evaluated endpoints, there is little evidence of the potential for ecological risk within the EPA/GSA Area. In the aquatic habitats, groundwater COPCs are not impacting surface water; there is little evidence to suggest that metals are impacting the benthic community; and overall, frogs and higher receptors are not indicated to be significantly impacted. In the terrestrial environment, soil invertebrate communities have not been significantly impacted; and there is no potential risk attributable to metals in small mammals or to carnivorous higher receptor. There is a low potential for risk to invertiverous birds from aluminum, cadmium, chromium, lead, selenium, and zinc. Note however, LOAEL-based HQs were less than 1.0, with the exception of for selenium, which had a residual risk (i.e., difference between site and reference site risk) of <1.0.

Although PAHs were detected at concentrations exceeding sediment quality benchmarks in the Area 18 streams (notably at six locations – SD1638, SD1811, SD1812, SD 1813, SD1814 [and its duplicate SD1816], and SD1815); there were no observed adverse effects in either the benthic macroinvertebrate community survey or the bioassay tests with *H. azteca*. However, the potentially remaining PAH source area contamination in Area 18A was to be further investigated in the risk management stage to determine whether it is impacting the streams in Area 18B. This further investigation demonstrated that the PAH contamination is not related to DoD activities and should not be considered for remedial actions. The results are presented in more detail in the ERM summary (Section 2.10.3) and directly below.

As noted in the ERM summary, further delineation of soil concentrations in Areas 18A (for PAHs and zinc), 18C (for zinc), 18D (for PAHs and lead), and 18F (for PAHs) were requested by NJDEP or recommended by Weston Solutions in the ERM. The results of the 2013 sampling or discussions relating to the recommendations and requests are presented by subarea below.

Area 18A

As noted in Subsection 2.2.8, observations made during a site visit in August 2013 and review of area topographic maps indicate that it is unlikely surface runoff from Area 18A would reach the upstream portions of the Area 18B Stream where the highest levels of PAH contamination have been observed. However, to address NJDEP's concern, surface (0-0.5 ft bgs) and subsurface (2-3 ft bgs) soil samples were collected at Investigation Area 18A in a previously un-sampled area that appears to be down slope of the areas that were remediated in 1992 and 1998 by USACE (see location 18A44 on Figure 2-1). PAHs in the surface sample were detected at levels less than ecological soil benchmarks. No PAHs were detected in the subsurface sample.

Additional sediment samples were collected from the Area 18B Stream to further define the extent of PAH contamination in stream sediments. During the sediment sampling, a sample was collected from the surface (0-0.5 ft bgs) at each location. At the upstream locations, a subsurface sample was also collected at the request of NJDEP. The PAH results exceeded NJDEP human health and ecological screening standards in nearly all samples.

The most recent as well as historical results indicate that PAH concentrations tend to decrease with distance downstream of the storm sewer outfall. The Area 18B Stream is fed by two 48-inch diameter storm drains which appear to collect stormwater runoff from upgradient locations including rooftops and paved areas around Buildings 245, 246 and possibly 229. A review of the Map Annex that accompanies the Dames and Moore ASR (1993a) shows that an aboveground storm drain appears at the general location of the Area 18B Stream in the 1963 site plan. The map presenting the location of the aboveground storm drain shows a network of upgradient, belowground storm drains that discharge to the Area 18B drainage ditch. This map also shows storm drains adjacent to Buildings 245 and 246 (the two large buildings located west of Areas 18A

and 18B) discharging to the Area 18B drainage ditch. Likewise, a 1958 (revised 1960) storm drain map prepared by the Army shows the same drainage configuration.

Meaningful comparisons of the current results with the previous sample results from the Area 18B Stream are difficult based on the dynamic nature of the stream's sand substrate. Over time, the stream substrate and the associated PAH levels are likely to change and are impacted by major storm events that likely scour older substrate and replaces it with materials from upgradient locations.

As presented in Subsection 2.3.8, there is no temporal trend apparent with regards to the total PAH concentrations within the Area 18B Stream. Likewise, there is not a clear trend with depth. The lack of a clear contamination pattern could be related to the sandy substrate and the likely source of the PAHs. These results, especially at the upstream sampling locations, are indicative of an intermittent source of contamination to the Area 18B Stream that is heavily dependent on storm events, such as periodic discharge from the two 48-inch stormwater discharge pipes located at the headwater of the Area 18B Stream. One would expect relative consistency in concentrations if the source was from the previously remediated areas at Investigation Area 18A. In addition, data from historical soil samples collected at the water table between the Area 18B stream and the Area 18A remediation areas did not detect PAHs.

These recent sample results, in concert with historical soil sampling results indicating PAHs analyzed from the surrounding area soil were either not detected or were detected at low levels, indicate that soil migration is likely not a source of PAH contamination to the Area 18B Stream. Rather, the results of the recent sample collection effort indicate that the contamination identified within the Area 18B Stream most likely is the result of storm water discharge from upgradient areas. No further investigation of this issue is proposed.

Zinc surface soil concentrations exceeding the background-based PRG in Area 18A are limited to four samples along the roadway. Given that the LOAEL-based HQ calculated for the site was less than 1.0, significant ecological effects associated with zinc are unlikely.

Area 18C

Zinc surface soil concentrations exceeding the background-based PRG in Area 18C are grouped in two areas. Given that the LOAEL-based HQ calculated for the site was less than 1.0, significant ecological effects associated with zinc are unlikely.

Area 18D

As noted in Subsection 1.3.4, although significant portion of Investigation Area 18D is within the EPA/GSA Area, based on ongoing concerns at Investigation Area 18D associated with MEC, it is being evaluated under a separate USACE task order contract.

Area 18F

Investigation Area 18F is a developed area owned by EPA; with the only non hard-cover area along the rail lines. The FUDS program is designed to investigate and remediate CERCLA releases for which DoD is responsible. The areas along the former railroad lines do not have a history of a CERCLA release. Based on information available to date, there is no evidence that DoD is responsible for contaminants associated with the rail-beds. It has been demonstrated that there are some elevated metals and other contaminants along former and existing rail-beds. These are attributed to the fill and material that were used to construct the rail-beds and not the result of a CERCLA release. Urban fill used to construct a rail-bed or other building roadway; parking lot etc. does not constitute a CERCLA release. Therefore, PAH concentrations associated with the former railroads within the former Raritan Arsenal should not be considered as they relate to any future decisions on remediation of the EPA/GSA Area.

Therefore, given the information available at the time of this report, it is concluded that ecological risks within the EPA/GSA Area are either not of concern or not attributable to DoD activities and should not be considered for remedial action.

3. CONCEPTUAL SITE MODEL (CSM)

This section discusses the CSM based on an evaluation of the environmental and physical setting of the EPA/GSA RI Area, institutional knowledge of contamination sources, and an assessment of potential contaminant exposure pathways and human and ecological receptors. It is important to note that all known sources of contamination within the EPA/GSA Area, either identified during the Archival Searches or subsequently discovered, have been sampled and in some case have undergone extensive interim response actions.

The former Raritan Arsenal site is located in Edison and Woodbridge Townships, Middlesex County, New Jersey. The site is bordered to the north and northwest by Woodbridge Avenue, to the southwest by Mill Road and the Industrial Land Reclamation Landfill, and to the south and east by the Raritan River (Figure 1-2). The former Raritan Arsenal was used by the U.S. Army from 1917 to 1963. Operations at the site included the receipt, storage, shipment, and decommissioning of ordnance, arms, and machinery. The EPA/GSA Area occupies approximately 178 acres in the north central portion of the former Raritan Arsenal.

The former Raritan Arsenal is located on the northern side of the Raritan River, which discharges to Raritan Bay approximately 5 miles to the east. The former Raritan Arsenal site geology is characterized by an overburden layer, approximately 10 to 80 feet thick, composed of unconsolidated sediments underlain by bedrock composed of shales, metamorphosed shales, and an igneous diabase sill. The site groundwater hydrology is characterized by separate aquifers in the overburden and bedrock. Groundwater within both the overburden and bedrock aquifers flows southeastward across the site toward the Raritan River. The depth to groundwater in the overburden zone varies from 2 to 30 feet, depending on the location.

Historical contaminants consisted of VOCs, PAHs, pesticides, and metals in surface and subsurface soils and VOCs and metals in groundwater. The source of soil contamination was the presence of buried ordnance, historical railroad lines, drums, and demolition and associated building debris discovered at the various Investigation Areas located within the EPA/GSA Area, and non DoD-related activities throughout the area, such as the demolition of buildings, construction of asphalt walkways, and historical pesticide use. The source of VOC contamination

in the groundwater was historical releases, leaking buried drums and debris. As described in Section 2, interim response actions have been performed at various areas, thereby removing the contaminant source areas. While generally discussed in this report, the contamination issues related to the residual groundwater concentration, including vapor intrusion and IAQ, are being evaluated as a separate project under a separate USACE task order contract.

Individuals that could be exposed to soil include groundskeepers, construction/utility workers, indoor workers, and hypothetical future residents. The outdoor worker receptors have the potential to be exposed to surface and/or subsurface soil via incidental ingestion, dermal contact, inhalation of dust emissions, and inhalation of VOCs released from soil. Indoor workers have no direct contact with soil and therefore, the dermal contact pathway is not evaluated for this receptor. The future use of the area is anticipated to remain under government control. It was, however, conservatively assumed that the area could be developed and used for residential use in the future. Recreational and/or trespasser exposure is not expected as access to the EPA/GSA RI Area is restricted and monitored by guards and surveillance cameras. Section 6 discusses the potentially exposed receptors in greater detail.

There is currently no use of groundwater on site. All buildings are connected to municipal water. Groundwater is not expected to be used in the future because any new buildings will connect to municipal water. Additionally, the CEA and WRA are in place for portions of the former Raritan Arsenal. The CEA encompasses the portions of the former Raritan Arsenal where groundwater is contaminated as a result of DoD activities. Therefore, there is no contact with the groundwater. It is possible that the indoor air may be affected as a result of the vapor intrusion pathway. However, the vapor intrusion pathway is being evaluated as a separate project with groundwater.

A number of geophysical and MEC surveys have been performed within the EPA/GSA Area with no MEC discoveries. Based on the historical uses of the Investigation Areas, the EPA/GSA Area has only one area with a history of potential MEC (Investigation Area 1). Investigation Area 1 is a 0.57 acre (shown on Figure 2-1) has a reported history of destruction of adapter boosters, point and base detonating fuses, and 37 mm to 6-inch gun projectiles. Investigations were conducted at Investigation Area 1 in 1988 and 1992 that included both MEC surveys and intrusive investigations

of anomalies using a shovel and backhoe. No MEC items were found. More recently, a supplemental records review for Investigation Area 1 was performed (CH2M HILL, 2013). It was concluded that no additional MEC investigation is warranted. MEC has not been identified in the surface or subsurface during previous inspections and investigations and is not a concern at Investigation Area 1.

Other areas were also investigated for MEC as shown on Table ES-1. A removal action completed in 2002 removed small arms ammunition debris consisting of expended bullets embedded in the backstop of a small arms range target berm. The only additional munition related items found were incidental discoveries documented as: one 57-mm projectile (inert) and one empty machine shell.

It is noted that a process is in place as a safety measure for intrusive work within the boundaries of the former Raritan Arsenal. The process in place is enforced by Edison Township and requires construction support over the entire former Raritan Arsenal. It requires that property owners obtain an evaluation by USACE to determine if there are any concerns with conducting intrusive activities. This process has taken place in the past and not resulted in the need for construction oversight. Appendix D contains a letter from USACE to Edison Township recommending the process to be followed.

4. NATURE AND EXTENT OF CONTAMINATION

This section compares the available site data (soil, sediment, and groundwater) with Federal and New Jersey criteria to determine the nature and extent of contamination. Section 4.1 presents a brief summary of the data that were available for the comparisons. The soil, sediment, and groundwater comparisons are discussed in Sections 4.2, 4.3, and 4.4, respectively.

4.1 AVAILABLE DATA

As discussed throughout Section 2, a number of sample collection efforts have occurred at the EPA/GSA Area dating back to the mid-1980s. This subsection presents the data available for comparisons with Federal screening criteria and NJDEP SRSs. Table 4-1 presents a general summary of the past investigations that have taken place in chronological order. Data were not collected for a number of the past investigations but these investigations are included on Table 4-1 for completeness. For the investigations that did include sample collection, the status of the data (i.e., available and included in the summaries or not) is summarized.

4.1.1 Soil

The soil data from the following investigations were available and included in the data comparisons:

- *Final Report of Investigation, Area 1 Investigation* (Weston, 1996a);
- *Final Report of Investigation, Area 18A Investigation* (Weston, 1996b);
- *Supplemental Investigation, Areas 2, 3, 7, 9, 11, 16, 18A, 19, Inland Container, and W* (Weston, 1999a);
- *Final Supplemental Report of Investigation, Areas 18B, 18C, 18D, 18F, and 18G Investigations* (Weston, 1999b);
- *Supplement 2 Phase II Remedial Investigation Report* (Weston, 2000);
- *Remedial Action Report, Remedial Construction – Areas 11, 12, 18A, 18C, and W* (Weston, 2002);
- *Remedial Action Report, Remedial Construction – Areas 12, 18B, 18C, and Building 256* (Weston, 2004b);

- *Final Screening-Level Ecological Risk Assessment, Former Raritan Arsenal* (Weston, 2004a);
- *Supplemental Remedial Investigation Report, Area 18C – Ramp Area and Buildings 151/165* (Weston, 2005a);
- *Final Baseline Ecological Risk Assessment, Former Raritan Arsenal* (Weston, 2008a);
- *Final Supplemental Remedial Investigation Report, Area 18E* (Weston, 2011);
- *Final Remedial Action Completion Report* (H&S, 2013); and
- Additional soil data collected from Area 18A (Avatar, 2013).

As shown on Table 4-1, analytical data were not collected for a number of investigations performed at the EPA/GSA Area. These investigations included ASRs, MEC surveys, and various other types of reports related to the environmental investigations of the EPA/GSA Area (see Table 4-1 for a description). Soil data from areas that were excavated during interim response actions were not included in comparisons. Soil data from other sources that were of unknown quality or data that were not available electronically were also not included. Post excavation confirmatory samples that were laboratory-analyzed and of known quality were used.

Soil data collected from the Asbestos Landfill located within Investigation Area 18C were not evaluated in this RI as the source of the contamination (asbestos and non-asbestos) is not from DoD activities. The Asbestos Landfill is a result of GSA-directed demolition conducted in the late 1970s and early 1980s.

4.1.2 Sediment

The sediment data presented in the Site-Wide Surface Water and Sediment Investigation report (Weston, 1996d) and the Final BERA (Weston, 2008a) were available for comparisons. In addition, the sediment data collected in October 2013 from the Area 18B Stream were included in the comparisons (Avatar, 2013). A number of the samples collected in October 2013 were from locations that were sampled in 1994 and 2005. The older data from the re-sampled locations were not included in the comparisons since the data collected in 2013 better represent site contaminant conditions.

4.1.3 Groundwater

A number of monitoring wells within the boundaries of the EPA/GSA Area have been installed, developed, and sampled since the early 1990s (see Figure 2-1). The groundwater data included in the comparisons were associated with Groundwater AOCs 2, 4, and 8, all of which originate within the EPA/GSA Area. VOCs are the primary contaminants associated with Groundwater AOCs 2, 4, and 8.

4.2 Soil Comparisons

For the soil comparisons, the following criteria for restricted and unrestricted uses were used: EPA's Regional Screening Levels (RSLs) (EPA, 2017) and New Jersey's Soil Remediation Standards (SRSs) (NJDEP, 2017). The industrial soil RSLs and the non-residential SRSs were used for the restricted use comparisons. The residential soil RSLs and the residential SRSs were used for the unrestricted use comparisons.

The ecological effect comparisons were based on surface soil (0 to 2 ft bgs) and used the lowest screening value from the following: EPA Region V Ecological Screening Levels, (EPA Region V, 2003), EPA Soil Screening Levels (EPA, 2005a through 2005i, 2006a, 2007a through 2007e, and 2008), Oak Ridge National Laboratory (ORNL) screening benchmarks for phytotoxicity (Efroymson et al., 1997a), ORNL screening benchmarks for earthworms (Efroymson et al., 1997b), and the ORNL PRGs (Efroymson et al., 1997c).

Figure 2-1 presents the sample locations for the EPA/GSA Area. The figure presents the soil Investigation Areas discussed in Section 2 along with the location of interim response actions. Only sampling locations with laboratory analytical data are presented. Appendix E presents the available soil data.

4.2.1 Human Health Comparisons

Table 4-2 presents the human health comparisons for the EPA/GSA Area soil (0 to 10 ft bgs) to the previously mentioned Federal and state criteria. Table 4-2 also presents the following information:

- List of contaminants detected in the soil;

- The range of detected concentrations;
- The location of the maximum concentration;
- The detection frequency; and
- The screening levels for restricted and unrestricted uses.

The maximum detected concentration for each detected analyte was compared with the criteria. The criterion was shaded on Table 4-2 if the maximum detected concentration exceeded the criterion. The maximum concentrations for the following analytes exceeded at least one of the criteria:

PAHs	Pesticides	PCBs	VOCs	Metals
Benzo(a)anthracene	4,4-DDT	Aroclor 1260	Chloroform	Antimony
Benzo(a)pyrene	Dieldrin		Ethylbenzene	Arsenic
Benzo(b)fluoranthene		**SVOCs**	TCE	Chromium
Benzo(k)fluoranthene		Pentachlorophenol	VC	Lead
Dibenz(a,h)anthracene				Thallium
Indeno(1,2,3,cd)pyrene				Vanadium
Naphthalene				

The following subsections discuss the analytes presented in the table above in greater detail. Background levels are considered for arsenic, chromium and the carcinogenic PAHs (cPAHs) (Section 4.2.1.1). Sample-specific exceedances (i.e., point comparisons) are presented in Section 4.2.1.2. Comprehensive comparisons with the NJDEP SRSs are included in Section 4.2.1.3. Finally, contaminant levels in deep soil (> 10 ft bgs) are discussed in Section 4.2.1.4.

4.2.1.1 Background Levels

The State of New Jersey has published background levels for metals and other analytes including PAHs (BEM, 1998). The applicable background levels vary depending on the location within the State. The former Raritan Arsenal is situated within the Coastal Plain Region. The Coastal Plain Region data were obtained from sampling points that were located in parks (playgrounds, city parks, etc.) The rationale for sampling parks was to maximize the probability of finding undisturbed soil and to minimize the probability of collecting samples too close to known hazardous waste sites (BEM, 1998). This is an important point to be considered when evaluating

the Coastal Plain Region background data. Ideally, background samples should take into account both native and anthropogenic background sources. Biasing the samples to soils in undisturbed areas introduces negative bias of unknown magnitude for the background comparisons.

The published background levels most likely do not represent the background levels of PAHs in the immediate vicinity of the former Raritan Arsenal. The background PAH levels associated with the former Raritan Arsenal, a well-populated and heavily used area containing many asphalt parking areas, would be expected to be greater than the levels observed at more pristine sites. The subsections that follow compare the site levels of arsenic, chromium, and PAHs, all of which are traditionally risk drivers in a HHRA, with New Jersey background levels.

4.2.1.1.1 Arsenic

The NJDEP background level for arsenic is 19 mg/kg and is based on a 95th percentile concentration of 248 areas that were sampled within New Jersey. This level is the basis of the state soil criteria (SRS). Table 4-3 presents arsenic summary statistics comparing the soil arsenic levels from the Soil EA and the Soil EA minus the arsenic levels found along the former railroad tracks in Investigation Areas 18E and 18F (see Figure 4-1). Note that the arsenic data from the Asbestos Landfill were not included in these comparisons.

The maximum observed arsenic level in Soil EA (including the railroad track data) is 488 mg/kg. The highest levels of arsenic are found at locations 18E123, 18F07, 18F21, all of which are found along the former railroad tracks in Investigation Areas 18E and 18F. The maximum arsenic level observed outside of the former railroad tracks in Investigation Areas 18E and 18F is 111 mg/kg. This concentration was found at location 18C14, which is located between former and current railroad tracks in the northern corner of Investigation Area 18C (see Figure 2-1).

The area-wide arithmetic mean arsenic level is 13.6 mg/kg. The mean arsenic level not including samples from the former railroad tracks is 4.7 mg/kg. The median values for the entire area (3.1 mg/kg) and the entire area minus the former railroad tracks (2.1 mg/kg) are similar. A significant reduction in arsenic levels is observed in the 90th and 95th percentile values when the data from the former railroad tracks are not considered (see Table 4-3). The purpose of these comparisons is to show that the majority of the elevated arsenic concentrations and exceedances of the statewide

background level were found along the former railroad tracks between former Buildings 202 and 203 within Investigation Area 18F and extending into Investigation Area 18E.

In the past, arsenic compounds were used in addition to creosote to inhibit/control the attack of insects as the rail ties were treated to resist decay. Arsenical pesticides were likely used for weed control along the rail-beds and the creosote may have been used as an insecticide. CERCLA expressly states that no person may recover under CERCLA 107 (42 USC 9607) for any response costs or damages resulting from the application of a registered pesticide. FIFRA defines pesticides to include herbicides (see 7 U.S.C. 136). This means that the arsenic and creosote are not considered a hazardous substances under CERCLA, and that there is no CERCLA release. If there is no CERCLA release, then there is no authority to act under the FUDS program. Therefore, arsenic concentrations associated with the former railroads within the former Raritan Arsenal should not be considered as they relate to any future decisions on remediation of the EPA/GSA Area.

4.2.1.1.2 Chromium

A review of the site chromium levels that were assumed to be entirely in the hexavalent state indicates that the human health criteria for restricted and unrestricted land uses were exceeded at the majority of sampling locations within the EPA/GSA Area. The total chromium results were evaluated as hexavalent chromium for comparisons with criteria. This is a conservative approach that will show exceedances of criteria when in fact it is likely that hexavalent chromium is present at only a fraction of the total chromium levels. For example, where both total and hexavalent chromium data are available from the same samples at or near the former Raritan Arsenal, hexavalent chromium is typically 10% or less of the total (Weston, 2011).

To put the site chromium levels in perspective, site concentrations were compared with background levels from New Jersey (BEM, 1998). Select statistical values for chromium are presented in Table 4-4. A review of the chromium data shows that the highest levels are found in Investigation Areas 18E and 18F, most notably along the former railroad tracks located between former Buildings 202 and 203 (see Figure 4-1).

The maximum detected chromium level in EPA/GSA Area soils is 685 mg/kg at location 18F07, along a former railroad track. The site-wide arithmetic mean chromium level is 25.4 mg/kg in the surface soil, which exceeded the arithmetic mean chromium level in NJDEP background of 18.7 mg/kg. The 90th percentile site-wide chromium concentration is similar to the NJDEP level. The 95th percentile site-wide chromium concentration is 94.9 mg/kg. The NJDEP background 95th percentile for chromium is 39.8 mg/kg.

As an additional background comparison, the chromium data from the former railroad tracks located between former Buildings 202 and 203 within Investigation Area 18F and extending into Investigation Area 18E were removed from the Soil EA chromium dataset and the data were re-summarized and compared with the NJDEP background levels (see Table 4-4). The site chromium levels were similar to or less than the NJDEP levels when the chromium data collected along the former railroad tracks are not considered in the comparisons.

The presence of chromium along the railroad tracks is attributed to the use of chromium-based compounds (primarily chromated copper arsenate) as a preservative for the wooden railroad ties and not historical DoD operations. The elevated chromium levels therefore do not constitute a CERCLA release. Therefore, chromium concentrations associated with the former rail lines should not be considered as they relate to any future decisions on remediation of the EPA/GSA Area.

4.2.1.1.3 Carcinogenic PAHs

The comparisons presented in this subsection focus on the carcinogenic PAHs (cPAHs) including:

- Benzo(a)pyrene
- Benzo(a)anthracene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Chrysene
- Dibenz(ah)anthracene
- Indeno(1,2,3-cd)pyrene

It is likely that many of the observed levels of cPAHs in EPA/GSA Area soils are not from DoD operations or activities but rather from non-DoD sources such as railroads, construction of walkways, parking areas, demolition of buildings, site drainage, etc. Another potentially

significant source of cPAHs in site soil is the periodic brush fires that occur in the undeveloped portion of the former Raritan Arsenal. It is difficult to quantify the amount of PAHs deposited from the atmosphere during the burn events but it is not expected to be insignificant as it has been reported that fires occur in the area multiple times per year. The most recent fire occurred on April 10, 2014.

Appendix F presents a series of photographs documenting the locations of soil samples collected within the EPA/GSA Area with elevated cPAH levels.

To put the cPAHs levels in perspective, the site cPAH levels in soil were compared with levels found in New Jersey (see Table 4-5). As one would expect, the site soil levels exceeded the New Jersey background data (BEM, 1998) in almost every case. These results are not indicative of DoD sources of cPAHs at the EPA/GSA Area but are reflective of the lower concentration of cPAHs one would expect to find at parks and other undisturbed areas that constitute the New Jersey background data set.

4.2.1.2 Point Comparisons

Table 4-6 presents point comparisons for the analytes whose maximum detected concentration exceeded a Federal or state criterion in Table 4-2. To streamline the presentation of exceedances, Table 4-6 shows only those locations with an exceedance of at least one criterion (Federal or state). Throughout this report, J-qualified analytical data results were treated as detected concentrations. The J-qualified results were given equal weight as unqualified positive detections. However, J-qualified concentrations are often times unreliable estimates and should be treated as such when making decisions at the EPA/GSA Area.

Figures 4-2 and 4-3 present the soil sampling locations and identify the location of the human health criterion exceedances. Figure 4-2 presents locations of PAH exceedances. PAHs were presented on a separate figure due to the number of locations with exceedances. It is recommended that the reader view Figure 4-2 along with Table 4-6 to gain an understanding of the locations and magnitude of PAH exceedances. Figure 4-3 presents exceedances of other analytes. Figure 4-3 contains exceedance boxes that include the sample identification, the sample depth interval, the

sample result, and the criterion that was exceeded. The following subsections discuss the frequency of the exceedances by analyte.

4.2.1.2.1 PAHs

Benzo(a)anthracene – exceeded the unrestricted (i.e., residential) use criterion at 17 locations. The restricted use criteria exceeded at only one location. The table below presents a breakdown of the exceedances by Investigation Area.

Benzo(a)anthracene Exceedances		
Area	Unrestricted Use Exceedances	Restricted Use Exceedances
Area 18A	3	0
Area 18C	7	1
Area 18G	7	0

Benzo(a)pyrene – exceeded the unrestricted use criterion at 75 locations. The restricted use criteria were exceeded at nine locations. The table below presents a breakdown of the exceedances by Investigation Area.

Benzo(a)pyrene Exceedances		
Area	Unrestricted Use Exceedances	Restricted Use Exceedances
Area 1	2	0
Area 18A	13	2
Area 18B	10	0
Area 18C	28	3
Area 18G	22	4

Benzo(b)fluoranthene – exceeded the unrestricted use criterion at 22 locations. The restricted use criteria were exceeded at only one location. The table below presents a breakdown of the exceedances by Investigation Area.

Benzo(b)fluoranthene Exceedances		
Area	Unrestricted Use Exceedances	Restricted Use Exceedances
Area 18A	3	0
Area 18B	1	0

Benzo(b)fluoranthene Exceedances		
Area	Unrestricted Use Exceedances	Restricted Use Exceedances
Area 18C	6	1
Area 18G	12	0

Benzo(k)fluoranthene – exceeded the unrestricted use criterion at one location in Investigation Area 18C. The restricted use criteria were not exceeded in any Investigation Area.

Dibenz(a,h)anthracene – exceeded the unrestricted use criterion at 32 locations. The restricted use criteria were exceeded at two locations. The table below presents a breakdown of the exceedances by Investigation Area.

Dibenz(a,h)anthracene Exceedances		
Area	Unrestricted Use Exceedances	Restricted Use Exceedances
Area 18A	6	0
Area 18B	2	0
Area 18C	9	1
Area 18G	15	1

Indeno(1,2,3-cd)pyrene – exceeded the unrestricted use criterion at 9 locations. The restricted use criteria were exceeded at one location. The table below presents a breakdown of the exceedances by Investigation Area.

Indeno(1,2,3-cd)pyrene Exceedances		
Area	Unrestricted Use Exceedances	Restricted Use Exceedances
Area 18A	2	0
Area 18C	3	1
Area 18G	4	0

Naphthalene – exceeded the unrestricted use criterion at two locations. One location was in Investigation Area 18A. The other location was in Investigation Area 18C. The restricted use criteria were not exceeded.

4.2.1.2.2 Pesticides

4,4-DDT – exceeded the unrestricted use criteria at one location in Investigation Area 18C. The restricted use criteria were not exceeded.

Dieldrin – exceeded the unrestricted use criteria at one Investigation Area 18C location. The restricted use criteria were not exceeded.

4.2.1.2.3 PCBs

Aroclor-1260 – exceeded the unrestricted use criteria at four locations. The restricted use criteria were not exceeded. The table below presents a breakdown of the exceedances by Investigation Area.

Aroclor 1260 Exceedances		
Area	Unrestricted Use Exceedances	Restricted Use Exceedances
Area 18A	1	0
Area 18C	1	0
Area 18E	2	0

4.2.1.2.4 VOCs

Chloroform – exceeded the unrestricted and restricted use criteria at one (Area 18E) location.

Ethylbenzene – exceeded the unrestricted use criterion at two locations. The restricted use criteria were not exceeded.

TCE – exceeded the unrestricted use criterion at three locations. The restricted use criteria were exceeded at one location. The table below presents a breakdown of the exceedances by Investigation Area.

TCE Exceedances		
Area	Unrestricted Use Exceedances	Restricted Use Exceedances
Area 18C	2	1
Area 18E	1	0

VC – exceeded the unrestricted use criterion at one (Area 18A) location. The restricted use criteria were not exceeded.

4.2.1.2.5 SVOCs

Pentachlorophenol – exceeded the unrestricted and restricted use criteria at two (Area 18C) locations.

4.2.1.2.6 Metals

Antimony – exceeded the unrestricted use criteria at 2 (Area 18F and Area 18G) locations. The restricted use criteria were not exceeded.

Arsenic – exceeded the NJDEP level for unrestricted and restricted use at 53 locations. The NJDEP standard of 19 mg/kg is based on typical background concentrations of arsenic for New Jersey. The table below presents a breakdown of the exceedances by Investigation Area.

Area	Arsenic Exceedances
Area 18B	1
Area 18C	3
Area 18E	21
Area 18F	27
Area 18G	1

Lead – exceeded the unrestricted use criterion at 29 locations. The restricted use criterion was exceeded at 20 locations. The table below presents a breakdown of the exceedances by Investigation Area.

Lead Exceedances		
Area	Unrestricted Use Exceedances	Restricted Use Exceedances
Area 18A	2	1
Area 18B	2	1
Area 18C	2	0
Area 18E	4	4
Area 18F	17	12
Area 18G	2	2

Thallium – exceeded the unrestricted use criterion at five (one Area 18A and four Area 18E) locations. The restricted use criteria were not exceeded.

Vanadium – exceeded the NJDEP unrestricted use criterion at two (Area 18C) locations. The restricted use criteria were not exceeded.

4.2.1.3 NJDEP Comparisons

Table 4-2A presents additional comparisons for select analytes with the NJDEP SRSs. The comparisons focused on the analytes whose maximum detected concentrations from the 0 to 10 ft bgs depth range exceeded the most restrictive NJDEP criterion. As shown on Table 4-2A, the maximum detected concentrations for Aroclor 1260, six PAHs, two pesticides, two VOCs, one SVOC, and four metals exceeded their respective NJDEP SRS for residential soil. The maximum detected concentrations for the PAHs and 4,4-DDT were observed in the same sample location (TP-18C72A).

The following paragraphs describe for each analyte the frequency of detection, comparisons with the NJDEP SRSs, and the frequency that each analyte exceeds the SRSs.

4.2.1.3.1 Frequency of Detection

Frequency of detection (FOD) is defined as the number of times an analyte is detected out of the total number of times the analyte was sampled. A review of the FOD for the analytes on Table 4-2A indicates that Aroclor 1260, dieldrin, chloroform, pentachlorophenol, and naphthalene were infrequently detected and are therefore not a widespread concern.

- Aroclor 1260 was detected in four of 222 samples for a detection percentage (%) of approximately 2%.
- Dieldrin was detected in two of 173 samples (detection % of approximately 1%).
- Chloroform was detected in two of 354 samples (detection % of approximately 1%).
- Pentachlorophenol was detected in one of 209 samples (detection % less than 1%).
- Naphthalene was detected more frequently but not at a percentage that suggests widespread contamination. It was detected in 7% of the samples (20 detects out of 281 samples).

The PAHs and metals were detected more frequently than the other analytes. This is not surprising given the prevalence of these analytes in soil as a result of anthropogenic and/or naturally occurring sources.

4.2.1.3.2 Comparisons with NJDEP SRSs

Two comparisons were made against the NJDEP SRSs for nonresidential and residential soil. The first comparison consisted of the maximum detected concentrations. The second comparison consisted of the exposure point concentrations (EPCs) (i.e., the 95 percent upper confidence limit of the mean, 95% UCL). The 95% UCL is a conservative representation of the average concentration throughout an area, in this case the EPA/GSA Area. A full discussion on the calculation of the EPCs can be found in Section 6.

As depicted on Table 4-2A, the maximum detected concentrations were all greater than the residential SRSs. The maximum concentration-to-residential SRS ratios ranged from less than two for naphthalene, 4,4-DDT, dieldrin, and vanadium to 94 for benzo(a)pyrene. The maximum concentration-to-nonresidential SRS ratios for Aroclor 1260, naphthalene, both pesticides, TCE, antimony, and vanadium were less than one. That is, the maximum detected concentrations for these analytes were less than the nonresidential SRSs. The nonresidential ratios for the other analytes, including five of the PAHs, chloroform, pentachlorophenol, arsenic, and lead, ranged from 1.5 for indeno(1,2,3-c,d)pyrene to 26 for arsenic.

When the EPCs (95% UCLs) are compared to the SRSs, arsenic is the only analyte that exceeded the residential and nonresidential SRSs with a ratio of 1.1. The arsenic EPC was 21.6 mg/kg which is essentially equal to the NJDEP SRS of 19 mg/kg. EPCs for benzo(a)pyrene and pentachlorophenol exceeded the residential SRSs with ratios of 2.5 and 2.2, respectively.

EPC comparisons are a valuable component to this screening evaluation since they are inherently based on area-wide estimates of contaminant concentrations rather than a single point with the highest level. The results of the EPC comparisons suggest that when viewed on a site-wide basis, the average site-wide concentrations are generally not a concern.

4.2.1.3.3 Number of Exceedances

The number of exceedances is another measurement that should be considered to properly interpret screening results. The exceedance rate is defined as the number of samples that exceed the screening criterion divided by the number of samples that were analyzed. Figures 4-2A and 4-3A show the locations of NJDEP SRS exceedances. PAHs are shown on Figure 4-2A. Other analytes are depicted on Figure 4-3A.

The number of exceedances for Aroclor 1260, two of the PAHs, both pesticides, chloroform, pentachlorophenol, and the metals is low (see Table 4-2A).

- Four Aroclor 1260 samples exceeded its residential SRS (the nonresidential SRS was not exceeded). Aroclor 1260 was detected in only four of 222 samples.
- Naphthalene exceeded its residential SRS in two samples (the nonresidential SRS was not exceeded). It was detected in 20 of 281 samples.
- One 4,4-DDT sample exceeded its residential SRS (the nonresidential SRS was not exceeded). It was detected in 32 of 172 samples.
- One dieldrin sample exceeded its residential SRS (the nonresidential SRS was not exceeded). Dieldrin was detected in only two of 173 samples.
- Chloroform exceeded its residential and nonresidential SRSs in only one sample. It was detected in only two of 354 samples.
- Pentachlorophenol exceeded its nonresidential and residential SRSs in only one sample. It was detected in only one of 209 samples.
- Antimony exceeded its residential SRS in only two samples (the nonresidential SRS was not exceeded). It was detected in 143 of 334 samples.
- Vanadium exceeded its residential SRS in only two samples. It was detected in 43 of 44 samples.

Arsenic and lead have more exceedances of the SRSs. Arsenic exceeded its SRS in 53 of 487 samples collected which equates to an 11% exceedance rate. Nearly all of the arsenic exceedances were from the former railroad tracks between former Buildings 202 and 203. As discussed in Section 4.2.1.1.1, arsenic concentrations associated with the former railroads within the former Raritan Arsenal should not be considered as they relate to any future decisions on remediation of the EPA/GSA Area.

Lead exceeded its residential SRS in 29 of 516 samples, equating to a 6% exceedance rate. Lead also exceeded its nonresidential SRS but to a lesser extent. The number of lead exceedances represents a small fraction of the overall lead dataset and does not suggest widespread lead soil contamination.

Samples TP-18C71A, TP-18C72A, and TP-18C75A had the highest levels of PAHs (see Figure 4-2A). These were subsurface test pit samples collected in 1996 during the Phase II RI performed for Investigation Area 18C. As described in the Phase II RI report (Weston, 1999b), general building demolition debris or trash (including brick, cement, piping, tires, sheet metal, etc.) was encountered within these test pits. The construction/demolition debris uncovered by the test pits is most likely the source of the PAH contamination observed in the samples from these locations based on field observations. As discussed previously for the Asbestos Landfill, this construction/demolition debris is a result of GSA-directed demolition conducted in the late 1970s and early 1980s. The USACE does not believe that the Army is responsible for the disposal of this debris and these data should not be considered as they relate to decisions on Army actions for the EPA/GSA Area.

4.2.1.3.4 Conclusion

This analysis thoroughly evaluated the analytes that had concentrations that were greater than NJDEP SRSs for nonresidential and residential soil. The number of exceedances represents a small fraction of the overall dataset and does not suggest widespread soil contamination. The results clearly demonstrate that none of the analytes were frequently detected in soil at levels of concern within the EPA/GSA Area assuming nonresidential and residential exposures. The observed exceedances were geographically dispersed (see Figures 4-2A and 4-3A) and not concentrated in a single location indicating a potential source area. The majority of the highest concentrations and exceedances are located where the source cannot be attributed to past DoD activities.

It is therefore concluded that No Further Action is required on behalf of USACE to address the residual levels of contamination found within the EPA/GSA Area soil.

4.2.1.4 Point Comparisons – Soil Greater than 10 ft bgs

Table 4-7 presents comparisons of detected concentrations in soil deeper than 10 ft bgs with Federal and state screening criteria. The maximum detected concentration for each detected analyte was compared with the criteria. The criterion was shaded on Table 4-7 if the maximum detected concentration exceeded the criterion. The maximum concentrations for the following analytes exceeded at least one of the criteria:

PAHs	VOCs	Metals
Benzo(a)anthracene	Ethylbenzene	Arsenic
Benzo(a)pyrene	TCE	Chromium
Benzo(b)fluoranthene	VC	Thallium
Benzo(k)fluoranthene		
Dibenz(a,h)anthracene		
Indeno(1,2,3,cd)pyrene		
Naphthalene		

Table 4-8 presents point comparisons for the analytes whose maximum detected concentration in soil greater than 10 ft bgs exceeded a criterion in Table 4-7. To streamline the presentation of exceedances, Table 4-8 shows only those locations with an exceedance of at least one criterion. The following summarizes the frequency of the exceedances by analyte.

Analyte	Number of Detected Samples	Number of Exceedances			
		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Benzo(a)anthracene	9	1	2	1	1
Benzo(a)pyrene	5	1	3	1	2
Benzo(b)fluoranthene	5	1	1	1	1
Benzo(k)fluoranthene	5	0	1	0	0
Dibenz(a,h)anthracene	3	1	2	1	1
Indeno(1,2,3,cd)pyrene	3	0	1	1	1
Naphthalene	11	0	3	0	2
Ethylbenzene	16	0	3	0	0
TCE	131	13	30	8	19
VC	18	1	6	1	2
Arsenic	40	NA	NA	1	1
Chromium	60	No comparisons; Site levels similar to background			
Thallium	3	0	1	0	0

4.2.1.4.1 NJDEP Comparisons

Soil samples deeper than 10 ft bgs were also compared exclusively with the NJDEP SRSs (see Table 4-7A). The maximum detected concentrations for six PAHs, two chlorinated VOCs (TCE, and VC), and arsenic exceeded their respective NJDEP SRSs for residential soil. They also exceeded their nonresidential SRSs, with the exception of naphthalene. The maximum detected concentrations for six of the PAHs were observed in the same sample location (SS-18G03C, collected from 16.6 to 17.1 ft bgs).

A review of the FOD for the analytes on Table 4-7A indicates that the PAHs are infrequently detected with the FOD ranging from 5% to 16% and are therefore not a widespread concern for deep soil. The FOD for the VOCs ranged from 8% (VC) to 57% (TCE). The VOCs were detected in the vicinity of the Groundwater AOC 2 source area within Area 18C. The residual VOCs in this area are being evaluated under the groundwater and vapor intrusion project for the former Raritan Arsenal. Arsenic was detected more frequently than the other analytes.

The exceedance rate for the analytes presented on Table 4-7A was less than or equal to 8%. This indicates that the exceedances are restricted to a limited number of samples. Based on the information presented in this subsection, it is concluded that No Further Action for soil is required on behalf of USACE. The groundwater monitoring activities associated Groundwater AOC 2 to address the residual levels of contamination found within the deep soil associated EPA/GSA Area will continue.

4.2.2 Ecological Comparisons

Table 4-9 presents the data for soil concentrations observed in Area 18 with ecological soil screening criteria. Figure 4-4 presents the locations of the ecological soil screening level exceedances. The soil samples selected for comparisons with ecological screening criteria were collected from undeveloped areas with ecological habitat. The selected sample locations are consistent with those evaluated in the ecological risk assessments that were conducted for the former Raritan Arsenal.

4,4'-DDT exceeded the benchmark at two locations. Five metals (aluminum, antimony, iron, lead, and vanadium) exceeded their respective benchmarks at all locations sampled. Other metals detected at concentrations exceeding their benchmarks in at least one of the locations sampled included copper, mercury, and selenium.

The results of the updated soil screening are consistent with the original SLERA conducted by Weston (2004a) and would not change the inputs to/results of the BERA (Weston, 2008a).

4.3 Sediment Comparisons

As mentioned in Section 2, sediment data have been collected from the EPA/GSA Area. The sediment data are compared to human health and ecological criteria in the following subsections. The sediment data were collected from intermittent streams that often times do not contain flowing water and were therefore considered to be soil for the purposes of potential human exposures. Given the absence of readily available sediment screening criteria for human health exposures, the following soil criteria for restricted and unrestricted uses were conservatively used for the sediment comparisons: EPA's RSLs (EPA, 2017) and New Jersey's SRSs (NJDEP, 2017). Using soil screening criteria for sediment comparisons will overstate the number and degree of exceedances since the frequency and magnitude of soil exposure incorporated into the soil criteria is greater than one would expect for sediment contact.

For the sediment, comparisons were made to ecological sediment screening benchmarks. The ecological effect comparisons were based on the lowest screening value from the following: ORNL screening benchmarks for sediment-associated biota (Jones et al., 1997), EcoTox Thresholds (EPA, 1996), EPA Region III Biological Technical Assistance Group (BTAG) Freshwater Sediment Screening Values (EPA, 2006b), Provincial Sediment Quality Guidelines (Fletcher et al., 2008), Threshold Effect Concentrations (TECs) (MacDonald et al., 2000), and Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario (Persaud et al., 1996).

4.3.1 Human Health Comparisons

Table 4-10 presents the human health comparisons for the EPA/GSA Area sediment (0 to 2 ft bgs) to the previously mentioned Federal and state criteria for soil contact. The maximum detected

concentration for each detected analyte was compared with the criteria. The criterion was shaded on Table 4-10 if the maximum detected concentration exceeded the criterion. Figure 4-5 presents the locations of the screening criteria exceedances. The maximum concentrations for the following analytes exceeded at least one of the criteria:

PAHs	Pesticides	SVOCs	Metals
Benzo(a)anthracene	Aldrin	Carbazole	Arsenic
Benzo(a)pyrene	gamma-Chlordane		Chromium
Benzo(b)fluoranthene	Heptachlor epoxide		Lead
Benzo(k)fluoranthene			
Chrysene			
Dibenz(a,h)anthracene			
Indeno(1,2,3,cd)pyrene			
1-Methylnaphthalene			
Naphthalene			

Table 4-11 presents point comparisons for the analytes whose maximum detected concentration in sediment exceeded a criterion in Table 4-10. The following summarizes the frequency of the exceedances by analyte.

Analyte	Number of Detected Samples	Number of Exceedances			
		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Benzo(a)anthracene	18	6	10	6	8
Benzo(a)pyrene	18	9	14	10	11
Benzo(b)fluoranthene	18	6	10	6	8
Benzo(k)fluoranthene	17	1	6	1	3
Chrysene	19	0	2	0	1
Dibenz(a,h)anthracene	13	6	10	6	9
Indeno(1,2,3,cd)pyrene	16	3	10	4	7
1-Methylnaphthalene	9	0	1	0	0
Naphthalene	10	2	6	2	6
Aldrin	3	3	3	3	3
gamma-Chlordane	1	0	0	0	1
Heptachlor epoxide	15	3	5	3	5
Carbazole	15	NBA	NBA	2	2
Arsenic	23	NA	NA	1	1
Chromium	26	No comparisons; Site levels similar to background			
Lead	26	0	1	0	1

4.3.1.1 NJDEP Comparisons

Sediment were also compared exclusively with the NJDEP SRSs (see Table 4-10A). The maximum detected concentrations for eight PAHs, three pesticides, one SVOC, arsenic, and lead exceeded their respective NJDEP SRSs for residential soil. They also exceeded their nonresidential SRSs, with the exception of chrysene, gamma-chlordane, and lead.

It is clear from all of the information presented in Table 4-10A that the PAHs observed in the sediment are frequently detected. As discussed in Section 2.3.8 and Appendix B, the presence of PAHs (and other contaminants) in the sediment are not a results of past DoD operations and should not be considered for any future decisions on remediation of the EPA/GSA Area.

4.3.2 Ecological Comparisons

Table 4-12 presents the ecological comparisons for sediment. Figure 4-4 presents the locations of the ecological sediment screening level exceedances.

Based on the updated benchmark comparisons, the analytes exhibiting frequency of exceedances of their applicable sediment benchmarks consisted of metals, PAHs, pesticides, and dibenzofuran. Sixteen PAH compounds detected in freshwater sediment sampling locations exceeded their applicable benchmarks in most of the locations sampled. Nine detected pesticides (4,4'-DDD, 4,4'-DDT, delta-BHC, dieldrin, endosulfan II, endrin aldehyde, endrin ketone, heptachlor, and methoxychlor) exceeded their respective benchmarks in at least one sampled location. Two metals (copper and lead) exceeded their benchmarks in at least one freshwater sediment sampling location.

The results of the updated sediment screening are consistent with the original SLERA conducted by Weston (2004a) and would not change the inputs to/results of the BERA (Weston, 2008a).

4.4 Groundwater Comparison

Three groundwater AOCs originate within the EPA/GSA Area: AOCs 2, 4, and 8. Samples were collected for VOCs from the AOCs during September/November 2017. The contaminant concentrations were compared with the Federal Maximum Contaminant Levels (MCLs) and the

NJDEP GWQS. Sample results are presented on Tables 4-13 through 4-15. Figures 4-6 through 4-8 present the monitoring well locations and the wells with exceedances of screening levels.

4.4.1 Groundwater AOC 2

During the September 2017 monitoring event, seven wells (MW-114, MW-139, MW-140, MW-160-1, MW-311, MW-314, and MW-CP-IV-1) were sampled within Groundwater AOC 2 (see Table 4-13). Three wells (MW-317, MW-318, and MW-320) were sampled in November 2017. There were four analytes with at least one detected concentration that exceeded NJDEP GWQS:

- TCE: detected in all sampled wells with concentrations exceeding the GWQS of 1 µg/L in 8 of the 10 wells sampled (concentration range – 1.6 µg/L to 57 µg/L). The maximum detected concentration (57 µg/L) was observed in MW-139. The TCE concentration in MW-114 (source well) was 9.1 µg/L.
- Cis-1,2-DCE: the sample from MW-114 (source well) had a concentration of 100 µg/L that exceeded the NJDEP GWQS of 70 µg/L. Cis-1,2-DCE was detected in all of the other sampled wells with concentrations ranging from 1.2 µg/L to 54 µg/L.
- VC: concentrations from five wells (MW-114 – 76 µg/L, MW-139 – 7.1 µg/L, MW-140 – 9.6 µg/L, MW-311 – 17 µg/L, and MW-314 – 1.2 µg/L) exceeded the GWQS of 1 µg/L. VC was detected in one additional well at 0.75 µg/L.
- PCE: concentrations from two wells (MW-139 – 3 µg/L and MW-CP-IV-1 – 1.1 µg/L) slightly exceeded the GWQS of 1 µg/L. PCE was detected in six additional wells with concentrations ranging from 0.21 µg/L to 0.84 µg/L.
- 1,4-Dioxane: the sample from MW-314 (source well) had a concentration of 14 µg/L that exceeded the NJDEP GWQS of 0.4 µg/L. 1,4-Dioxane was detected in one of the other sampled wells (MW-139) with a concentration of 0.24 µg/L.

Figure 4-6 shows monitoring well locations with exceedances of the AOC 2 COCs.

4.4.2 Groundwater AOC 4

Groundwater AOC 4 was subdivided into Groundwater AOC 4A and Groundwater AOC 4B based on the distribution of TCE values. Four wells (MW-46A, MW-120, MW-EPA-2A, and OB-7A) were sampled within Groundwater AOC 4A in September 2017 (see Table 4-14). One well (MW-321) was sampled in November 2017. There were two analytes with at least one detected concentration that exceeded NJDEP GWQS:

- TCE: concentrations from two wells (MW-46A – 5 µg/L and MW-120 – 1.5 µg/L) exceeded the GWQS of 1 µg/L. TCE was detected in one additional well at 0.89 µg/L.
- VC: MW-120 was the only well with VC concentrations (4.3 µg/L) that exceeded the GWQS of 1 µg/L.

Figure 4-7 shows monitoring well locations with exceedances of the AOC 4A COCs. MW-122 was the only well sampled within AOC 4B, and had no exceedances of NJDEP GWQS.

4.4.3 Groundwater AOC 8

Groundwater AOC 8 is subdivided into Groundwater AOC 8A/B, AOC 8C, and AOC 8D. Eight monitoring wells (MW-88A, MW-106A, MW-121, MW-134, MW-136, MW-153, MW-156, and MW-EPA-10A) were sampled with Groundwater AOC 8A/B in September 2017. There were three analytes with at least one detected concentration that exceeded NJDEP GWQS:

- TCE: six wells had TCE concentrations that exceeded the NJDEP GWQS of 1 µg/L with levels ranging from 1.7 µg/L to 130 µg/L.
- VC: one well had a VC concentration of 2.1 µg/L that exceeded the NJDEP GWQS of 1 µg/L.
- Bromodichloromethane: the sample from MW-136A had a concentration of 2.1 µg/L that slightly exceeded the NJDEP GWQS of 1 µg/L.
- 1,4-Dioxane: the sample from MW-EPA-10A had a concentration of 0.48 µg/L that slightly exceeded the NJDEP GWQS of 0.4 µg/L.

Two monitoring wells (MW-87A and MW-125) were sampled within Groundwater AOC 8C in September 2017. TCE was detected in both wells at concentrations (MW-87A – 1.1 µg/L and MW-125 – 18 µg/L) that exceeded the GWQS of 1 µg/L.

Two wells (MW-8 and MW-89A) associated with AOC 8D were sampled in September 2017. The analytical results for MW-8 showed concentrations of TCE (98 µg/L) and vinyl chloride (2.7 µg/L) that exceeded the respective GWQS. MW-89A did not have any exceedances of the GWQS.

Table 4-15 and Figure 4-8 present the data and location of the monitoring wells within this AOC.

5. CONTAMINANT FATE AND TRANSPORT

Neither chemical concentrations nor chemical structures remain constant in the environment. When a chemical is released into the environment, it may be transported, transformed, and/or accumulated in one or more media. This section discusses the processes and various chemical and physical properties that affect the fate and transport of the contaminants detected at the former Raritan Arsenal.

5.1 CONTAMINANT SOURCES

The primary source of the contaminated media at the former Raritan Arsenal including the EPA/GSA Area is the varied military-related operations that occurred between 1916 and 1963 as well as the activities that have occurred after the DoD ceased operations. Historical military uses at the site that have contributed to the contamination include its use as an arsenal and weapons storage and handling facility, as well as a number of manufacturing and training missions. Since transfer of ownership of the former Raritan Arsenal from the Army to private and public entities, additional contamination has been introduced from sources outside the historical uses by the Army including, among others, the application of pesticides and herbicides, introduction of fill material into some areas, demolition of buildings, chemical spills/releases by private enterprises, development of asphalt parking areas and walkways, and uncontrolled dumping.

Another potentially significant source of contamination, especially PAHs, is the periodic brush fires that occur in the undeveloped portion of the former Raritan Arsenal. It is difficult to quantify the amount of PAHs deposited from the atmosphere during the burn events but it is not expected to be insignificant as it has been reported that fires occur in the area multiple times per year. The most recent fire occurred on April 10, 2014.

5.2 MIGRATION PATHWAYS

The potential contaminant migration pathways include the following:

- Storm water/surface water runoff releasing and transporting contaminants in soil to other areas on-site via site drainage;

- Wind erosion/volatilization releasing COPCs from soil;
- Leaching of contaminants present in soil to groundwater; and
- Migration of volatile compounds from groundwater into buildings (vapor intrusion).

5.3 ENVIRONMENTAL FATE AND TRANSPORT

This section deals with the environmental fate and transport characteristics of the contaminants in the EPA/GSA Area. This section describes the specific properties of the contaminants of concern and how the chemicals degrade and move in the environment.

Organic contaminants detected in soil above the EPA RSLs or NJDEP SRSs for restricted (i.e., industrial) and unrestricted (i.e., residential) use include PAHs, chlorinated pesticides, PCBs, SVOCs, and VOCs. Organics detected in groundwater above the Federal MCLs and the NJDEP GWQS includes VOCs (e.g., PCE, TCE, and cis-1,2-DCE).

Inorganics detected in soil above the EPA RSLs or NJDEP's SRSs for restricted and unrestricted use included antimony, arsenic, chromium, lead, mercury, thallium, and vanadium.

5.3.1 Transport and Attenuation Processes

Contaminants may exist in the subsurface in solid, aqueous, or vaporous phases. The persistence of contaminants in soil and groundwater is determined by such things as their chemical properties and concentrations, location and configuration of the source, geochemical and biochemical reactions, soil type, as well as other factors.

Factors and processes that control the distribution of chemicals in water-bearing units, in addition to the aforementioned factors, are the water-bearing zone transmissivity, soil/rock properties, advection, and hydrodynamic dispersion. Processes that tend to attenuate the dispersion of contaminants include retardation resulting from sorption, volatilization, degradation, and mineral precipitation.

Many factors influence the ultimate fate of the contaminants of concern. Some of these factors are discussed below.

Solubility

The solubility of a compound is considered to be the most important transport factor because it determines the concentration of contaminants that are dissolved in water. The contaminants of concern in the soil at the Site such as PAHs (e.g., benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, and dibenz[a,h]pyrene), chlorinated pesticides, PCBs, metals and many of the SVOCs generally have an insignificant solubility in water (benzo[a]pyrene has a solubility in the low µg/L range) (Table 5-1). VOCs generally have fairly high solubilities, as indicated by their presence in groundwater. Metals and semi-metals (e.g., arsenic) solubilities are generally determined by the properties presented in Section 5.3.3.

Sorption

The sorption properties of individual solutes are dependent on soil and groundwater characteristics. The soil/sediment partition or sorption coefficient (K_{oc}) is defined as the ratio of adsorbed chemical per unit weight of organic carbon to the aqueous solute concentration. The coefficient indicates the propensity of a compound to sorb to generally immobile organic carbon or other substrates and, therefore, provides a means for estimation of the relative mobility of solutes (Montgomery, 2000). The rate of travel for each chemical depends on the degree of sorption. If a chemical is extensively adsorbed by particles, it will be rendered relatively immobile. PAHs, pesticides, and PCBs are moderately to strongly sorbed and VOCs are not.

The vadose zone typically contains greater amounts of organic material and metal oxides (which may also act as sorbents) than the saturated zone, which may make the rate of movement in the vadose zone substantially less than that in the saturated zone (USEPA, 1989). In general, the relative amount of sorption by soil or sediment materials that do not contain organic matter is as follows from most to least sorption: clay > silt > sand > gravel (Walton, 1988). It would be expected that sorption would exert a fairly strong influence in retarding the migration of most of the site contaminants.

Volatilization

Volatilization is the transport of a compound from the solid or liquid phase into the vapor phase and, ultimately, into the atmosphere. PAHs, pesticides, PCBs, and SVOCs generally have low to moderate vapor pressures and/or Henry's Law constants and are not volatile. As the name implies, VOCs are volatile.

Most metals are not volatile and arsenic compounds are not volatile under most conditions (all except strongly reducing) but mercury can be volatile. Based on the soil contaminants of concern, volatilization is not expected to be a significant site-wide transport mechanism except for the VOCs.

Degradation

Chemicals released to the environment are susceptible to several degradation pathways, including chemical degradation, photolysis or photochemical degradation, and biodegradation. Compounds formed by these processes may be more or less toxic and/or more or less mobile than the parent compound. Metal and semimetals do not degrade but may change form. Microorganisms exhibit decreasing ability to degrade more complex compounds such as PAHs. As the number of fused aromatic rings increase in PAHs, the more resistant they are to degradation.

5.3.2 Properties of Organic Contaminants of Concern

5.3.2.1 VOCs

Solvents

The detected VOCs on-site generally fall under the category of chlorinated aliphatic hydrocarbons (CAHs). CAHs are characterized by straight-chain structures; a variable number of single, double, and triple bonds; and the presence of chlorine. CAHs have many applications, such as solvents, degreasers, dry cleaning agents, gasoline additives, refrigerants, and organic synthesis agents (Moore and Ramamoorthy, 1984).

CAHs tend to have high solubilities, high volatilities, low to moderate partition coefficients, high mobilities, and densities greater than water. They are relatively easily volatilized into the atmosphere (if conditions are suitable), or leached from soil into groundwater.

Once in the subsurface, the CAHs typically undergo progressive dehalogenation. PCE may be progressively broken down to TCE (typically anaerobically), 1,2-dichloroethene (1,2 DCE) or 1,1-dichloroethene (1,1 DCE), and vinyl chloride. The relative rate of dechlorination of CAHs decreases as chlorines are sequentially removed, therefore, the rate of degradation of PCE is more rapid than that of TCE or the DCE isomers, and reductive dechlorination of vinyl chloride may not be observed. As such, vinyl chloride is typically persistent and the formation of carbon dioxide or ethylene (ethene) is rather slow, but is enhanced by the presence of methane (Vogel et al., 1987).

Similarly, chloroform may be progressively broken down to methylene chloride, methyl chloride, then to methane.

Tetrachloroethene

Tetrachloroethene has a solubility of 150 mg/L (Montgomery, 2000), high volatility, moderate to high mobility, and a density greater than water. As a result, it is relatively easily volatilized into the atmosphere (if conditions are suitable), or leached from soil into groundwater.

Trichloroethene

TCE has a solubility of approximately 1,100 mg/L (Montgomery, 2000), high volatility, moderate to high mobility, and a density greater than water.

5.3.2.2 Petroleum Hydrocarbons

Petroleum hydrocarbons are highly complex mixtures of paraffinic, cycloparaffinic (naphthalenic) and aromatic hydrocarbons, containing a low percentage of sulfur and trace amounts of nitrogen and oxygen compounds. They are used as fuels (gasoline, fuel oils) and lubricants. They are toxic if ingested and can cause irritation and/or illness if inhaled or absorbed through the skin. Petroleum hydrocarbon mixtures range in color from black and dark brown to light yellow and clear, depending on the degree of refinement. Petroleum hydrocarbons are immiscible with water, resulting in a floating oily layer on top of the groundwater surface and a smaller dissolved component in the groundwater (typically benzene, toluene, ethylbenzene, and xylenes (BTEX).

Both the floating and the dissolved components tend to migrate in the direction of groundwater flow.

Benzene and Ethylbenzene

Ethylbenzene is an aromatic hydrocarbon compound that consists of a benzene ring with an ethyl group. Benzene and ethylbenzene have many industrial and agricultural applications and, therefore, are widely distributed. They are an important constituent of petroleum products and some coal tar byproducts, and are also used separately as an industrial solvent. Benzene is very mobile due to its high solubility and moderate sorption. Benzene is highly susceptible to aerobic degradation and biodegradation. Ethylbenzene is less mobile and more persistent than benzene. Benzene is toxic at elevated concentrations, and has been found to be carcinogenic.

5.3.2.3 Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are a group of semivolatile organic compounds composed of fused benzene rings. Physical and chemical properties vary with molecular weight. PAHs are frequently found in tar, asphalt, and fuels and are used in manufacturing pesticides, preservatives, and antiseptics (Moore and Ramamoorthy, 1984). In general, PAHs tend to have very low solubilities, high partition coefficients, and very low mobilities. Aqueous solubility and volatility decrease with increasing molecular weight. PAHs are generally confined to the soil or sediment, except for some of the compounds with higher solubilities (e.g., naphthalene). Because of their affinity to sorb to soil, they can be a component of fugitive dusts from contaminated areas. Microorganisms exhibit decreasing ability to degrade PAHs as the number of fused aromatic rings increase. Benzo[a]pyrene has five rings and is relatively resistant to degradation. All of the PAH contaminants of concern have at least 4 fused rings except naphthalene. Lower molecular weight PAHs biodegrade to carbon dioxide and water, but higher molecular weight PAHs may form phenolic and acidic metabolites (Moore and Ramamoorthy, 1984). PAHs range in toxicity and some of them have been found to be carcinogenic. Elevated levels of PAHs pose a health hazard when they are inhaled, ingested, or absorbed through the skin.

5.3.2.4 Insecticides

Chlordane, dieldrin, heptachlor, and DDT, and toxaphene are organochlorine insecticides whose former production and widespread use in agricultural and landscaping applications has resulted in their release into the environment. Organochlorine compounds have strong chlorine-carbon bonds that do not break down easily. They are persistent because they are resistant to bio-transformation and biotic degradation, and have low water solubilities, and as a result, are found in low concentrations in all media. They are all classified as Level I priority Persistent, Bioaccumulative, and Toxic (PBT) chemicals and Persistent Organic Pollutants (POPs). All of these insecticides are classified as class B2 compounds, probable human carcinogens.

Chlordane

Chlordane is a thick glassy liquid whose color ranges from colorless to tan or amber and has a pungent chlorine-like odor. Chlordane is not a single chemical, but is a mixture of more than 50 chemicals which are a complex mixture of chlordane isomers, other chlorinated hydrocarbons, and by-products. However, in most temperate climates, only the two chlordane isomers: alpha and gamma chlordane, generally persist. In the United States, it was banned for all uses in 1988. Chlordane has a solubility in water of 56 µg/L.

DDD/DDE/DDT

4,4'-DDT is a pesticide once widely used to control agricultural and disease-carrying insects. DDT is a white, crystalline solid with little to no odor. Volatilization from moist soil surfaces is expected to be an important fate process based upon vapor pressure, but, adsorption to soil is expected to attenuate volatilization. The reported half-live for DDT in soil ranges from 2 to greater than 15 years (Toxnet, 2011). Its use in the U.S. was banned in 1972 because of damage to wildlife, but is still used in some countries.

4,4'-DDE and 4,4'-DDD are chemicals similar to DDT that contaminate commercial DDT preparations. In addition to contaminating DDT, DDD and DDE are breakdown products (metabolites) of DDT. These metabolites are present virtually everywhere in the environment and

are more persistent than the parent compound. DDE has no commercial use, but, DDD was also used to kill pests. DDD has a water solubility between 20 and 90 µg/L (Montgomery, 2000). All three compounds are classified as B2 compounds (probable human carcinogens).

Dieldrin/Aldrin

Dieldrin is a chlorinated hydrocarbon that has a ring structure based on naphthalene. It is a white to tan powder with a mild chemical odor. Dieldrin is also a degradation product of aldrin, a similar insecticide. In 1974, the USEPA restricted its use to termite control by direct soil injection. In general, dieldrin should be unlikely to leach appreciably from soil to water. However, aldrin and dieldrin have among the lowest sorption coefficients of the Level I PBT pesticides, and dieldrin has a water solubility of 186 µg/L to 200 µg/L (Montgomery, 2000). Volatilization is the principal route of loss of dieldrin from soil; however, the process is relatively slow because of the low vapor pressure of dieldrin. Biodegradation and hydrolysis are unimportant fate processes, and therefore, dieldrin persists for long periods.

Heptachlor Epoxide

Heptachlor is a white to light tan waxy solid with a camphor-like odor. In 1988, the USEPA cancelled all uses of heptachlor except for fire ant control in underground transformers. Heptachlor and its degradation product heptachlor epoxide are moderately bound to soil and have low mobility and are highly persistent. Bacteria and animals break down heptachlor to form heptachlor epoxide. Heptachlor epoxide is more likely to be found in the environment than its parent compound. The epoxide is more mobile because it dissolves more easily in water than its parent compound (solubility of 275 µg/L versus 180 µg/L for the parent compound) and is more persistent. Heptachlor epoxide is neither manufactured nor has a use.

5.3.2.5 Polychlorinated Biphenyls (PCBs)

Polychlorinated Biphenyls (PCBs) are mixtures of chlorinated organic compounds, historically used in electrical transformers, capacitors, heat transfer and hydraulic systems, adhesives, paints and sealants. PCB mixtures (named Aroclors) range from heavy organic liquids to waxy solids

and are composed of 209 different congeners that vary in the number and position of chlorines. Their widespread use was mainly due to their chemical stability, low water solubility, low vapor pressure, low flammability, high heat capacity and low electrical conductivity, and they were used to enhance the performance of oils in transformers and capacitors. World production of PCBs ended in 1983; however most manufacturers halted production in the 1970s due to evidence of the highly carcinogenic nature of the compounds.

Their persistence and potential health effects make them of concern. PCBs generally have low solubilities and high partition coefficients and, therefore, are usually immobile within the soil. PCBs will strongly partition into soil and sediment with high organic and/or clay content. PCBs are usually persistent in the environment, but can be biodegraded under a variety of aerobic conditions through breakage of the biphenyl structure and, less often, anaerobically under very reducing conditions through dechlorination. Rates of biodegradation are approximately one order of magnitude slower for PCBs with four chlorines versus those with fewer chlorines, and another order of magnitude slower for PCBs with six chlorines versus those with four chlorines (Andrews et al., 1990).

Carbazole

Carbazole is a di-benzo aromatic compound that naturally occurs in coal, petroleum, and peat and can be released to the environment from the incomplete combustion of these materials. Several thousand tons of carbazole are produced each year from coal tar and crude oil. Coal tar produced at high temperature contains an average of 1.5 percent carbazole.

It is used widely in synthesis of dyes, pharmaceuticals, plastics, insecticides, lubricants, rubber antioxidants, and for odor inhibitor in detergents. Human exposure to carbazole occurs through inhalation of contaminated air and consumption of water and char-broiled food. High exposure occurs through smoking cigarettes.

Carbazole may be susceptible to rapid aerobic and anaerobic biodegradation in soil, provided that specific degrading bacteria are present in the microbial community.

Carbazole is a suspected carcinogen. A high partition coefficient and a low water solubility indicate that it would have low to slight mobility in soil. Sorption of carbazole to soil is nonlinear and highly correlated with the organic content of the soil. Carbazole is essentially non-volatile (HSDB, 2013).

Pentachlorophenol

Pentachlorophenol (PCP) exists as colorless or white crystals or dark gray to brown when impure. It has a phenolic odor only when hot. Pentachlorophenol was a widely used biocide, but it is now a restricted use pesticide and is no longer available to the general public. Its primary use was as a wood preservative. PCP is highly toxic when ingested by humans; the EPA has classified pentachlorophenol as a Group B2, probable human carcinogen.

Pentachlorophenol has a low to very low mobility in soil, low volatility, and has a solubility of 14 mg/L in water. Bioaccumulation of PCP is highly pH dependent, with more bioaccumulation at lower pH.

Pentachlorophenol degrades both aerobically and anaerobically; however, aerobic degradation is more rapid than anaerobic degradation.

Acraldehyde (Acrolein)

Acraldehyde, most commonly called acrolein, is used as a pesticide for control of aquatic weeds and algae as well as a biocide to kill bacteria. Acrolein is acutely toxic by inhalation, oral, and dermal exposures.

Due to the reactivity with organic matter, acrolein is not likely to persist in the environment. Acrolein degrades into several compounds including acrylic acid, allyl alcohol, propanol, propionic acid, oxalic acid, and finally carbon dioxide. In addition a metabolite of acrolein, glycidol, is considered a probable human carcinogen.

Degradation and volatilization are believed to be the major pathways for dissipation of acrolein in water. Limited information indicates that acrolein does not strongly partition into sediment. It has high water solubility (212 g/L) and is quite mobile horizontally and vertically (EPA, 2008).

5.3.3 Inorganic Chemical Properties

Metals and semi-metals (metalloids, such as arsenic) are used in many industrial applications and are fairly widespread within the soil in areas with previous heavy industrial activity. Unlike organic constituents, metals cannot be degraded. The fate and transport of metals in soil and groundwater depends mostly upon physio-chemical properties of the associated matrix. Depending on conditions, some metals are precipitated, some are adsorbed to colloids or other surfaces or held by ion exchange, and some are transported by surface water and groundwater as free ions or as metal/ligand complexes (USEPA, 1989).

The mobilities of metals are principally controlled by pH, oxidation/reduction potential (REDOX), and the presence of metal hydroxides, clay minerals, or organic compounds. Heavy trace metals have very high potentials for retardation. Downward transportation of metals from the soil surface occurs when the metal retention capacity of the soil is overloaded, or when metals are solubilized by a change in conditions (e.g., a decrease in pH). When the concentration of metals exceeds the ability of the soil to retain them, the metals will travel downward with the leaching waters. Surface transport through dust and erosion of soil are also common transport mechanisms. The following is an evaluation of the inorganic COCs specific properties.

5.3.3.1 Arsenic

Arsenic, as an element, is a heavy, brittle, silver-gray or off-white semi-metal (metalloid). Arsenic is widely distributed and was used in leather tanning processes, as a wood preservative (chromated copper arsenate [CCA]), and in pre-World War II inorganic pesticides. Arsenic is also found in coal and coal combustion by-products (e.g., fly ash) (Nriagu, 1994). Arsenic is currently used primarily in metallurgy for hardening nonferrous alloys and in semiconductors (SETAC, 1988).

The physical and chemical properties of arsenic vary with the form (e.g.; oxides, salts, organics, etc.). Arsenic can exist primarily in two valence states (As^{3+} (III) and As^{5+} (V)). Both are toxic;

however, As (III) (the reduced state found in anaerobic soil) is the more toxic form and As (V) is the most common form (the oxidized form, which is stable in aerobic soil)(FRTR, 2002).

Arsenic solubility is controlled by the dissolution of iron oxyhydroxides. Dissolved arsenic species can be absorbed by ferric hydroxides and aluminum and manganese oxides, which are stable over a wide Eh-pH range. Arsenic is coprecipitated [as As(V)] with iron oxyhydroxides and sulfides and released upon their solubilization (McBride, 1994).

Under normal site conditions (rain and groundwater pH in the range of 4 to 7), arsenic tends to be relatively insoluble and immobile (McBride, 1994).

Under reducing conditions, arsenic mobility is increased (As (III) valance arsenic is less strongly absorbed than As (V)). Arsenic is most mobile under mildly reducing conditions lacking hydrogen sulfide. Methane-generating bacteria can convert arsenic to mobile organic forms in neutral to alkaline soil. Volatile alkylarsene compounds may form under strongly reducing conditions (McBride, 1994). Most organic arsenic species result in negligible effects on human systems. Organic arsenic is readily degraded to inorganic arsenic in the environment (Masschelein, Delaune, and Patrick, 1991).

5.3.3.2 Antimony

Antimony (Sb) is a semi-metallic chemical element which can exist in two forms: the metallic form is bright, silvery, hard and brittle; the non-metallic form is a gray powder. The most important metallurgical use for antimony is as an alloying ingredient in lead and other metals to increase hardness and stiffness (SETAC, 1988). It is also used in solder, sheet and pipe metal, bearings, castings, and pewter. Antimony oxide is added to textiles and plastics to prevent them from catching fire. It is also used in paints, ceramics, and fireworks, and as enamels for plastics, metal, and glass (SETAC, 1988).

Antimony is a non-essential element in humans, animals, and plants. It occurs most commonly in the Sb^{3+} (III) and Sb^{5+} (V) oxidation states, but it is normally found as an anion. Its toxicity depends upon chemical form and oxidation state with Sb (III) compounds more toxic than Sb (V)

compounds. Antimony has a geochemical behavior and toxicity similar to arsenic. In soil, Sb(III) and antimony Sb(V) oxidation states are stable under reducing and oxidizing conditions, respectively (McBride, 1994).

The mobility of antimony in soil is rated as medium, with reducing conditions associated with poor drainage lessening mobility (McBride, 1994), except at very acid and alkaline pHs. Antimony has an affinity for silicate clay minerals and appears to co-precipitate with hydrous iron, manganese, and aluminum oxides (SETAC, 1988).

In oxidizing conditions, Sb(V) is likely to form the anionic hydroxide molecule $Sb(OH)_6^{1-}$ above pH 4, and $Sb(OH)_5$ in more acid solution.

5.3.3.3 Chromium

Chromium generally occurs in the +3 (chromic) oxidation state as the Cr(III) cation, and in the +6 (VI) oxidation state as CrO_4^{2-} (chromate). However, soil conditions generally favor the Cr (III) form, a very immobile cation that complexes strongly with organic matter and sorbs on oxides and silicate clays, even at quite low pH (McBride, 1994).

Furthermore, Cr(III) readily substitutes for iron in mineral structures, and precipitates as insoluble $Cr(OH)_3$ at higher pH. The chromic form is, therefore, very immobile in most soil and generally unavailable to plants if the soil is not exceedingly acidic.

At higher pH, a small fraction of the Cr(III) in soil can be oxidized to chromate, CrO_4-, a very toxic form of chromium. This oxidation is promoted by manganese oxides. Chromate adsorbs less strongly than Cr(III), and the mobility and bioavailability of this anion is consequently higher. Generally, however, if pollutants containing chromate are applied to soil, most or all of the chromate is spontaneously reduced to Cr(III), especially under acid conditions and with organic matter present. Organic matter supplies reducing agents and complexing groups, stabilizing the chromic form. The soil therefore has the ability to detoxify chromate and immobilize the element (McBride, 1994).

Chromium is rated as an immobile element, most of which is difficult to extract from soil even by aggressive chemical agents. Toxicity of Cr to plants is occasionally seen in unusually Cr-rich soil formed from the parent rock, serpentinite, or under high pH conditions favorable to Cr(III) oxidation.

5.3.3.4 Lead

Lead, as an element, is a heavy, ductile, soft, gray solid. The main uses of lead are in lead acid storage batteries, ammunition, nuclear and x-ray shielding devices, cable covering, ceramic glazes, noise control materials, bearing, brass and bronze, casting metals, and solder. The lead use pattern has changed significantly from the past with declining use in antiknock compounds in gasoline and in paint and pigment (SETAC, 1988).

The physical and chemical properties of lead vary with the form (e.g., oxides, salts, organics, etc.) Lead (Pb) is principally in the Pb(II) oxidation state in soil. Lead solubility is highly dependent on pH and Eh. In general, lead is the least mobile heavy metal in soil, especially under reducing or non-acid conditions. Lead is absorbed by organic matter, clay minerals, hydrous iron and manganese, and is precipitated by forming low solubility compounds with major anions (e.g., sulfate). Lead is more soluble under acidic conditions. Under normal site conditions (rain and groundwater pH in the range of 4 to 5), however, lead tends to be relatively insoluble and immobile (McBride, 1994).

Lead becomes very insoluble in reduced soil because of its precipitation by sulfide generated from sulfate reduction. Sulfhydryl groups, if present in humus, strongly complex the Pb(II) cation. Under oxidizing conditions, the Pb(II) cation becomes less soluble as soil pH is raised. Complexation with organic matter, chemisorption on oxides and silicate clays, and precipitation as the carbonate, hydroxide, or phosphate are all favored at higher pH. In alkaline soil, solubility may increase by formation of soluble Pb-organic and Pb-hydroxy complexes. The Pb(II) ion has a particularly high affinity for manganese oxides, possibly explained by manganese oxidation of Pb(II) to Pb^{4+}(IV), a very insoluble ion.

As expected from the strong complexation of Pb(II) by organic matter, lead bioaccumulates in the humus-rich surface layer of soil.

5.3.3.5 Mercury

The chemistry of mercury in the environment is complex, not only because it has various oxidation states (neutral, + 1, + 2), but also because of biotic and abiotic methylation and the volatility of several forms of mercury. Mercury is strongly sorbed onto soil and sediment and sorption is one of the important controlling pathways. The primary sorbents are hydrous iron and manganese oxides, clay, and organics. The sorption process is rapid and, once it has occurred, desorption of mercury is negligible (SETAC, 1988).

In soil environments, the cationic form, Hg^{2+} (Hg (II)), is most common, because Hg(I) has a limited stability range. Acidic oxidizing conditions in soil tend to stabilize Hg(II), which complexes only moderately strongly with organic matter. Adsorption of Hg(II) on silicate clays and oxides is more favorable at higher pH (SETAC, 1988).

Under anaerobic conditions, soil microbes methylate mercury, forming volatile organomercury compounds. However, at the same time, anaerobic conditions and the presence of sulfur can cause precipitation of low solubility mercury sulfide.

Mercury accumulation in soil tends to correlate with the organic matter level. The highest natural mercury concentrations are in peaty and waterlogged soil.

Toxicity to organisms is usually attributable to soil conditions that favor the production of volatile forms of mercury. Metallic mercury and dimethylmercury are volatile under normal environmental conditions. The volatilization rate is also a function of the type of soil, being higher in sand and slower in clay. Dimethylmercury has a very low solubility in water and a high vapor pressure, resulting in rapid volatilization from aquatic systems (SETAC, 1988).

5.3.3.6 Thallium

Pure thallium is a soft, malleable, bluish-white metal but always is combined in nature. Most anthropogenic sources of thallium are solid wastes and emissions from coal combustion and ferrous and non-ferrous smelting. Thallium is a constituent of coal and many sulfide ores.

Thallium is more toxic to humans than mercury, cadmium, or lead. Thallium salts are highly water soluble. Thallium usually occurs as a monovalent cation in water. The solubility of thallous compounds are relatively high so that monovalent thallium is readily transported through aqueous routes into the environment. (Peter and Viraraghavan, 2004).

5.3.3.7 Vanadium

Vanadium is a silvery gray, ductile, and malleable transition metal, but is always found combined in nature. The principal use of vanadium is as an alloying addition to iron and steel, particularly in high strength steel. Vanadium compounds are also employed as catalysts. Vanadium (V) in soil exists predominantly in the V(V) and V(IV) oxidation states. However, V(III) which is not stable in aerobic conditions, may substitute for iron in iron oxides.

Vanadium has a very high mobility in oxidized soil that is neutral to alkaline, but a lower mobility if the soil is more acidic. The mobility of vanadium under reducing or acid conditions is moderate to low. The presence of humus promotes the reduction of vanadium, and therefore a low redox potential may not be necessary to immobilize vanadium (SETAC, 1988).

6. HUMAN HEALTH RISK ASSESSMENT

6.1 INTRODUCTION

The HHRA evaluates the contamination present in site soil and sediment to estimate the potential risks (cancer and noncancer) associated with human contact with these media at the EPA/GSA Area. When determining potential exposures to evaluate, consideration was given to the current and reasonably anticipated future uses of the site. The HHRA was conducted in accordance with CERCLA guidance. Published guidance from the USACE and the NJDEP were also considered.

A HHRA serves multiple roles in the CERCLA decision-making process, including:

- Estimating the potential risks to exposed individuals if no actions are taken (i.e., baseline conditions);
- Assisting in determining the need for remedial action; and
- Providing a basis for determining cleanup goals.

Because the EPA/GSA Area is being investigated and remediated under the DERP-FUDS program, the RI, including the assessment of human health risks, was conducted in accordance with CERCLA. The USACE has sought the services of NJDEP through a Defense Services Memorandum of Agreement (DSMOA), under which the state supports the regulatory framework established under DERP.

The HHRA was conducted to determine the extent to which soil and/or sediment may require action under CERCLA. This approach is consistent with how USACE conducts RIs under CERCLA nationwide, and is required by federal regulations.

The HHRA was based on EPA and USACE guidance and methods, site-specific information, and NJDEP guidance including:

- EPA Risk Assessment Guidance for Superfund (RAGS), Volume I;
    1. Human Health Evaluation Manual, Part A (EPA, 1989).

2. Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment (EPA, 2004).

3. Human Health Evaluation Manual, Part F, Supplemental Guidance for Inhalation Risk Assessment (EPA, 2009).

- EPA Exposure Factors Handbook (EPA, 1997);
- EPA Supplemental Guidance for Developing Soil Screening Levels (EPA, 2002);
- EPA ProUCL software (EPA, 2013);
- EPA Regional Screening Levels (EPA, 2017);
- EPA Update of Standard Default Exposure Factors (EPA, 2014);
- Other relevant EPA risk assessment guidance;
- USACE's Risk Assessment Handbook, Volume I: Human Health Evaluation (USACE, 1999);
- NJDEP Soil Remediation Standards – Ingestion and Dermal Exposure Pathway – Basis and Background (NJDEP, 2008a); and
- NJDEP Soil Remediation Standards – Inhalation Exposure Pathway – Basis and Background (NJDEP, 2008b).

The HHRA presented in this section is an update to the original HHRA completed for the former Raritan Arsenal (Watermark, 2009). The technical approach followed during the performance of this updated HHRA is described in the Final Work Plan – Human Health Risk Assessment – Former Raritan Arsenal (Watermark, 2007) with modifications to reflect recent risk assessment guidance, updates to toxicity values, and specific guidance from USACE.

6.2 HAZARD IDENTIFICATION

The hazard identification presents the data available to assess site risks, outlines the approach used to summarize the data, and identifies the contaminants of potential concern (COPCs). The hazard identification process involves the following tasks:

- Review of the previous site investigations and available data;
- Identification of the media of potential concern;

- Summarization of the data to be used in the HHRA;
- Establishment of the guidelines for data reduction;
- Evaluation of the data for use in the risk assessment; and
- COPC selection process.

The following subsections describe each of these tasks in greater detail.

6.2.1 Groundwater

As mentioned in Section 1, contamination associated with groundwater and the vapor intrusion pathway are being evaluated as a separate project under a separate task order contract. There is currently no use of groundwater on site. All buildings are connected to municipal water. Groundwater is not expected to be used in the future because new buildings will connect to municipal water. Additionally, the CEA and WRA are in place for portions of the former Raritan Arsenal. The CEA encompasses the portions of the former Raritan Arsenal where groundwater is contaminated as a result of DoD activities. As described in Section 2.8, MNA was recommended for groundwater AOCs 2, 4, and 8.

6.2.2 Media of Potential Concern

Based on the previous investigations performed at the former Raritan Arsenal, multiple visits to the area, and the current and reasonably anticipated future uses, exposure to contaminated soil is of potential concern to human receptors at the EPA/GSA Area. The sediment data collected from the drainage ditches within the EPA/GSA Area were treated as soil for the HHRA. Discussions with individuals that have knowledge of site conditions along with observations made during visits to the area indicate that water flows through the drainageways only during and immediately following heavy rainfall or snowmelt. During periods without precipitation, the ditches tend to be dry. Therefore, potential exposure to the drainage ditches was treated as soil exposure scenario in this HHRA.

6.2.3 Data Used in the Risk Assessment

Section 2 presents an overview of all of the data that have been collected during multiple RIs at the Investigation Areas within the EPA/GSA Area. The data from the investigations listed below were available and included in the HHRA:

- *Final Report of Investigation, Area 1 Investigation* (Weston, 1996a);
- *Final Report of Investigation, Area 18A Investigation* (Weston, 1996b);
- *Supplemental Investigation, Areas 2, 3, 7, 9, 11, 16, 18A, 19, Inland Container, and W* (Weston, 1999a);
- *Final Supplemental Report of Investigation, Areas 18B, 18C, 18D, 18F, and 18G Investigations* (Weston, 1999b);
- *Supplement 2 Phase II Remedial Investigation Report* (Weston, 2000);
- *Remedial Action Report, Remedial Construction – Areas 11, 12, 18A, 18C, and W* (Weston, 2002);
- *Remedial Action Report, Remedial Construction – Areas 12, 18B, 18C, and Building 256* (Weston, 2004b);
- *Final Screening-Level Ecological Risk Assessment, Former Raritan Arsenal* (Weston, 2004a);
- *Supplemental Remedial Investigation Report, Area 18C – Ramp Area and Buildings 151/165* (Weston, 2005a);
- *Final Baseline Ecological Risk Assessment, Former Raritan Arsenal* (Weston, 2008a);
- *Final Supplemental Remedial Investigation Report, Area 18E* (Weston, 2011);
- *Final Remedial Action Completion Report* (H&S, 2013); and
- Supplemental soil and sediment data collected from Area 18A and Area 18B Stream in October 2013 by Avatar Environmental.

Soil data from areas that were excavated during interim response actions were not used in the HHRA. Soil data from other sources that were of unknown quality or data that were not available electronically were not used in the HHRA. Post-excavation confirmatory samples that were

laboratory-analyzed and of known quality were used in the HHRA. As described in Section 2 and shown on Figure 2-1, a number of interim response actions have already taken place at the EPA/GSA Area. Areas that were successfully remediated based on confirmation samples were not evaluated as part of the HHRA.

Soil data collected from the Asbestos Landfill located within Investigation Area 18C were not evaluated in this RI as the source of the contamination (asbestos and non-asbestos) is not from DoD activities. The Asbestos Landfill is a result of GSA-directed demolition conducted in the late 1970s and early 1980s.

In general, the samples collected at the former Raritan Arsenal have been analyzed for the following constituents: VOCs, SVOCs, explosives, PAHs, pesticides, PCBs, and metals.

For the purposes of evaluating human health risk, two exposure areas (EAs) were considered for the EPA/GSA Area based on the potential likelihood of human exposure. The first EA consists of the entire EPA/GSA Area with the exception of the site drainage ditches and associated features which represent the second EA. The first EA is referred to as the Soil EA. The second EA is referred to as the Drainage Ditch EA. The rationale for evaluating exposures to the media in the site drainage ditches separately from the rest of the EPA/GSA Area is that the frequency of exposure is likely to be much lower in the drainage ditches due to accessibility and attractiveness than elsewhere within the EPA/GSA Area. Calculating risks separately for the EAs allows for separate risk management decisions to be made for each EA.

6.2.4 Guidelines for Data Reduction

The following guidelines for data reduction were used to produce the data summaries for each EA. These approaches are consistent with EPA RAGS (EPA, 1989).

- If an analyte was not positively identified in any sample for a given medium because it was reported as a nondetect (indicated by a “U” qualifier), because it was present as a result of blank contamination (indicated by a “B” qualifier for organics), because it was identified as a tentatively identified compound (TIC) (indicated by a “N” qualifier for organics), or because it was rejected (indicated by an “R” qualifier), it was not addressed for that medium;

- Analytical results with a "U" data qualifier represent nondetect samples for the analyte evaluated. Section 6.3.2 discusses how nondetect samples were used in the calculations of the 95 percent upper-confidence limits (95% UCL).The same approach was used for organic results with a "B" qualifier ; and

- If a sample duplicate was collected and analyzed, the average of the two reported concentrations was used for subsequent calculations unless there was a greater than 50% difference, in which case the higher of the two concentrations was used. In the case of a detected sample and a nondetect duplicate, the detected concentration was carried through subsequent calculations.

6.2.5 Data Evaluation

The data evaluation summarizes the data for use in the risk assessment. Summary tables have been prepared and present the following information:

- List of analytes detected;
- Range of detected concentrations;
- Location of maximum detected concentration;
- Frequency of detection;
- Limits of quantitation; and
- Arithmetic mean.

6.2.5.1 Soil EA

Summaries for two soil data groupings were presented for the Soil EA: one for the surface soil (0 to 2 ft bgs) and one for the surface/subsurface soil (0 to 10 ft bgs), hereafter termed the "aggregate soil". These data groupings are based on the known and anticipated uses of the EPA/GSA Area. The surface soil data were used to evaluate the receptors that are not expected to contact soil at depth, while the aggregate soil data were used to evaluate those receptors that could potentially contact the soil beneath the surface as part of normal work activities (i.e., construction and utility workers) or future receptors (i.e., hypothetical future residents) who could contact the soil to a depth of 10 ft bgs as a result of the mixing of soils that is likely to occur during construction activities.

Tables 6-1 and 6-2 present the data summaries for the surface and aggregate soil at the Soil EA, respectively. Detected analytes included VOCs, SVOCs, PAHs, PCBs, pesticides, petroleum hydrocarbon, and metals.

6.2.5.2 Drainage Ditch EA

Table 6-3 presents the summary for soil/sediment (0 to 2 ft bgs) sample results from the Drainage Ditch EA. Detected analytes included VOCs, SVOCs, PAHs, PCBs, pesticides, metals, and cyanide.

6.2.6 Selection of Contaminants of Potential Concern (COPCs)

A COPC selection process was conducted to identify a subset of analytes that were detected in each EA at levels that could pose a potential risk to exposed human receptors. The criteria that were used to determine COPCs included:

- Non-detection – If an analyte was not detected in any samples, it was not evaluated as a COPC.
- A comparison of maximum detected concentrations to risk-based criteria – If the maximum detected concentration for a given analyte was greater than its EPA Regional Screening Level (RSL) (EPA, 2015) for residential soil exposure or its NJDEP Residential Soil Remediation Standard (SRS) (NJDEP, 2008a and 2008b), it was identified as a COPC. When an analyte did not have a screening criterion available, a suitable surrogate analyte was identified and the screening value for the surrogate analyte was used in the COPC selection process. The analytes for which surrogate screening values were used are noted on the COPC screening tables (Tables 6-1 through 6-3). There were cases where a suitable surrogate could not be identified for an analyte and a comparison to screening criteria could not be performed. These analytes were not carried forward in the risk assessment. Per CERCLA guidance for selecting COPCs, the RSLs based on noncancer health effects were adjusted to reflect a target hazard quotient (THQ) of 0.1 (the published values are set at a THQ of one) to account for potential additivity or cumulative effects of multiple contaminants on similar organs. A target risk (TR) for cancer based criteria of one-in-a-million (expressed as 1E-06) was used. No adjustments were made to the published NJDEP SRS values. In cases where an analyte had both a cancer and a noncancer screening value, the lower (i.e., more stringent) of the two values was used for screening.

Metals (i.e., calcium, iron, magnesium, potassium, and sodium) considered to be essential nutrients to human health were eliminated from consideration as COPCs.

Tables 6-1 and 6-2 present the COPC selection process for the analytes that were detected in the surface and aggregate soil at the Soil EA, respectively. The maximum detected concentrations in surface soil for a number of analytes exceeded the residential soil screening criteria including PAHs, PCBs, pentachlorophenol, trichloroethylene (TCE), and metals. In the aggregate soil, the maximum detected concentrations for a number of analytes exceeded the residential soil screening criteria including the analytes listed above from the surface soil plus chloroform, DDT, dibenzofuran, dieldrin, ethylbenzene, vinyl chloride, and xylenes.

Table 6-3 presents the COPC selection process for the analytes that were detected in the Drainage Ditch EA. The maximum detected concentrations for a number of analytes exceeded the residential soil screening criteria including PAHs, pesticides, carbazole, dibenzofuran, and metals.

6.3 EXPOSURE ASSESSMENT

The exposure assessment characterizes the nature, extent, and magnitude of potential exposure of human receptors to COPCs considering the current and the reasonably anticipated future uses of the EPA/GSA Area. The exposure assessment involves several elements, including:

- Evaluating the exposure setting, which includes describing the local land and water uses and identifying the potentially exposed human populations;
- Developing a conceptual site model (CSM), which includes describing the source of contamination, the transport and release mechanisms, the exposure media, the exposure routes, and the potentially exposed populations;
- Calculating the exposure point concentrations (EPCs) for each COPC for each of the exposure scenarios and routes of exposure;
- Identifying the exposure models and parameters that were used to calculate the exposure doses; and
- Calculating the exposure doses for both cancer and noncancer effects.

Doses and risks were estimated based on the reasonable maximum exposure (RME). The RME is a high-end description of risk defined by EPA guidance (1992) as:

> "… a plausible estimate of the individual risk for those persons at the upper end of the risk distribution. The intent of this description is to convey an estimate of risk in the upper range of the distribution, but to avoid estimates which are beyond the true distribution."

In addition, the central tendency exposure (CTE) was evaluated. The CTE represents the exposure which is based on average exposure parameters to calculate an average exposure dose and risk to an individual.

6.3.1 Conceptual Site Model (CSM) for Human Exposures

A CSM describes the contaminant source(s), the release and transport mechanisms, the exposure media, the exposure routes, and the potentially exposed human populations. The primary objective of the CSM is to identify the complete and incomplete exposure pathways. A complete pathway has all of the components listed above, whereas an incomplete pathway is missing one or more. Figure 6-1 presents the CSM for the EPA/GSA Area. Each element of the CSM is described in detail in the following sections.

6.3.1.1 Source of Contamination

The primary source of the contaminated media at the former Raritan Arsenal including the EPA/GSA Area is the varied military-related operations that occurred between 1916 and 1963. Historical military uses at the site that may have contributed to the contamination include its use as an arsenal and weapons storage and handling facility, as well as a number of manufacturing and troop training missions. Since transfer of ownership of the former Raritan Arsenal from the Army to private and public entities, additional contamination has been introduced to the site from sources outside the historical uses by the Army including, among others, the application of pesticides and herbicides, introduction of fill material into some areas, chemical spills/releases by private enterprises, demolition of buildings, uncontrolled dumping, and brush fires.

6.3.1.2 Release and Transport Mechanisms

There are three primary mechanisms that can release and transport COPCs at the site: surface water runoff, wind erosion/volatilization, and leaching into groundwater. Surface water runoff occurs during precipitation events when COPCs in the soil are released and transported to other areas on

site via site drainage. Wind erosion can play a role in releasing COPCs from soil. This is primarily related to areas with less than 50 percent vegetative cover and where activities such as heavy truck traffic on unpaved roads and other construction-related activity are occurring (EPA, 2002).

While the fully developed areas are unlikely to experience significant wind erosion, dust emissions may be an important route of exposure at the undeveloped areas given the potential for future construction activities. It is also possible that VOCs present in the soil can volatilize and be inhaled.

As noted previously, leaching to groundwater and the subsequent groundwater contamination has been evaluated separately and are not the focus of this risk assessment.

6.3.1.3 Exposure Media and Routes of Exposure

The potentially contaminated media evaluated in this HHRA included soils and sediments. COPCs in soil may be incidentally ingested and absorbed through the skin by exposed human receptors. In addition, dust or VOCs released from the soil into the air would be available for inhalation. The sediment associated with the Drainage Ditch EA was treated as soil with the exception that the inhalation pathway was not evaluated.

Surface water in the ditches associated with the Drainage Ditch EA is shallow and is present only after precipitation events. The water dries up during extended periods without precipitation. Based on this, there is limited exposure potential. Potential exposure to the surface water in the Drainage Ditch EA was not evaluated.

6.3.1.4 Potentially Exposed Populations

Four potentially exposed populations were evaluated for the EPA/GSA Area as shown in Figure 6-1:

- **Groundskeeper** – a groundskeeper could be exposed to soils throughout the Soil EA during typical activities such as cutting lawns, landscaping activities, and other tasks that could require contact with surface soils. The groundskeeper could also be exposed to the affected media associated with the Drainage Ditch EA but at a much lower frequency.

- **Construction/Utility Worker** – it is possible that construction activities or utility installation and maintenance activities could expose workers to site soils in the Soil EA to a depth of 10 ft bgs which is the assumed depth of typical construction activities. The actual depth of excavation could vary as groundwater could be encountered at less than 10 ft bgs at some areas. Exposure to the Drainage Ditch EA was not evaluated for the construction/utility worker since they were not expected to contact the soil/sediment within the drainage features.

- **Indoor Worker** – an employee of the U.S. EPA could come into contact with site surface soils throughout the Soil EA as part of their typical activities. This exposure would be significantly lower than groundskeeping exposure, as the worker was assumed to be involved in office duties that would require him/her to spend the majority of their time at work indoors. The indoor worker was assumed to not contact the media in the Drainage Ditch EA.

- **Future Residents** – it was conservatively assumed that the EPA/GSA Area could be developed for residential purposes in the future. Although this scenario is considered highly unlikely, it was evaluated to estimate the upper-bound of the potential site risks, and to evaluate the need for a remedy for unlimited use and unrestricted exposure (UU/UE). The future residents (child and adult) were assumed to contact the soil in the Soil EA on a regular basis. The residents would be exposed to aggregate soil due to soil disturbances during construction activities that could result in the re-mixing and re-distribution of subsurface soils to the ground surface. Future residents were also assumed to be exposed to the Drainage Ditch EA but at a much lower frequency.

6.3.2 Exposure Point Concentrations (EPCs)

EPCs are the COPC concentrations that a receptor is assumed to come in contact with at a site assuming that the receptor would randomly visit all areas of the site. The EPC used in most cases was the one-sided 95% UCL of the mean. EPA's ProUCL software program (Version 5.0.00) was used for calculating UCLs in this risk assessment, as this program allows the user to calculate distribution-specific UCLs, as well as UCLs for data that do not exhibit a specific distribution (EPA, 2013).

The first step in computing a UCL of a population mean is to test for the data distribution. ProUCL tests for normal, lognormal, and gamma distributions. There are a number of procedures to test for data distribution:

- Graphical test based upon a Q-Q plot;

- Lilliefors test (tests for normality or lognormality for data sets with samples sizes greater than or equal to 50);
- Shapiro-Wilk W test (tests for normality or lognormality for data sets with samples sizes less than 50);
- Anderson-Darling test (tests for gamma distribution); and
- Kolmogorov-Smirnov test (tests for gamma distribution).

ProUCL recommends that a graphical Q-Q plot test should always be accompanied by other more powerful tests (i.e., Lilliefors, Shapiro-Wilk, Anderson Darling, and Kolmogorov-Smirnov tests). The Shapiro-Wilk test or the Lilliefors test was run at a 0.05 level of significance in conjunction with the Q-Q plot to test for normality or lognormality. The Anderson Darling and Kolmogorov-Smirnov tests were run to test for gamma distribution at a 0.05 level of significance. If the data set does not fit any of the three distributions tested, then EPA guidance recommends nonparametric approaches for estimating sample statistics.

The list below presents the process for determining the EPCs.

- If 8 or more samples were collected within a data grouping, but the data set contained fewer than 4 detects, the EPC was based on an ad-hoc value. The 75th percentile was used as the ad-hoc EPC instead of a higher percentile value or even the maximum concentration to avoid over-estimating the EPC to a significant degree. Note that in certain situations when the 75th percentile exceeded the maximum detected concentration due to censored data, the maximum detected concentration was used as the EPC. Full detection limits were used as values for the non-detected samples.
- If 8 or more samples were collected within a data grouping and the data set contained at least 4 detects, but the data set contained less than 50% detects (EPA, 2007f), a nonparametric-based UCL/EPC was considered. The nonparametric-based value was derived using either Kaplan-Meier (KM) or bootstrapping estimation procedures, unless there were fewer than 10 detects. If there were fewer than 10 detects, the bootstrapping estimates were not considered. Censored data (non-detects) were treated per the recommendation of ProUCL.
- If 8 or more samples were collected within a data grouping and the data set contained at least 50% detects (EPA, 2007f), the appropriate distribution of the data set were determined and UCLs/EPCs were selected as guided by the ProUCL supporting documentation. If the recommended UCL exceeded the maximum detected concentration, a Chebyshev-based UCL was selected as the EPC if possible. If the

Chebyshev-based UCL was still higher than maximum detected concentration, the maximum concentration was selected as the EPC. Censored data (non-detects) were treated per the recommendation of ProUCL.

Tables 6-4 through 6-6 present the EPCs used in the HHRA.

6.3.3 Exposure Equations and Parameters

This section presents the equations and parameters that were used to estimate the chronic daily intakes (CDIs; exposure doses) of the COPCs for each receptor through the applicable exposure pathways. Many of the exposure parameters that were used are standard values recommended by EPA (EPA, 2014) and are presented and discussed in the subsections that follow. Where a standard value could not be obtained or was not appropriate, site-specific information and professional judgment was used. The text and exposure equation tables in the following sections show the exposure assessment input assumptions.

Exposure doses are dependent upon the magnitude, frequency, and duration of exposure. They are estimated by combining the COPC concentration (i.e., the EPC) and the exposure parameters. The exposure doses are expressed as intakes in milligrams of COPC per kilogram of body weight per day (mg/kg-day). Two types of doses were calculated in this risk assessment. The first, the lifetime average daily dose (LADD), which is averaged over a 70-year lifetime, was used to estimate cancer risk. The second, the average daily dose (ADD), which is averaged over the actual exposure duration for each receptor, was used to estimate noncancer health effects.

The following list presents the exposure parameters that were used to estimate COPC intakes. Tables 6-7 through 6-20 present the parameters listed below for the exposure scenarios evaluated in the HHRA.

- Exposure frequency (EF) – represents the number of days per year (days/year) that a human receptor is engaged in a particular activity that could result in exposure;
- Exposure duration (ED) – represents the total length of time in years that a receptor engages in an activity that could result in exposure;
- Exposure time (ET) – represents the number of hours per day (hr/day) that a receptor engages in an activity that could result in exposure;

- Body weight (BW) – represents the average receptor body weight over the exposure period, expressed in kilograms (kg);

- Averaging time (AT) – represents the period over which exposure is averaged, expressed in days. Averaging time is dependent on the type of evaluation: cancer or noncancer. The cancer AT (AT_c) is based on a 70-year lifetime for all age groups, which equals 25,550 days (i.e., 70 years x 365 days/year). The noncancer AT (AT_{nc}) equals the receptor-specific ED multiplied by 365 days/year;

- Soil ingestion rate (IRS) – represents the amount of soil that is incidentally ingested on a daily basis, expressed in units of milligram per day (mg/day). The soil ingestion rates were used to evaluate exposure associated with both the Soil EA and the Drainage Ditch EA;

- Fraction ingested (FI) – a unitless term that represents the fraction of soil that is ingested from the contaminated source;

- Exposed skin surface area (SA) – represents the amount of skin exposed to contaminated soil, expressed in units of square centimeters per day (cm^2/day);

- Soil-to-skin adherence factor (AF) – describes the amount of soil that adheres to the skin per surface area unit, expressed as milligrams per square centimeter (mg/cm^2);

- Dermal absorption factor (ABS) – a unitless, COPC-specific term that represents the fraction of COPC that is assumed to penetrate the skin after dermal exposure with contaminated soils. The ABS factors were obtained from EPA's dermal risk assessment guidance (EPA, 2004). Table 6-7 presents the ABS values for the COPCs;

- Particulate emission factor (PEF) – a site-specific value that relates the concentration of a COPC in soil to the concentration of dust particles in air, expressed as cubic meters per kilogram (m^3/kg). Airborne dust levels were modeled based on wind erosion and truck traffic on unpaved roads. Tables 6-8 and 6-9 present the PEFs that were used in the HHRA for the Soil EA based on wind erosion and truck traffic on unpaved roads respectively;

- Volatilization factor (VF) – a COPC- and site-specific value that relates the concentration of a volatile COPC in soil to the concentration of that volatile COPC in air, expressed as m^3/kg. Tables 6-10 through 6-12 present the VFs and the supporting calculations that were used in the HHRA for the Soil EA; and

- Relative bioavailability factor (RBA) – arsenic risks from incidental ingestion are calculated with a RBA of 0.6 (EPA, 2017). Absolute bioavailability can be thought of as the absorption fraction. Relative bioavailability accounts for differences in the bioavailability of a contaminant between the medium of exposure (e.g., soil) and the media associated with the toxicity value (e.g., the arsenic toxicity values are derived from drinking water studies). The 60% oral RBA for arsenic is empirically-based. It represents an upper-bound estimate from numerous studies where the oral RBA of soil-borne arsenic

in samples collected from across the U.S. was experimentally determined against the water-soluble form. This RBA only applies to the incidental ingestion pathway and was applied to both the Soil and Drainage Ditch EAs.

To ensure that risk estimates are conservative and protective of human health, intakes based on a combination of upper-end, typically the upper 90th or 95th percentile, and average exposure factors termed the RME, were calculated (EPA, 1992). The CTE risks provide additional insight into the degree of uncertainty associated with the conservative risk estimates by using average or 50th percentile exposure factors, where appropriate. Exposure factors for both the RME and CTE scenarios are presented in the following sections and accompanying tables.

6.3.3.1 Groundskeeper

Groundskeepers could be exposed to soil COPCs while performing routine activities throughout the Soil EA, such as mowing lawns, grounds upkeep and maintenance. The groundskeepers could also be exposed to COPCs while working in the Drainage Ditch EA. It was assumed that the groundskeeper exposure is occurring at the present time and will continue to occur in the future. It was assumed that the groundskeepers are exposed to surface soil and sediment (0 to 2 ft bgs). Exposure pathways evaluated for the Soil EA included incidental ingestion, dermal contact, inhalation of dust emissions, and inhalation of VOCs released from soil. Exposure pathways evaluated for the Drainage Ditch EA included incidental ingestion and dermal contact. Tables 6-13 and 6-14 present the exposure parameters and models that were used to estimate groundskeeper exposure.

For exposure at the soil EA, the outdoor worker EF of 225 days/year was used for the RME (EPA, 2014). For the CTE, the EF was assumed to be about half of the RME value (110 days/year). The EFs for the Drainage Ditch EA were significantly less than the Soil EA due to accessibility with the EFs ranging from 26 days/year for the RME (assumes exposure once every two weeks) to 13 days/year for the CTE.

The default worker ED of 25 years was used for the RME (EPA, 2014). For the CTE, an ED approximately half of the RME value was used (12 years). The AT_{nc} was 9,125 days and 4,380 days for the RME and CTE, respectively. The adult BW was 80 kg (EPA, 2014). The IRS for an

outdoor worker of 100 mg/day was used for the RME (EPA, 2014). The IRS for an indoor worker of 50 mg/day was used for the CTE (EPA, 2014). A value of 1.0 was used for the RME FI, indicating that 100% of ingested soil is assumed to come from the site. The FI was reduced by 50% for the CTE evaluation.

The SA was 3,527 cm^2/day (EPA, 2014) and applies to both the RME and CTE. The RME AF value was 0.12 mg/cm^2 (EPA, 2014). For the CTE, the geometric mean AF for the commercial/industrial groundskeeper of 0.02 mg/cm^2 was used (EPA, 2004). Inhalation exposure (ET) was assumed to be 8 hours/day for the RME and 4 hours/day for the CTE for the Soil EA only. The PEF for the Soil EA was assumed to be based on wind erosion.

6.3.3.2 Construction/Utility Worker

Given the potential for construction activities and utility work at the EPA/GSA Area, a worker scenario that combines the exposure from construction and utility activities was evaluated for the Soil EA. The construction worker was assumed to be a worker who is involved with the construction of new buildings or other structures. The utility worker was assumed to be involved in the installation and maintenance of utility lines. It was assumed that the construction and utility-related work are both soil intensive activities that last for a short duration. Therefore, a single exposure scenario was modeled to estimate exposure to both receptors. It was assumed that the construction/utility worker exposure is occurring at the present time and will continue in the future. The construction/utility worker was assumed to be exposed to soil to a depth of 10 ft bgs. Exposure pathways evaluated for this worker scenario include incidental soil ingestion, dermal contact with soil, inhalation of dust emissions, and inhalation of VOCs released from the Soil EA. Tables 6-15 and 6-16 present the exposure parameters and models that were used to estimate construction/utility worker exposure to soil for the RME and CTE, respectively.

Construction and utility work-related activities likely result in a high level of soil contact for an assumed period of three months. The RME EF for the construction/utility worker was 60 days/year, which equates to exposure 5 days a week for 12 weeks. For the CTE, a value of one-half of the RME was used (30 days/year). An ED of one year was used for the RME and CTE. The AT_{nc} was 365 days/year for the RME and CTE. The adult BW was 80 kg (EPA, 2014). The

IRS value for construction workers of 330 mg/day was used for the RME (EPA, 2002). The IRS for other outdoor workers (100 mg/day) was used for the CTE (EPA,2014). A value of 1.0 was used for the RME FI, indicating that 100% of ingested soil is from the site. The FI was reduced to 50% for the CTE evaluation.

The exposed SA was 3,527 cm^2/day (EPA, 2014) and applied to both the RME and CTE. The 95th percentile soil-to-skin AF value for construction workers of 0.3 mg/cm^2 was used for the RME (EPA, 2004). For the CTE, the geometric mean AF for construction workers of 0.1 mg/cm^2 was used (EPA, 2004). The ET was assumed to be 8 hours/day for the RME and 4 hours/day for the CTE. The PEF was assumed to be based on truck traffic on unpaved roads.

6.3.3.3 Indoor Worker

An indoor worker was evaluated based on the office use at the EPA/GSA Area. Employees were assumed to spend the majority of the work day indoors with exposure to COPCs through incidental ingestion of surface soils that have become entrained in indoor dust, and inhalation of airborne COPCs as a result of wind erosion and volatilization, as their primary exposure routes. EPA suggests that indoor workers have no direct contact with soil (EPA, 2002). Therefore, the dermal contact pathway was not evaluated. Tables 6-17 and 6-18 present the exposure parameters and models that were used to estimate indoor worker exposure to soil for the Soil EA.

The indoor worker EF of 250 days/year was used for the RME (EPA, 2014). For the CTE, an EF of half of the RME was used (125 days/year). The default worker ED of 25 years was used for the RME (EPA, 2014). For the CTE, an ED approximately half of the RME value was used (12 years). The AT_{nc} was 9,125 days and 4,380 days for the RME and CTE, respectively. The adult BW was 80 kg (EPA, 2014). The IRS for an indoor worker of 50 mg/day was used for the RME (EPA, 2014). An IRS of half of the RME value was used for the CTE (25 mg/day). A value of 1.0 was used for the RME FI. The FI was reduced to 50% for the CTE evaluation. Inhalation exposure was assumed to be 8 hours/day for the RME and 4 hours/day for the CTE. The PEF was assumed to be based on wind erosion.

6.3.3.4 Future Residents

Residential development is unlikely at the EPA/GSA Area given the current and likely future land use at the site and the nature of the site activities and surroundings. However, a future residential scenario was evaluated to determine an upper-bound on the level of risks posed by the site. It was assumed that residents could contact aggregate soil as a result of mixing that is expected to occur during construction activities. The future residents were also assumed to contact the media in the Drainage Ditch EA although at a lower frequency than at the Soil EA. Soil EA exposure pathways evaluated include incidental soil ingestion, dermal contact with soil, inhalation of outdoor dust, and inhalation of VOCs in soil. The incidental ingestion and dermal contact pathways were also evaluated for the Drainage Ditch EA. Tables 6-19 and 6-20 present the exposure parameters and models that were used to estimate the residential exposure.

For exposures in the Soil EA, an EF of 350 days/year was used for both the RME and CTE (EPA, 2014). For exposures in the Drainage Ditch EA, exposure was assumed to occur two days per week between April and October for a total of 56 days/year. An EF value of half of the RME value was used for the CTE (28 days/year).

An ED of 26 years (20 years as an adult and 6 years as a child) was used for the RME (EPA, 2014). For the CTE, an ED of 15 years (9 years as an adult and 6 years as a child) was used (EPA, 1997). The AT_{nc} for the RME for the child and adult were 2,190 days and 7,300 days, respectively. The AT_{nc} for the CTE for the child and adult were 2,190 days and 3,285 days, respectively. The child and adult BWs were 15 kg and 80 kg, respectively (EPA, 2014). For the RME, the IRS for the child and adult was 200 mg/day and 100 mg/day, respectively (EPA, 2014). The CTE IRS estimates were 100 mg/day and 50 mg/day for the child and adult, respectively. A value of 1.0 was used for the RME FI. The FI was reduced to 50% for the CTE estimate.

The exposed SAs for the child and adult resident of 2,373 cm^2/day and 6,032 cm^2/day were used for both the RME and CTE, respectively (EPA, 2014). For the RME, geometric mean soil-to-skin AFs of 0.2 mg/cm^2 (children playing in wet soil) and 0.07 mg/cm^2 (residential gardeners) were used for the child and adult, respectively (EPA, 2014). For the CTE, geometric mean AFs of 0.04 mg/cm^2 (children playing in dry soil) and 0.01 mg/cm^2 (residential gardeners) were used for the

child and adult, respectively (EPA, 2004). Inhalation exposure was assumed to be 24 hours/day for both the RME and CTE at the Soil EA only. The PEF for the Soil EA was assumed to be based on wind erosion.

6.4 TOXICITY ASSESSMENT

The toxicity assessment identifies the toxicity values for the COPCs used in the estimation of potential cancer risks and noncancer health effects. It also provides a description of the terms that are used to estimate toxic effects (i.e., cancer and noncancer effects) along with the data sources. Summary tables are included that present the toxicity values for each COPC (Tables 6-21 through 6-24).

6.4.1 Cancer Effects

For cancer effects, the toxicity values are expressed as oral cancer slope factors (CSF) in units of per milligrams of COPC per kilogram of body weight per day $(mg/kg\text{-}day)^{-1}$ or as inhalation unit risk factors (IUR) in units of per micrograms of COPC per cubic meter $(\mu g/m^3)^{-1}$. EPA has assigned each contaminant a "weight-of-evidence" category that represents the likelihood of it being a human carcinogen (EPA, 1989). Six weight-of-evidence categories exist:

- A – Human carcinogen;
- B1 – Probable human carcinogen, limited human data are available;
- B2 – Probable human carcinogen, sufficient evidence in animals and inadequate or no evidence in humans;
- C – Possible human carcinogen;
- D – Not classifiable as to human carcinogenicity; and
- E – Evidence of non-carcinogenicity for humans.

As of 2005, EPA revised the weight-of-evidence categories to include the following five cancer hazard descriptors (EPA, 2005j):

- Carcinogenic to humans;

- Likely to be carcinogenic to humans;
- Suggestive evidence of carcinogenic potential;
- Inadequate information to assess carcinogenic potential; and
- Not likely to be carcinogenic in humans.

COPCs that are classified in categories A through C following the 1989 weight-of-evidence classification and in the first three categories according to the 2005 classification system are generally carried through the risk characterization step if CSFs have been developed.

For carcinogens that act with a mutagenic mode of action for carcinogenesis, EPA recommends application of Age-Dependent Adjustment Factors (ADAFs) to the CSF to address early lifetime exposures and the increased susceptibility of children to carcinogens (EPA, 2005j). Further discussion is provided in Section 6.5.1.

6.4.2 Noncancer Effects

Noncarcinogens refer to contaminants that cause toxic effects other than cancer. Noncancer effects can include, for example, central nervous system damage, reproductive effects, and other systemic effects. For noncancer effects, the toxicity values are expressed as oral reference doses (RfD) in units of mg/kg-day and reference concentrations (RfC) in units of mg/m^3. The premise of noncancer toxicity values is that there is an exposure level below which deleterious noncancer effects are not expected to occur.

6.4.3 Sources of Toxicity Values

When available, CSFs and RfDs were obtained from the following sources in the order presented (EPA, 2003b; DoDM, 2012):

- Tier 1 – Integrated Risk Information System (IRIS) (EPA, 2018);
- Tier 2 – EPA's Provisional Peer Review Toxicity Values (PPRTVs); and
- Tier 3 – Other Toxicity Values including California EPA (CalEPA) values, Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels (MRLs), and toxicity values developed by various state agencies.

6.4.4 Dermal Exposure

Dermal toxicity values were derived from the oral toxicity values as described in EPA dermal risk assessment guidance (EPA, 2004). In general, the oral CSFs (CSF_o) and oral RfDs (RfD_o) are expressed as administered doses (i.e., the amount of a contaminant administered per unit time and weight). Conversely, exposures resulting from the dermal pathway are expressed as absorbed doses. Therefore, it is necessary to make an adjustment to the oral toxicity value to account for the contaminant-specific absorption efficiency.

The fraction of a COPC that is absorbed in the gastrointestinal tract, also known as ABS_{gi}, is a critical factor when adjusting from an administered to an absorbed dose. The ABS_{GI} values that were used in this risk assessment were obtained from EPA (2004). The CSF_o and RfD_o are each adjusted to an absorbed dose using different methods. The dermal CSF (CSF_d) was derived by dividing the CSF_o by the ABS_{gi} as shown in Equation 6-1.

Equation 6-1

$$CSF_d = \frac{CSF_o}{ABS_{gi}}$$

Where:

CSF_d	=	Dermal cancer slope factor $(mg/kg\text{-}day)^{-1}$
CSF_o	=	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$
ABS_{gi}	=	Fraction of COPC absorbed in the gastrointestinal tract (unitless).

The dermal reference dose (RfD_d) was derived by multiplying the RfD_o by the ABS_{gi} as shown in Equation 6-2.

Equation 6-2

$$RfD_d = RfD_o \times ABS_{gi}$$

Where:

RfD_d	=	Dermal reference dose (mg/kg-day).
RfD_o	=	Oral reference dose (mg/kg-day).
ABS_{gi}	=	Fraction of COPC absorbed in the gastrointestinal tract (unitless).

6.4.5 Summary of Toxicity Values Used in HHRA

Tables 6-21 through 6-24 present the available toxicity values (oral, dermal, and inhalation) for each COPC, as well as the source, the EPA weight-of evidence category, the route of administration, and the critical effect.

6.5 RISK CHARACTERIZATION

The risk characterization integrates the information developed in the exposure assessment and the toxicity assessment into an evaluation of the potential risks associated with exposure to COPCs. Both cancer risks and noncancer health effects were evaluated for the RME and CTE scenarios. Cancer risks were calculated for those COPCs with evidence of carcinogenicity and for which cancer toxicity values are available. Noncancer health effects were evaluated for COPCs (i.e., including carcinogens) for which noncancer toxicity values are available.

6.5.1 Cancer Risk

In accordance with EPA policy (EPA, 1989), cancer risk is expressed as the probability that an individual will develop cancer during a 70-year lifetime in excess of the background risk for developing cancer. Therefore, the calculated cancer risks represent the incremental lifetime cancer risk to the specific receptors in excess of the background probability of developing cancer. Cancer risk is expressed in scientific notation as the probable number of cancers produced by COPC exposure per a defined population number (i.e., 1 in 1,000,000 or 1E-06). The calculated cancer risk is a plausible upper-bound estimate of the true risk.

Potential cancer risks from the ingestion and dermal contact pathways were calculated by multiplying the estimated LADD intake that is calculated for a COPC through an exposure route by the exposure route-specific CSF (see Equation 6-3).

Equation 6-3

$$Risk = LADD \times CSF$$

Where:

LADD	=	Lifetime average daily dose; intake averaged over a 70-year lifetime as mg COPC/kg-body weight per day.

CSF	=	COPC- and route-specific cancer slope factor $(mg/kg\text{-}day)^{-1}$.

Potential cancer risks from the inhalation pathway were calculated by multiplying the modeled air concentration (CA) by the IUR as shown in Equation 6-4.

Equation 6-4

$$\text{Inhalation Cancer Risk} = CA \times IUR$$

Where:

CA	=	Modeled air concentration ($\mu g/m^3$).
IUR	=	COPC-specific inhalation unit risk $(\mu g/m^3)^{-1}$.

Cancer risks were summed across the relevant pathways for a given receptor and exposure scenario to yield a cumulative lifetime risk. EPA's cancer risk range is an increased risk of developing cancer, based on a plausible upper-bound estimate of risk, of approximately 1 in 1,000,000 (1E-06) to 1 in 10,000 (1E-04). Risks that exceed this range typically require some type of remedial action, while risks within or below this risk range typically do not.

Carcinogens that act with a mutagenic mode of action

For carcinogens that act with a mutagenic mode of action for carcinogenesis, EPA recommends application of ADAFs to the CSF to address early lifetime exposures and the increased susceptibility of children to carcinogens (EPA, 2005j). As presented in the RSL Table (EPA, 2017), the following COPCs exhibit a mutagenic mode of action for carcinogenesis:

Benzo(a)anthracene	Dibenz(a,h)anthracene
Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene
Benzo(b)fluoranthene	Chromium (hexavalent form)
Benzo(k)fluoranthene	Trichloroethylene
Chrysene	Vinyl chloride

The ADAFs for specific age-groups classes are presented below:

Age (years)	ADAF (unitless)
0 to <2	10

Age (years)	ADAF (unitless)
2 to <16	3
≥16	1

Equation 6-5 illustrates how the ADAFs were included in the calculations of risk for carcinogenic PAHs and chromium. Trichloroethylene and vinyl chloride were evaluated with different approaches and are discussed in further detail below. Section 6.5.3 provides the scenario-specific risk calculation tables.

Equation 6-5

PAHs and Chromium

$$Risk_{moa} = LADD \times CSF/IUR \times ADAF$$

Where:

$Risk_{moa}$	=	Age-group specific cancer risk based on COPCs (PAHs and chromium) that exhibit a mutagenic mode of action.
LADD	=	Lifetime average daily dose based on intake parameters specific to the age group evaluated; intake averaged over a 70-year lifetime as mg COPC/kg-body weight per day.
CSF	=	COPC- and route-specific cancer slope factor $(mg/kg\text{-}day)^{-1}$.
IUR	=	COPC-specific inhalation unit risk $(\mu g/m^3)^{-1}$.
ADAF	=	Age group specific Age-Dependent Adjustment Factor.

RME Residential lifetime exposure factors were divided into two age groupings: child – 0 to 6 years and adult – 6 to 26 years. CTE Residential lifetime exposure factors were divided into two age groupings: 6 years as a child – 0 to 6 years and 9 years as an adult – 20 to 29 years. This discontinuous exposure pattern was selected in order to utilize the most conservative ADAFs for both the child and adult age groups. Potential risk to an individual resident was assessed using the information presented below.

Age (years)	Exposure Factors	Exposure Duration (years)	ADAF (unitless)
0 to <2	Child (RME or CTE)	2	10
2 to <6	Child (RME or CTE)	4	3
6 to <16	Adult (RME)	10	3
20 to <29	Adult (CTE)	9	1

Age (years)	Exposure Factors	Exposure Duration (years)	ADAF (unitless)
16 to <26	Adult (RME)	10	1

Total Risk for RME resident exposures = Risk $_{0 \text{ to } <2}$ + Risk $_{2 \text{ to } <6}$ + Risk $_{6 \text{ to } <16}$ + Risk $_{16 \text{ to } <26}$

Total Risk for CTE resident exposures = Risk $_{0 \text{ to } <2}$ + Risk $_{2 \text{ to } <6}$ + Risk $_{20 \text{ to } <29}$

Trichloroethylene

As discussed in the *Toxicological Review of Trichloroethylene* (EPA, 2011), TCE is carcinogenic by a mutagenic mode of action for induction of kidney tumors. There is also more limited evidence for non-Hodgkin lymphoma (NHL) and liver carcinogenicity. In order to account for the mutagenic mode of action for kidney tumors, EPA recommends applying ADAFs when estimating kidney cancer risks from early life exposure to TCE. However, NHL and liver cancer must also be accounted for in the cancer risk estimates. To accommodate all three carcinogenic effects, cancer risks were derived for each age group, including adjusted kidney cancer potency values and unadjusted potency values for liver cancer and NHL.

Equations 6-6 and 6-7 presented below illustrate how the ADAFs are included in the pathway-specific risk calculations for trichloroethylene and how the adjusted kidney and unadjusted liver and NHL CSFs are integrated:

Equation 6-6

$$\text{Ingestion Risk}_{moa} = \text{LADD} \times \text{CSF}_{kidney} \times \text{ADAF} + \text{LADD} \times \text{CSF}_{liver+NHL}$$

Equation 6-7

$$\text{Inhalation Risk}_{moa} = \text{CA} \times \text{IUR}_{kidney} \times \text{ADAF} + \text{CA} \times \text{IUR}_{liver+NHL}$$

Where:

Risk_{moa}	=	Age-group specific cancer risk from TCE exposure.
LADD	=	Lifetime average daily dose based on intake parameters specific to the age group evaluated; intake averaged over a 70-year lifetime as mg COPC/kg-body weight per day.
CA	=	Modeled indoor air concentration ($\mu g/m^3$).

CSF	=	TCE end point-specific cancer slope factor $(mg/kg\text{-}day)^{-1}$.
IUR	=	TCE end point-specific inhalation unit risk $(\mu g/m^3)^{-1}$.
ADAF	=	Age group specific Age-Dependent Adjustment Factor.

RME Residential lifetime exposure factors were divided into two age groupings: child – 0 to 6 years and adult – 6 to 26 years. CTE Residential lifetime exposure factors were divided into two age groupings: 6 years as a child – 0 to 6 years and 9 years as an adult – 20 to 29 years. This discontinuous exposure pattern was selected in order to utilize the most conservative ADAFs for both the child and adult age groups. Potential risk to an individual resident was assessed using the information presented below.

Age (years)	Exposure Factors	Exposure Duration (years)	ADAF (unitless)
0 to <2	Child (RME or CTE)	2	10
2 to <6	Child (RME or CTE)	4	3
6 to <16	Adult (RME)	10	3
20 to <29	Adult (CTE)	9	1
16 to <26	Adult (RME)	10	1

Total Risk for RME resident exposures = $Risk_{0\ to\ <2} + Risk_{2\ to\ <6} + Risk_{6\ to\ <16} + Risk_{16\ to\ <26}$

Total Risk for CTE resident exposures = $Risk_{0\ to\ <2} + Risk_{2\ to\ <6} + Risk_{20\ to\ <29}$

Vinyl chloride

Vinyl chloride is also considered to act via a mutagenic mode of action and was identified as a COPC in aggregate soil at the Soil EA. Several studies have provided evidence for early-life sensitivity to carcinogenesis associated with vinyl chloride exposure (EPA, 2000). This sensitivity is independent of later life chronic exposures. For this reason, the cancer risk equations for evaluation of vinyl chloride exposures in scenarios including young children differ from those of other contaminants and those used in adult only exposures. Because chemical-specific information is available for evaluating vinyl chloride risks, unique equations are used rather than the equations using general ADAF factors. The lifetime cancer risk can be approximated by adding risks from

the non-overlapping exposures in early life and later. The later-life exposure is prorated over the life span. The risk from early-life exposure is not prorated over exposure duration.

The following equation is used to evaluate lifetime residential cancer risks from soil ingestion exposures to vinyl chloride:

Equation 6-8

$$\text{Risk} = (\text{LADD x CSF}) + \left(\frac{\text{EPC x IRS}_c \text{ x FI x CF}}{\text{BW}_c} \text{ x CSF} \right)$$

Where:

LADD	=	Lifetime average daily dose; intake averaged over a 70-year lifetime (mg/kg-day).
CSF	=	COPC- and route-specific cancer slope factor $(mg/kg\text{-}day)^{-1}$.
EPC	=	COPC-specific exposure point concentration for soil (mg/kg).
IRS_c	=	Child ingestion rate of soil (mg/day).
FI	=	Fraction ingested (unitless).
CF	=	Conversion factor (kg/mg).
BW_c	=	Child body weight (kg).

Due to the absence of an ABS_{GI} for vinyl chloride, lifetime residential cancer risks from dermal exposures to vinyl chloride could not be evaluated.

The following equation is used to evaluate lifetime residential cancer risks from inhalation of particulates/volatiles released from soil for vinyl chloride:

Equation 6-10

$$\text{Risk} = (\text{ADC x IUR}) + (\text{CA x IUR})$$

Where:

ADC	=	Lifetime average daily concentration; averaged over a 70-year lifetime $(\mu g/m^3)$.
IUR	=	COPC- specific inhalation unit risk $(\mu g/m^3)^{-1}$.
CA	=	COPC-specific air concentration $(\mu g/m^3)$.

6.5.2 Noncancer Health Effects

Potential noncancer health effects were evaluated by the calculation of hazard quotients (HQs) and hazard indices (HIs). For the ingestion and dermal contact pathways, the HQ is the ratio of the ADD through a given exposure route to the COPC- and route-specific RfD. The HQ-RfD relationship is illustrated by Equation 6-9.

Equation 6-9

$$HQ = ADD/RfD$$

Where:

HQ	=	Hazard quotient.
ADD	=	Average daily dose; estimated daily intake averaged over the exposure duration (mg/kg-day).
RfD	=	Reference dose (mg/kg-day).

For inhalation exposure, the HQ is the ratio of the modeled air concentration (CA) and the COPC-specific RfC as presented in Equation 6-10.

Equation 6-10

$$\text{Inhalation } HQ = CA / (RfC \times CF)$$

Where:

HQ	=	Hazard quotient
CA	=	Modeled air concentration (µg/m^3)
RfC	=	COPC-specific reference concentration (mg/m^3)
CF	=	Conversion factor (1,000 µg/mg)

HQs were summed to calculate HIs for each scenario. HIs were calculated for each exposure route, and a total HI was calculated based on exposure to the COPCs from exposure routes for each receptor.

If the HI was greater than one, further evaluation is necessary before a recommendation for site remediation is made. In addition, if the site HI was greater than one, the HI was calculated for COPCs with common target endpoints because the COPC-specific RfD values are based on a critical target organ effect (EPA, 1989). Thus, it is inappropriate to add all HQs (regardless of target endpoint) because the resulting HI will reflect an artificially high estimate of noncancer

toxicity for an exposed population. Therefore, the HQs were also segregated by COPC-specific target organ and summed to yield organ-specific HIs. The HQs from COPCs that are lacking target endpoint information (designated as 'No Information' in the tables presented in Section 6.5.3) were not included in the summation of organ-specific HIs.

6.5.3 Risk Results

The following subsections discuss the risk results for the Soil EA and the Drainage Ditch EA.

6.5.3.1 Soil EA

Tables 6-25 through 6-28 present general summaries of the estimated cancer risks and noncancer HIs for each receptor for both the RME and the CTE at the Soil EA. Figures 6-2 and 6-3 show the risk levels in graphical format.

Future Residents – Tables 6-29 through 6-34 present the cancer risks and HQs/HIs for the future residents. Tables 6-35 through 6-38 present the cancer risk calculations for the COPCs that demonstrate a mutagenic mode of action for carcinogenesis. The total RME cancer risk (1E-04) was equal to the upper end of EPA's acceptable risk range (see Table 6-29). The RME cancer risk from the incidental soil ingestion pathway was the major contributor to the total RME risk estimate. The total RME risks from chromium (8E-05 assumed to be in the hexavalent form) and arsenic (3E-05) contributed nearly 100% of the total RME risk. The total CTE cancer risk (3E-05) was within EPA's acceptable risk range (see Table 6-30).

The total RME HI for the child resident (2) was marginally greater than the noncancer benchmark of one (see Table 6-31). The RME HI from the incidental soil ingestion pathway was the major contributor to the total RME HI. None of the COPCs had a HI greater than one. The HI from arsenic contributed approximately 5% of the total RME HI. The adult RME HI was less than one (see Table 6-32). The CTE HIs were also less than one (see Tables 6-33 and 6-34).

Groundskeeper – Tables 6-39 through 6-42 present the cancer risks and HQs/HIs for the groundskeeper. The total RME cancer risk (2E-05) was within EPA's acceptable risk range (Table 6-39). As presented on Table 6-40, the total CTE cancer risk (1E-06) was equal to the low end of

EPA's acceptable risk range of 1E-06 to 1E-04. The total RME and CTE HIs were less than the noncancer benchmark of one (Tables 6-41 and 6-42).

Construction/Utility Worker – Tables 6-43 through 6-46 present the cancer risks and HQs/HIs for the construction/utility worker. As shown on Table 6-43, the total RME cancer risk (2E-06) was within EPA's acceptable risk range. The total CTE cancer risk was less than EPA risk range (Table 6-44). The total RME and CTE HIs were less than the noncancer benchmark of one (Tables 6-45 and 6-46).

Indoor Worker – Tables 6-47 through 6-50 present the cancer risks and HQs/HIs for the indoor worker. The total RME cancer risk (9E-06) was within EPA's acceptable risk range (Table 6-47). The total CTE cancer risk was less than the EPA risk range (Table 6-48). The total RME and CTE HIs were less than the noncancer benchmark of one (Tables 6-49 and 6-50).

Lead Evaluation

Exposure to lead in the Soil EA was evaluated using the Integrated Exposure Uptake Biokinetic Model (IEUBK). The results of the IEUBK lead modeling are presented on Figure 6-4. The average surface soil lead concentration of 173 mg/kg (see Table 6-4) was used as site-specific IEUBK Model input. The surface soil average lead concentration was selected over the aggregate soil average lead concentration of 128 mg/kg for conservatism. Default values were used for all other model inputs. Concentrations (i.e., blood lead levels) calculated using the IEUBK model were compared to the established blood lead level of concern of 10 micrograms per deciliter (µg/dL). An additional step in the process estimates the probability that blood lead levels exceed 10 µg/dL. EPA's stated goal for lead is that individuals exposed would have no more than a 5 percent probability of exceeding the level of concern of 10 µg/dL. The IEUBK model output is included on Figure 6-4 as a probability distribution plot. The predicted geometric mean blood lead level is 2.5 µg/dL and there is a 0.15% probability of exceeding the level of concern of 10 µg/dL.

Although adult receptors were evaluated in the Soil EA, the EPA Adult Lead Model (ALM), which estimates fetal blood lead concentrations in women exposed to lead-contaminated soil in non-residential scenarios, was not run. The IEUBK model is a more conservative model for estimating

blood lead levels than the ALM. The results of the IEUBK model indicate that exposure levels to lead at the Soil EA do not exceed EPA's target level of concern for a residential child and are therefore also not a concern for adult workers.

6.5.3.2 Drainage Ditch EA

Tables 6-51 through 6-54 present general summaries of the estimated cancer risks and noncancer HIs for each receptor for both the RME and the CTE at the Drainage Ditch EA. Figures 6-2 and 6-3 show the risk levels in graphical format.

Future Residents – Tables 6-55 through 6-62 present the cancer risks and HQs/HIs for the future residents. Tables 6-63 through 6-65 present the cancer risk calculations for the COPCs that demonstrate a mutagenic mode of action for carcinogenesis. The total RME child cancer risk (2E-04) exceeded EPA's acceptable risk range (see Table 6-55). The RME cancer risk from the incidental soil ingestion pathway was the major contributor to the total RME child risk estimate. The total RME cancer risk from carcinogenic PAHs accounted for over 90% of the total. The total CTE child cancer risk and the adult cancer risks (RME and CTE) were within EPA's acceptable risk range (see Tables 6-56 through 6-58).

The total RME HI for the child resident (2) was marginally greater than the noncancer benchmark of one (see Table 6-59). The RME HI from the incidental soil ingestion pathway was the major contributor to the total RME HI. Benzo(a)pyrene had a HI equal to one. The adult RME HI was less than one (see Table 6-60). The CTE HIs were also less than one (see Tables 6-61 and 6-62).

Groundskeeper – Tables 6-66 through 6-69 present the cancer risks and HQs/HIs for the groundskeeper. The total RME cancer risk (9E-06) was within EPA's acceptable risk range (see Table 6-66). As presented on Table 6-67, the total CTE cancer risk was less than EPA's acceptable risk range of 1E-06 to 1E-04. The total RME and CTE HIs were less than the noncancer benchmark of one (see Tables 6-68 and 6-69).

Lead Evaluation

Exposure to lead in the Drainage Ditch EA was evaluated using the IEUBK Model. The results of the lead modeling are presented on Figure 6-5. The average lead concentration of mg/kg (see Table 6-6) was used as site-specific IEUBK Model input. Default values were used for all other model inputs. Concentrations (i.e., blood lead levels) calculated using the IEUBK model were compared to the established blood lead level of concern of 10 µg/dL. The predicted geometric mean blood lead level is 1.4 µg/dL and there is a less than 0.1% probability of exceeding the level of concern of 10 µg/dL. As with the Soil EA, the EPA ALM was not run for the Drainage Ditch EA as the results of the IEUBK model indicate that exposure levels to lead at the Drainage Ditch EA do not exceed EPA's target level of concern for a residential child and are therefore also not a concern for adult workers.

6.5.4 Evaluation of Significant Contributors to Risks

A review of the risk results and tables discussed in Section 6.5.3 indicates that the future residential exposure scenario resulted in unacceptable cancer risk levels for the Soil EA and the Drainage Ditch EA. None of the other receptors evaluated in this HHRA resulted in unacceptable risk levels. The following COPCs are the significant contributors to the future residential cancer risks.

- Carcinogenic PAHs (cPAHs) – Soil EA and Drainage Ditch EA.
- Arsenic – Soil EA.
- Chromium (assumed to be in the hexavalent form) – Soil EA.

The subsections that follow discuss these COPCs in greater detail to portray the future residential risks in the proper perspective. Section 4.2.1.1 presents comparisons of site levels of these COPCs with identified background levels from New Jersey.

6.5.4.1 Carcinogenic PAHs

The following PAHs constitute the cPAH category: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. The cPAHs accounted for approximately 20% of the total future residential risk for the Soil EA and over 90% of the risk for the Drainage Ditch EA. As will be discussed further in this section, non-DoD sources are responsible for the cPAH levels found in both EAs.

Research (Mahler, et al., 2012) indicates that coal-tar-based sealcoat which is commonly used in the eastern United States can be a significant source of PAHs in various environmental compartments including soil adjacent to sealcoat treated areas such as parking areas and walkways. The paper reported a central tendency (mean or median) ΣPAH concentration of 105 mg/kg adjacent to a coal-tar-based sealed parking lot. The ΣPAH concentration reported in the paper is represented by the sum of 16 PAHs. As a comparison, the mean total soil ΣcPAH concentration within the Soil EA is approximately 4.3 mg/kg. While USACE has not researched the use of coal-tar-based sealcoat at the EPA/GSA Area or elsewhere at the former Raritan Arsenal, the research of Mahler et al. and the results of this comparison indicate that detected site PAH concentrations are less than the range typically found near paved surfaces. These findings should be considered when making decisions at the former Raritan Arsenal with respect to PAHs.

6.5.4.1.1 Soil EA

The observed levels of cPAHs in soils and the resultant risk levels associated with the Soil EA are not from DoD operations or activities but rather from non-DoD sources such as contamination associated with railroad tracks, construction of walkways, parking areas, weathering of asphalt, demolition of buildings, site drainage systems, and periodic brush fires. Section 4.2.1.1 and Table 4-5 present a comparison of Site surface soil cPAH levels with levels found in New Jersey (BEM, 1998). The Site surface soil levels exceeded the New Jersey background data (BEM, 1998) in almost every case. The higher Site levels are not indicative of DoD sources of cPAHs at the EPA/GSA Area but are reflective of the lower concentration of cPAHs one would expect to find at parks and other undisturbed areas that constitute the New Jersey background data set.

Table 6-70 presents soil sample locations with three of the highest cPAH concentrations observed in the Soil EA. The sample-specific cPAH concentrations were derived by summing the individual results for the seven PAHs that make up the total cPAH. The three locations are from Investigation Area 18C. Location TP-18C72A had the highest cPAH concentration (275 mg/kg), followed by TP-18C75A (35.5 mg/kg) and TP-18C71A (29.3 mg/kg).

Samples TP-18C71A, TP-18C72A, and TP-18C75A were subsurface test pit samples collected in 1996 during the Phase II RI performed for Investigation Area 18C. As described in the Phase II

RI report (Weston, 1999b), general building demolition debris or trash (including brick, cement, piping, tires, sheet metal, etc.) was encountered within these test pits. The construction/demolition debris uncovered by the test pits is most likely the source of the cPAH contamination observed in the samples from these locations based on field observations. As discussed previously for the Asbestos Landfill, this construction/demolition debris is a result of GSA-directed demolition conducted in the late 1970s and early 1980s. The USACE does not believe that the Army is responsible for the disposal of this debris and these data should not be considered as they relate to decisions on Army actions for the Soil EA.

Table 6-71 presents an analysis of the impact of the cPAHs levels at locations TP-18C71A, TP-18C72A, and TP-18C75A on the future residential cancer risk levels for the Soil EA. Table 6-71 shows the EPCs used in the HHRA based on all cPAH data throughout the Soil EA to generate the future residential cancer risks discussed in Section 6.5.3 and presented in Table 6-29. Table 6-71 also shows the EPCs and future residential cancer risks without the cPAH levels from samples TP-18C71A, TP-18C72A, and TP-18C75A included in the calculations. The re-calculated total cPAH risk (6E-06) shows an approximate 70% reduction from the original cPAH risk levels for the Soil EA. This analysis clearly demonstrates that the cPAH contamination in samples TP-18C71A, TP-18C72A, and TP-18C75A, which is not the result of Army activities, is one of the reasons that the future residential scenario results in a total cancer risk equal to 1E-04. This is an important aspect to consider to properly interpret the future residential cancer risk level for the Soil EA.

6.5.4.1.2 Drainage Ditch EA

The elevated cancer risk for the Drainage Ditch EA is a result of the sediment sample results from the Area 18B Stream. The highest cPAH levels found in the Drainage Ditch EA were collected in 2013 from the Area 18B Stream. Although identified as a stream, the Area 18B Stream is actually an intermittent storm water drainageway constructed by the DoD when the Raritan Arsenal was active. During the sediment sampling conducted in October 2013, all of the sediment sampling locations were dry except for location SD1819, the farthest downstream location.

The 2013 cPAH sample results as well as historical results indicate that cPAH concentrations tend to decrease with distance downstream of the storm sewer outfall. The Area 18B Stream is fed by

two 48-inch diameter storm drains that appear to collect stormwater runoff from upgradient locations including rooftops and paved areas around Buildings 245, 246 and possibly 229. Note that Buildings 245 and 246 were demolished in early 2015.

As discussed in Section 2.3.8, there is no temporal trend apparent with regards to the cPAH concentrations within the Area 18B Stream. Likewise, there is not a clear trend with depth. The lack of a clear contamination pattern is likely related to the sandy substrate within the stream and the likely source of the cPAHs. These results, especially at the upstream sampling locations, are indicative of an intermittent source of contamination to the Area 18B Stream that is heavily dependent on storm events, such as periodic discharge from the two 48-inch stormwater discharge pipes located at the headwater of the Area 18B Stream. This is an important aspect to consider to properly interpret the future residential cancer risk level for the Drainage Ditch EA. The cPAH concentrations associated with the Area 18B Stream should not be considered as it relates to any future decisions on remediation of the Drainage Ditch EA.

6.5.4.2 Arsenic

The majority of the elevated arsenic concentrations were found along the former railroad between former Buildings 202 and 203 within Investigation Area 18F and extending into Investigation Area 18E (see Section 4.2.1.1.1 and Figure 4-1). Table 6-72 presents an analysis of the impact of the arsenic levels along the former railroad tracks between former Buildings 202 and 203 within Investigation Area 18F and extending into Investigation Area 18E on the future residential cancer risk for the Soil EA. Table 6-72 shows the EPCs used in the HHRA to generate the future residential arsenic cancer risks discussed in Section 6.5.3 and presented in Table 6-29. Table 6-72 also shows the EPCs and future residential risks without the arsenic levels from the former railroad tracks. The re-calculated total arsenic risk shows a 90% reduction from the original arsenic risk level. This analysis clearly demonstrates that the arsenic levels associated with the former railroad tracks in the Soil EA are another reason the future residential scenario results in a total cancer risk equal to 1E-04.

In the past, arsenic compounds were used in addition to creosote to inhibit/control the attack of insects as the rail ties were treated to resist decay. There is reason to believe that arsenic based

material may have been used for weed control along the rail-beds and the creosote may have been used as an insecticide. CERCLA expressly states that no person may recover under CERCLA 107 (42 USC 9607) for any response costs or damages resulting from the application of a registered pesticide. FIFRA defines pesticide to include herbicides (see 7 U.S.C. 136). This means that the arsenic and creosote are not considered a hazardous substances under CERCLA, and that there is no CERCLA release. If there is no CERCLA release, then there is no authority to act under the FUDS program. Therefore, arsenic concentrations associated with the former railroads within the former Raritan Arsenal should not be considered as they relate to any future decisions on Army actions for the EPA/GSA Area.

6.5.4.3 Chromium

Like arsenic and as described in Section 4.2.1.1.2, the elevated site chromium levels are mostly found along the former railroad tracks between former Buildings 202 and 203 within Investigation Area 18F and extending into Investigation Area 18E. The presence of chromium along the railroad tracks is attributed to the use of chromium-based compounds as a preservative for the wooden railroad ties and not historical DoD operations. Therefore, chromium concentrations associated with the former railroads within the former Raritan Arsenal should not be considered as they relate to any future decisions on remediation of the EPA/GSA Area.

Another important aspect to be considered for the chromium risk calculated in the HHRA is the form which chromium (i.e., valence state) is assumed to be present. Site specific chromium speciation data were not available; therefore, total chromium was evaluated in the risk calculations using hexavalent chromium (Cr +6) toxicity values as a worst case estimate. The use of Cr +6 toxicity values resulted in chromium being a significant contributor to the future residential risk estimate for the Soil EA. There were two soil samples collected from Investigation Area 18E in August 2009 that were analyzed for total chromium and Cr +6 (Weston, 2011). The sample results are summarized below. As shown, total chromium was detected in both samples and Cr +6 was not detected in either. While the dataset is limited, it does provide some evidence that Cr +6 is not present in the soil at the EPA/GSA at any significant levels of concern.

Sample ID	Sample Depth (ft bgs)	Total Chromium (mg/kg)	Cr +6 (mg/kg)
18E95A	7 – 7.5	18.1	2.2U (not detected)
18E98B	1.5 – 2	20.8	2.1U (not detected)

At two Superfund sites in EPA Region 1 (New England) with suspected or known hexavalent chromium sources, Cr +6 concentrations were 2 to 5% of the total chromium values. In addition, another Region 1 Superfund site not suspected to have a Cr +6 source had all non-detects for Cr +6. Given the available site-specific data and that there are no suspected sources of Cr +6 at the EPA/GSA Area, it is more appropriate to use the trivalent chromium toxicity values. Doing so would essentially eliminate the chromium risks.

Further, the carcinogenicity classification of Cr +6 is controversial. In IRIS, EPA's Tier 1 source of toxicity values (EPA, 2003), Cr +6 is classified as a known human carcinogen by the inhalation route of exposure. However, the carcinogenicity through the oral route of exposure cannot be determined and Cr +6 is therefore considered a group D carcinogen meaning that it is not classifiable as to human carcinogenicity.

NJDEP determined that Cr +6 through oral exposure is likely to be carcinogenic in humans and NJDEP derived an oral CSF, based on cancer bioassays (drinking water study of rats and mice) conducted by the National Toxicology Program. EPA acknowledges that there is uncertainty associated with the assessment of Cr +6. However, no updated consensus IRIS assessment (Tier I) has yet appeared, and chromium is still under review by the IRIS program. With respect to this HHRA, the conservative approach of using the NJDEP-derived CSF was used to evaluate chromium exposure.

The chromium concentrations associated with the former railroad tracks within the former Raritan Arsenal and the assumption that chromium is present in the hexavalent form should be taken into consideration if/when future decisions on remediation of the EPA/GSA Area are made.

6.6 UNCERTAINTY ANALYSIS

The uncertainty analysis provides information to the appropriate decision makers (i.e., risk managers) about the key assumptions, their inherent uncertainty and variability, and the impact of this uncertainty and variability on the estimates of risk. The uncertainty analysis shows that risks are relative in nature and do not represent an absolute quantification. The subsections that follow identify the major uncertainties inherent in the HHRA process by report section to determine if the calculated risks may have been overestimated or underestimated, and the approximate degree to which this may have occurred.

6.6.1 Analytical Dataset

- Soil data collected in the mid-1990s constitute a significant portion of the soil dataset that was used to calculate risks for the EPA/GSA Area. DoD ceased operations at the Arsenal in the 1960s, and so there is no reason to believe that the levels observed in the mid-1990s have increased due to continuing DoD sources. Thus, assuming no natural attenuation or physical changes have occurred, the locations of the previously observed levels of contamination will not have changed. It is expected that the soil data used in the risk assessment represent a conservative estimation of the current soil levels.

- **Use of J-qualified data** – Throughout this report, J-qualified analytical data results were treated as detected concentrations. In fact, the J-qualified results were given equal weight as unqualified positive detections in accordance with EPA's RAGS. However, J-qualified concentrations are often times unreliable estimates and should be treated as such when making decisions at the EPA/GSA Area.

6.6.2 Exposure Assessment

- **The selection of exposure scenarios** – It is possible that some scenarios evaluated in the HHRA overstated realistic exposures, and thus overestimated the actual site risks. For example, the evaluation of a future residential scenario would significantly overestimate potential site risks given the current conditions and anticipated future land uses.

- **The selection of exposure assumptions** – The exposure assumptions directly influence the calculated doses and ultimately the calculation of risk. The RME concept was used to estimate the exposure potential for each of the receptors that were evaluated in the HHRA. The RME is defined as the "maximum exposure that is reasonably expected to occur at the site" (EPA, 1989). In most cases, these assumptions are upper-bound estimates of potential real-life exposures, and possibly result in an overestimation of risk. For example, it was assumed that future residents are exposed to site soil for 350 days/year. This is clearly not the case as future residents would most likely not contact soil during periods of low

temperatures, when the ground is snow-covered, and during days with precipitation. The conservatism of these exposure parameters needs to be considered in order to properly interpret the risks calculated in this HHRA.

- **Calculation of 95% UCLs** – As presented in Section 6.3.2, one-side 95% UCLs were calculated and used as the EPCs. A conservative approach of using the full DL for NDs was followed for all COPCs in this HHRA. The resulting value represents a conservative estimate of the COPC concentration to which an individual could be exposed in any given exposure unit during the defined exposure duration and frequency. It is likely that using the full detection limit overestimates the site risk to some degree.

- **Future Residential Exposure** – The hypothetical future residential exposure scenario was evaluated to estimate the upper-end of the potential risks associated with the EPA/GSA Area. As demonstrated in Section 6.5.4, the future residential risks are significantly over-estimated. It was assumed that the EPA/GSA Area in its entirety could be developed for residential use. First, this is not expected to happen as the area is owned by the federal government and the ownership situation is unlikely to change. Second, the areas with the highest levels of contamination (landfill, former railroad tracks, and drainage/stream area) are not suitable for development of any kind without prior site preparation activities such as debris removal including soil.

6.6.3 Toxicity Assessment

- **The use of CSFs and RfDs** – Both cancer risks and noncancer health effects were evaluated using EPA-approved or provisional toxicity criteria. The CSFs and RfDs are derived to be health protective of human exposure. Therefore, risk calculations, which are partially based on toxicity estimates, are intended to be protective of exposed human populations including sub-populations that tend to be susceptible to exposure (e.g., young receptors, old receptors, and receptors with pre-existing conditions such as respiratory issues). The exact degree of overestimation cannot always be determined and each COPC must be evaluated on a case-by-case basis.

- **Lack of toxicity values for dermal exposure** – Toxicity values for dermal exposures have not been developed by EPA. Oral RfDs and oral CSFs were adjusted and used to assess toxicity from dermal exposures following guidelines provided by EPA. The dermal route of exposure can result in different patterns of distribution, metabolism, and excretion than occur from the oral route. When oral toxicity values for systemic effects are applied to dermal exposures, uncertainty in the risk assessment is introduced because these differences are not taken into account. Since any toxicity differences between oral and dermal exposure would depend on the specific COPC, use of oral toxicity factors can result in the overestimation or underestimation of risk. It is not possible to make a general statement about the direction or magnitude of this uncertainty.

- **Dermal carcinogenicity of PAHs** – The majority of animal and human studies of PAH exposure strongly suggest that the carcinogenic effects resulting from exposure occur at

the site of contact or administration (e.g., skin tumors from dermal contact, GI tumors from oral contact) (ATSDR, 1995). There is little evidence that PAHs produce systemic tumors following dermal contact (ATSDR, 1995). In order to justify the extrapolation of an CSF_o to a CSF_d, an assumption must be made that the type of cancer produced by oral administration is the same as that which would be expected following dermal contact (i.e., that dermal contact with PAHs would produce GI tumors). Since this is not believed to be the case, even though dermal absorption has been quantified for PAHs, extrapolation of the CSF_o to the dermal route of exposure introduces a high level of uncertainty into the analysis. Although it is unlikely that GI tumors would be produced by dermal contact with PAHs, since there is evidence that dermal contact with PAHs may cause skin cancer, the only available data (i.e., the CSF_o) was used to quantify potential cancer risk from dermal contact with PAHs. This approach introduces a high degree of uncertainty into the analysis, and may overestimate the dermal cancer risks from PAHs to a significant degree.

6.7 HUMAN HEALTH RISK ASSESSMENT CONCLUSIONS

The HHRA calculated risks for two EAs in the EPA/GSA Area: the Soil EA and the Drainage Ditch EA. The Soil EA consists of the entire EPA/GSA Area with the exception of the site drainage ditches and associated features which represent the Drainage Ditch EA. The rationale for evaluating exposures to the media in the site drainage ditches separately from the rest of the EPA/GSA Area is that the frequency of exposure is likely to be much lower in the drainage ditches due to accessibility and attractiveness than elsewhere within the EPA/GSA Area. Calculating risks separately for the EAs allows for separate risk management decisions to be made for each EA.

Soil data collected from the Asbestos Landfill located within Investigation Area 18C were not evaluated in this RI as the source of the contamination (asbestos and non-asbestos) is not from DoD activities. The Asbestos Landfill is a result of GSA-directed demolition conducted in the late 1970s and early 1980s.

The future residential exposure scenario resulted in unacceptable cancer risks in both EAs. None of the other exposure scenarios resulted in unacceptable risk levels. Future residential use of the EPA/GSA Area is considered highly unlikely, yet the future residential scenario was evaluated to estimate the upper-bound of the potential risks.

An evaluation was performed to investigate the sources of the contamination to put the calculated future residential risks into the proper perspective. It was determined that non-DoD sources are

the reasons for the unacceptable risk levels. As discussed in Section 6.5.4, risk estimates from cPAHs, arsenic, and chromium need to consider the non-DoD sources of contamination and other information including:

- Non-DoD sources of contamination associated with the building debris and surrounding area in Investigation Area 18C, the Area 18B Stream, and former railroad tracks in Investigation Areas 18E and 18F.
- Background concentrations of cPAHs, arsenic, and chromium.
- Chromium toxicity.

The analyses presented in Section 6.5.4 for these specific issues resulted in significant reductions in the future residential cancer risk for the Soil EA. Figure 6-6 provides a visual representation of the impacts of these changes. As shown in Figure 6-6, the future residential cancer risk for the Soil EA with these adjustments in place is below 1E-04, the upper limit for cancer risk established by the National Contingency Plan.

The situation for the Drainage Ditch EA is different. Over 90% of the future residential risk is a result of the cPAH contamination measured in the Area 18B Stream. As discussed in Sections 2.3.8 and 6.5.4, the cPAH contamination in the Area 18B Stream is the result of storm water discharge from upgradient areas. Therefore, cPAH concentrations associated with the Area 18B Stream are not considered for any future decisions on remediation of the EPA/GSA Area.

The conclusion of the HHRA for the EPA/GSA Area is that the potential risks to adults and children resulting from exposure to DoD-related contamination in soil are not a concern for restricted or unrestricted uses. This conclusion is based on all data available to define the nature and extent of contamination within the EPA/GSA Area. A summary of the ecological risk assessment conclusions can be found in Section 2.10.4.

7. CONCLUSIONS

The previous sections of this report present and summarize all of the RIs and interim response actions that have occurred within the Investigation Areas located at the EPA/GSA Area. The USACE's FUDS program conducts response activities at FUDS, such as the former Raritan Arsenal, in accordance with the DERP statute (10 USC § 2701 et seq.), CERCLA (42 USC § 9620 et seq.), EOs 12580 and 13016, and the NCP (40 CFR Part 300). This *Remedial Investigations and Remedial Actions Summary Report* and the attendant risk assessments are in compliance with CERCLA and the NCP.

Investigations commenced in the early 1960s and continue up to the present time and have included:

- Archival searches to identify areas of potential contamination based on historical operations;
- Geophysical and MEC surveys to search for subsurface anomalies that could in include historical disposal areas or buried MEC;
- Soil and groundwater investigations that delineated and characterized the levels of contamination throughout the EPA/GSA Area;
- UST removals;
- Response actions performed at Areas 18A, 18B, 18C (Building 256, Drum Disposal Areas 1 through 4), 18E, and 18F;
  - Area 18A: 1992 and 1998 soil removals
  - Area 18B: 2002 soil removals for lead and 2002 removal at Firing Range Backstop Area of ammunition debris consisting of expended bullets embedded in the backstop
  - Area 18C: UST removals, asbestos stabilization, 1998 and 2002 soil removals
  - Area18E: 2011 soil removals
  - Area 18F: none
  - Area 18G: UST removals
- Capping/covering of the asbestos landfill in Area 18C;

- Ongoing monitoring of the AOC 2, 4 and 8 groundwater plumes;
- A baseline HHRA that evaluated the degree of soil exposure within the EPA/GSA Area using health-protective assumptions on the current and future uses of the area; and
- A screening level and baseline ecological risk assessment (SLERA/BERA) that evaluated the potential exposure of ecological receptors to COPECs in specific habitat types including freshwater drainages, developed land, disturbed fields, and forested uplands. The consequent risk of that exposure was evaluated for a variety of aquatic and terrestrial receptors.

Because concerns for site contamination generally relate to either hazardous, toxic waste (HTW) or MEC, two types of investigations have been performed at the EPA/GSA Area. The first type of investigation focused on HTW issues related to past DoD activities. The HTW issues have been addressed through multiple RIs including the HHRA presented in Section 6 of this Report. The RIs focused on those areas known or suspected to be contaminated as identified in the ASRs. The conclusions related to the HTW issues are presented below in Section 7.1.

The second type of investigation focused on MEC issues. The MEC issues related to the EPA/GSA Area have been investigated through the ASRs, MEC surveys, and interim response actions. The conclusions related to the MEC issues are presented on Table 7-1 and below in Section 7.2.

7.1 HAZARDOUS AND TOXIC WASTE CONCLUSIONS

The historical RIs and the current RI and HHRA evaluated all identified potential contamination within the EPA/GSA Area. As described in Section 4 (Nature and Extent of Contamination), the available soil and sediment data were compared against restricted and unrestricted use screening criteria from EPA and NJDEP. When viewed from an area-wide perspective, the average soil concentrations are not a concern for any future use of the EPA/GSA Area. It is clear that contamination in the Area 18B Stream is present as demonstrated by the results of 2013 sediment sampling event (Avatar, 2013). However, as comprehensively described throughout this report, the sediment levels are the result of upgradient, non-DoD sources.

Although there are exceedances of the restricted and unrestricted use criteria, the CERCLA-compliant, site-specific baseline HHRA concludes that the calculated risk levels based on exposure to DoD-related contamination are acceptable for unrestricted use.

In summary, based on the results of the RI and HHRA, No Further Action is required on behalf of USACE for the soil and sediment associated with the EPA/GSA Area. Groundwater and vapor intrusion concerns are being investigated separately.

7.2 MEC CONCLUSIONS

A number of geophysical and MEC surveys have been performed within the EPA/GSA Area with no MEC discoveries. Table 7-1 presents the investigations that have occurred to search for MEC at each Investigation Area. Based on the historical uses of the Investigation Areas, the EPA/GSA Area has only one area with a history of potential MEC (Investigation Area 1). Investigation Area 1 is a 0.57 acre (shown on Figure 2-1) that was defined based on the presence of a ground scar observed in a 1939 aerial photo and was interpreted as a former demolition area (Weston, 1996a). Investigation Area 1 has a reported history of destruction of adapter boosters, point and base detonating fuses, and 37 mm to 6-inch gun projectiles. Investigations were conducted at Investigation Area 1 in 1988 and 1992 that included both MEC surveys and intrusive investigations of anomalies using a shovel and backhoe. No MEC items were found. More recently, a supplemental records review for Investigation Area 1 was performed (CH2M HILL, 2013). It was concluded that no additional MEC investigation is warranted. MEC has not been identified in the surface or subsurface during previous inspections and investigations and is not a concern at Investigation Area 1.

Other areas were also investigated for MEC as shown on Table 7-1. A removal action completed in 2002 removed small arms ammunition debris consisting of expended bullets embedded in the backstop of a small arms range target berm. The only additional munition related items found were incidental discoveries documented as: one 57-mm projectile (inert) and one empty machine shell.

The 57-mm projectile was recovered from Investigation Area 18E sometime between 1991 and 1994. The exact location of this discovery could not be determined. No other items were ever

discovered within Investigation Area 18E even during MEC surveys, building demolition activities, and a large scale soil removal. This 57-mm projectile finding is considered to be an anomaly. One machine gun shell was discovered on the ground surface adjacent to the former rail bed in Investigation Area 18G. This is also considered an anomalous finding as there were no other items discovered and the historical use of the area does not involve ordnance or munitions.

The items found (expended bullets, inert projectile, and empty machine gun shell) are considered munition debris (MD) and not MEC. The lack of MEC finds even after all of the investigatory work is supported by the general historical use of the areas. Based on this information, USACE believes there are no remaining MEC issues associated with the EPA/GSA Area that require additional investigations or evaluation. Furthermore, the USACE recommends No Further Action for MEC within the EPA/GSA Area.

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TABLES

Executive Summary Table

Table ES-1
MEC Investigation Activities Completed at the EPA/GSA Area

Area Name	Historical Area Use	History of MEC Use	Steps Taken to Investigate MEC	MEC Finds
Area 1	0.57 acre site that was used as a former demolition ground after WWI and into the early 1930s for the destruction of adapter boosters, point and base detonating fuses, and 37 mm to 6-inch gun projectiles.	Yes	• Early 1960s – 'surface search', no ordnance discovered • Jan 1988 – visual inspection and use of an ordnance locator instrument (MK 26). The ordnance locator identified numerous small ferrous objects 6 to 12-inches below grade. Hand excavation of several locations revealed pieces of wire and steel reinforcing bars and half of a small can. No MEC was found. • June 1988 – prior to site clearing and the geophysical survey, an additional visual inspection revealed no MEC on the surface. An ordnance locator identified eight metal objects below grade. Each item was excavated. None were MEC. • Sept/Oct 1988 – Magnetometer (MAG) and ground penetrating radar (GPR) surveys conducted. The surveys were completed on a 25-ft square grid over a 200-ft square area. The grid was established such that the stream which bisects the site did not interfere with data collection. The MAG survey showed no magnetic anomalies that could be associated with subsurface objects. The GPR survey identified no detectable subsurface anomalies which indicated buried objects or evidence of previous excavations. Therefore, there is no evidence that subsurface objects or bulk waste materials are present in Area 1. • May 1992 – entire area was surveyed with a GA-52B magnetometer. Hits were marked with red flagging and excavated using a shovel and/or backhoe. Only metallic scraps were found. No MEC related items were found.	None
Area 18A	3 acre site that was formerly a man-made pond, first appearing in a 1951 aerial photograph. Area went through extensive removal actions for HTW in 1992 and 1998	No	• MEC was not observed during the 1992 and 1998 removal actions that included extensive excavations over an area of approximately 12,100 ft^2.	None
Area 18B	Approximately 50 acres, surrounding Area 18A. Includes the location of a former firing range. Little information regarding specific operations at the firing range was available, but it appears that only small arms firing occurred. The extent of the former firing range was roughly delineated by historical ground scars noted while reviewing historical aerial photographs.	No	• July 1993 – geophysical mapping and sampling investigation for MEC was performed at four areas Area 1: 2,500 ft^2, Anomalies = 18, Anomalies Sampled = 18, MEC found = none Area 2: 11,250 ft^2, Anomalies = 55, Anomalies Sampled = 21, MEC found = none Area 3: 10,000 ft^2, Anomalies = 56, Anomalies Sampled = 14, MEC found = none Area 4: 625 ft^2, Anomalies = 4, Anomalies Sampled = 4, MEC found = none • 2002 – debris consisting of expended small arms embedded in the former firing range backstop area was removed • 2002 – removals were conducted at 3 areas for lead contamination in soil. MEC was not observed during the excavations.	None
Area 18C	58 acres that includes the foundations of two former buildings (Buildings 255 and 256) that were demolished in August 2014, asphalt and railroad areas, and undeveloped land. A portion of the site was historically used as a dumping ground for building debris.	No	• July 1993 – geophysical mapping and sampling investigation for MEC was performed at one area Area 1: 150 ft^2, Anomalies = 0, Anomalies Sampled = 0, MEC found = none • April 1996 – Electromagnetic (EM) and MAG surveys completed to locate and delineate suspected buried drum areas. The survey area was approximately 18.6 acres EM survey conducted with Geonics EM-31 terrain conductivity meter MAG survey conducted with GEOMETRICS G-858 cesium vapor Gradiometer/Magnetometer 25 anomalies were noted and investigated by test trenches No MEC related items were found • Aug 1999 – EM, GPR, and MAG surveys completed. The survey area was approximately 1.57 acres. • 1998 and 2002 – extensive excavations for HTW completed for approximately 1.1 acres. MEC was not observed.	None

Table ES-1
MEC Investigation Activities Completed at the EPA/GSA Area

Area Name	Historical Area Use	History of MEC Use	Steps Taken to Investigate MEC	MEC Finds
Area 18E	3 former Army buildings: Buildings 14, 15, and 19. Building 14 served as a small arms shop; Building 15 served as a machine shop; and Building 19 was referred to as a vehicle rebuild assembly shop. Review of historical aerial photography indicated that the three buildings were joined together as of 1940. Buildings were demolished in 1997.	No	• Sometime between 1991 and 1994, an inert 75-mm projectile was found. The location of the item (considered munition debris) and the manner in which it was discovered are unknown. • Aug 1999 – EM, GPR, and MAG surveys completed to locate USTs at two areas. The survey area was approximately 3,650 ft^2 Geophysical Survey Systems SIR System 2 was used for the GPR survey MAG survey conducted with GEOMETRICS G-858 cesium vapor Gradiometer/Magnetometer No anomalies were noted • Oct 2004 – MEC clearance performed at 17 proposed soil boring locations Downhole clearance was performed using combination of Schonstedt GA-52cd magnetic locator and MK-26 ferrous magnetic locator in conjunction with hand auger to advance the boring to maximum depth of 10 feet bgs. No anomalies requiring further investigation were identified. The results of the survey did not indicate the presence of MEC. • 2009 – MEC clearance performed at 61 locations. Clearance was performed using a combination of Schonstedt GA-52cd magnetic locator and MK-26 ferrous magnetic locator in conjunction with a hand auger to advance the boring to a maximum depth of 4 feet bgs. No anomalies requiring further investigation were identified in the 57 soil borings or the four monitoring well locations. The results of the survey did not indicate the presence of MEC. • 2011 - Excavations were performed at five areas (approximately 12,183 ft^2) to remove elevated concentrations of TCE and other VOCs. No MEC or related items were discovered	No

Table ES-1
MEC Investigation Activities Completed at the EPA/GSA Area

Area Name	Historical Area Use	History of MEC Use	Steps Taken to Investigate MEC	MEC Finds
Area 18F	Approximately 43 acres that historically contained a small arms packing operation and several warehouses. The Archives Search Report indicated Building 202 was used for parts storage and truck storage in 1918 and 1919. A fire occurred in Building 202 in 1929. Inert ordnance materials including fuses, bomb casings, wooden containers, and cartridge cases were stored in Building 202 in 1935. A reproduction office including blueprint machines, dark rooms, and sinks was located at an unspecified location within Building 202. However, this building was referred to as the packing and shipping shed in 1943. Wrenches, ordnance tools, and shovels were stored in Building 202 in 1946. The GSA owned Building 202 from 1963 until the early 1970s when the EPA acquired the property. Building 202 was demolished in 1994. Inert ordnance materials including fuses, bomb casings, wooden containers, and cartridge cases were stored in Building 203 in 1935. A pit of unspecified size was located along a steam pipe trench at an unknown location within Building 203. The GSA owned Building 203 from 1963 until the early 1970s, when it was transferred to the EPA. Building 203 was demolished by EPA in 1994.	Possible small arms packing in a building	Reported historical use in one building for small arms packing suggest the possibility of MEC. However, the area was surface cleared prior to closure of the arsenal in 1963. No subsequent MEC investigations have been conducted, but since the area is almost entirely covered by original Raritan Arsenal structures, the likelihood of subsurface MEC is small.	No
Area 18G	Approximately 21 acres that was historically used for equipment storage, as a gasoline station and automotive shop, and as a dump. Information reported in the Archive Search Report indicated that a dump was historically located in this area and had been covered over with concrete. The dump was reportedly used by Columbia Salvage Company to dispose of scrap material generated during ammunition salvage operations. The timeframe associated with dumping activities is not known. A gasoline station storage building and automotive shop were historically located near the northern corner of Area 18G, where it borders Area 18F. The exact dates for when the station was constructed and when the station was removed are unknown. However, the station was actively utilized by GSA/EPA into the 1980s. Two USTs previously located there were removed by the EPA in 1991.	No	• A single machine gun shell (considered to be munition debris) was discovered on the surface during a cultural resources survey. The location and date of this discovery is unknown. • 1998 – objective of the geophysical investigation was to determine the physical extent of historical dump. EM, GPR, and MAG surveys completed over 0.5 acres The extent of the former dump was delineated	No

Section 1 Tables

Table 1-1
Areas of Investigation at the Former Raritan Arsenal

Area Name	Approximate Acreage	Description
US EPA/GSA Property	**178 acres**	**Located in the north central portion of the former Arsenal, this area comprises Areas 1, 18A, 18B, 18C, 18E, 18F and 18G.**
Commercial/Industrial Area	1,233 acres	Located in the center of the former Arsenal, this area comprises Areas 2, 3, 4, 7, 8, 15, and 20, in addition to the Owens Illinois Area, Building 151, the Inland Container Corporation and the area in the far north of the former Arsenal referred to as the Exclusion Area.
Middlesex County College	169 acres	Located in the northwest corner of the former Arsenal, this area contains Areas 17, 17A, X, H, W, Building 118, and additional areas such as the High Traffic Area, UST removal areas and the PCB Transformer Areas,
Area 5	10 acres	Located in the central eastern portion of the former Arsenal, this area consists of the Former Chemical/Mustard Disposal Area.
Area 6, 6A, 6B, DSA#1 and Surrounding Areas	236 acres	Located in the southeastern portion of the former Arsenal, this area comprises the Former Burning Ground and Impoundment Areas, as well as an area of additional dredge deposits/spoils referred to as DSA#1.
Area 9 and 19	350 acres	Located in the central western portion of the former Arsenal, this area comprises Area 9 (Former Magazine H-65 Explosion Area) and Area 19 (Former Magazine Area).
Area 10	143 acres	Located on the western side of the former Arsenal, this area comprises the Former Wastewater Treatment and Magazine Area.
Area 11, DSA#2 and Surrounding Areas	130 acres	Located in the south central portion of the former Arsenal, this area comprises the Former Dredged Material and Explosives Disposal Area, as well as an area of additional dredge deposits/spoils referred to as DSA#2.
Area 12, OB/OD, DSA#3 and Surrounding Areas	235 acres	Located in the southwestern portion of the former Arsenal, this area comprises the Former Dredged Material and Explosives Detonation Area, an area referred to as OB/OD which presents the maximum “kick-out” distances of munitions from former explosive detonation operations, and an area of additional dredge deposits/spoils beyond the boundary of Area 12 referred to as DSA#3.

Table 1-1
Areas of Investigation at the Former Raritan Arsenal

Area Name	Approximate Acreage	Description
Area 13	23 acres	Located in the south central portion of the former Arsenal, this area comprises a thin strip of land alongside the dock, the Submerged Dock Area and approximately 17 acres of the Raritan River adjacent to the dock.
Area 16, 16A and Surrounding Areas	352 acres	Located in the southwest portion of the former Arsenal, this area comprises the Former Magazine Area.
Area 18D, Middlesex Interfaith Partners and Beechwood Development	104 acres	Located in the northwest portion of the former Arsenal, between Middlesex County College and the EPA/DSA Property, this area comprises the Trench of Shell Casings and the Beechwood Trench, a Condominium complex referred to as Beechwood Development, and homeless shelter referred to as Middlesex Interfaith Partners.
DSA#4 and DSA#6	94 acres	DSA #4 and DSA #6 are located within the center of the Raritan River, south of the former Arsenal, these areas comprise discontinuous islands where it was speculated that dredge deposits/spoils were placed.
DSA #5	228 acres	DSA#5 is also located to the south of the former Arsenal, and comprises the maximum extent of area permissible to dispose of dredge deposits/spoils on the southern shore of the Raritan River, and also comprises the “Spoils Area” an 8-acre parcel of spoils.
Total Area	**3,485 acres**	

- The current acreage in FUDSMIS is 3,283.5 acres. The acreage difference will be addressed when the project is delineated.

Table 1-2
Other Areas at the Former Raritan Arsenal

Area Name	Approximate Acreage	Description
Capped Area 14 (Ineligible)	189 acres	Located in the eastern portion of the former Arsenal, this was former marshland and used for deposition of dredged material from the Raritan River. The land owner (FBC) obtained NJDEP approval to construct a large package distribution complex on this site; with the backfilling, building, pavement and landscaping serving to cap soil contamination.
Army Reserve Center (Ineligible)	9 acres	Located to the west of the former Arsenal, these two non-contiguous areas are an active Army Reserve Center.
Total Area	**198 acres**	

Section 2 Table

Table 2-1
Investigation Area Summary
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Investigation Area	Description and Historical Use of Area	Previous Investigations Performed (date of report)	Removal Actions Performed
Area 1 (Former Demolition Area)	A 0.57 acre site that was used as a former demolition ground after WWI and into the early 1930s for the destruction of adapter boosters, point and base detonating fuses, and 37 mm to 6-inch gun projectiles.	- Contamination Evaluation (1989) - MEC Investigation (1992) - Phase I RI (1993) - Phase II RI (1996) - Supplemental MEC Investigation (2013)	- None
Area 18A (Former GSA/U.S. Army Pond Area)	Three acre area that was formerly a man-made pond, first appearing in a 1951 aerial photograph. It was identified as a "tar pit" during an archival investigation in 1991. The appearance of the tar pit in 1951 coincided with the appearance of two oil tanks. Information on the time frame of disposal and specific disposal practices was not provided in archival reports.	- Site Listing Investigation (1990) - Investigation and interim response activities (1993) - Phase II RI (1996) - Supplemental Phase II RI (1999) - Interim Response Action (2002) - Supplemental Soil Sampling (2013)	- 1992 removal: removed 15,300 gallons of contaminated surface water from the pond. Excavated approximately 176 tons of tar-based material. Approximately 2 ft of tar-based material was excavated. All visibly contaminated soil was removed. Excavated approximately 527 cubic yards (cy) of soil, product, and debris from the second disposal area. Excavations were to an average depth of 1.5 ft bgs with isolated depths to 4 ft bgs. - 1998 removal: based on the RIs, two areas of contamination were identified as requiring additional interim response actions (18A-1 and 18A-2). The total volume of soil removed was 2,485 cy.
Area 18B (Former Firing Range	Approximately 50 acre area that surrounds Area 18A, and includes the former location of a firing range. Little information regarding specific operations at the firing range was available, but it appears that only small arms firing occurred. The extent of the former firing range was roughly delineated by historical ground scars noted while reviewing historical aerial photographs.	- Site Inspection (1985) - Site Listing Investigation (1990) - Supplemental Phase II RI (1999) - Supplement 2 Phase II RI (2000) - Interim Response Action (2004) - Supplemental Sediment Sampling (2013)	- 2002 removal: a soil removal was conducted in 2002 to remove small arms ammunition debris at the former firing range backstop and remediate the lead-contaminated soil identified at the former firing range and at four areas associated with anomalous lead detections. The excavation area for the firing range area was 4,125 ft^2 to a depth of 2 ft bgs.
Area 18C (Former Landfill, Disposal, and Vehicle Processing Area)	58 acre area that includes the foundations of two former buildings (Buildings 255 and 256) that were demolished in August 2014, asphalt and railroad areas, and undeveloped land. A portion of the site was historically used as a dumping ground for building debris. Some of the debris that was dumped was known to contain asbestos. The area containing asbestos is approximately 0.25 acre within the larger total landfill area and is referred to as the Asbestos Landfill. The Asbestos Landfill is a result of GSA-directed demolitions conducted in the early 1990s. Contamination associated with the Asbestos Landfill is not quantitatively evaluated in this RI.	- Site Inspection (1985) - Site Listing Investigation (1990) - Phase II Supplemental Records Review/Site Inspection (1997) - Supplemental Phase II RI (1999) - Supplement 2 Phase II RI (2000) - Supplemental RI - Ramp Area (2005)	- UST removals: EPA removed former USTs that included a 25,000-gallon UST and a 15,000-gallon UST that contained No. 6 fuel oil, a 2,500-gallon UST that contained No. 2 fuel oil, and one 5,000-gallon UST that was reportedly used to store fuel and engine oil drained from newly painted tanks prior to shipping them overseas. The USTs were removed in the early 1990s. - 1998 removal: removals were performed at four locations in 1998. A total of approximately 4,300 cy of soil was removed. - 2002 removal: additional removals were performed in 2002 focusing on the residual contamination associated with the previous excavations. Approximately 9,200 tons of soil were removed.
Area 18E (Former Maintenance Area)	Includes three former Army buildings that were demolished by EPA in 1997: Buildings 14, 15, and 19. Based on the ASR (Dames and Moore, 1993a), Building 14 served as a small arms shop; Building 15 served as a machine shop; and Building 19 was referred to as a vehicle rebuild assembly shop. Review of historical aerial photography indicated that the three buildings were joined together as of 1940.	- Phase II Supplemental Records Review/Site Inspection (1997) - Supplement 2 Phase II RI (2000) - Final Supplemental RI (2011)	- 2011 removal: excavations were performed at five areas to remove elevated concentrations of TCE and other VOCs. Approximately 2,960 tons of soil was excavated.

Table 2-1
Investigation Area Summary
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Investigation Area	Description and Historical Use of Area	Previous Investigations Performed (date of report)	Removal Actions Performed
Area 18F (Former Warehouses)	Approximately 43 acre area that contained a small arms packing operation and several warehouses.	- Site Inspection (1985) - Site Listing Investigation (1990) - Supplemental Phase II RI (1999) - Supplement 2 Phase II RI (2000)	None
Area 18G (Former Dump	Approximately 21 acre area that was historically used for equipment storage, as a gasoline station and automotive shop, and as a dump.	- Site Inspection (1985) - Phase II Supplemental Records Review/Site Inspection (1997) - Supplemental Phase II RI (1999) - Supplement 2 Phase II RI (2000)	- UST removals: EPA removed two former USTs located at the former gasoline station in the early 1990s.

Section 4 Tables

Table 4-1
Summary of Available Data by Source
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Investigation Report/Source	Agency/Contractor	Report Date	Status of Data
Decontamination of the Ammunition Area	LEAD	1963	Not applicable; data not collected.
Final Engineering Report, Former Raritan Arsenal, Contamination Evaluation	O'Brien and Gere Engineers	1989	Data not available in electronic format
Ordnance and explosives wastes location and removal	IT Corporation, EOD Technology	1992	Not applicable; data not collected.
Draft Archive Search Report, Former Raritan Arsenal	Dames and Moore	1993	Not applicable; data not collected.
Final Report, Phase I Remedial Investigation of Selected Areas of Former Raritan Arsenal	Dames and Moore	1993	Data not available in electronic format
Final Report for the Geophysical Mapping and Sampling of Areas 2, 3, 4, 6, 8, 9, 10, 11, 13, 14, 15, 16, 16A, 18B, 18D, 19, and MCC	EOD Technology	1993	Not applicable; data not collected.
Remediation of Area 18A Pond, Area 18B, Area 18C	IT Corporation	1993	Not applicable; data not collected.
Final Report of Investigation, Area 1 Investigation	Weston Solutions	1996	**Data included in Data Summary Report (tables and figures)**
Final Report of Investigation, Area 18A Investigation	Weston Solutions	1996	**Data included in Data Summary Report (tables and figures)**
Geophysical Investigation Report, Area 18C Investigation	Weston Solutions	1996	Not applicable; data not collected.
Final Report of Investigation, Site-Wide Surface Water and Sediment Investigation	Weston Solutions	1996	**Data included in Data Summary Report (tables and figures)**
Phase II Supplemental Record Review/Site Inspection Report	Weston Solutions	1997	Not applicable; data not collected.
Supplemental Report of Investigation, Areas 2, 3, 7, 9, 11,, 16, 18A, 19, Inland Containers, and W Investigations	Weston Solutions	1999	**Data included in Data Summary Report (tables and figures)**
Final Supplemental Report of Investigation, Areas 18B, 18C, 18D, 18F, and 18G Investigations	Weston Solutions	1999	**Data included in Data Summary Report (tables and figures)**
Engineering Evaluation/Cost Analysis	Foster Wheeler Environmental Corporation	2000	Not applicable; data not collected.
Draft Supplement 2 Phase II Remedial Investigation Report	Weston Solutions	2000	**Data included in Data Summary Report (tables and figures)**
Final Remedial Action Report, Remedial Construction - Areas 11, 12, 18A, 18C, and W	Weston Solutions	2002	**Data included in Data Summary Report (tables and figures)**
Final Groundwater Natural Attenuation Report	Weston Solutions	2003	**Data included in Data Summary Report (tables and figures)**
Final Remedial Action Report, Remedial Construction - Areas 12, 18B, 18C, and Building 256	Weston Solutions	2004	**Data included in Data Summary Report (tables and figures)**
Final Screening-Level Ecological Risk Assessment Report	Weston Solutions	2004	**Data included in Data Summary Report (tables and figures)**
Final Supplemental Remedial Investigation Report, Area 18C - Ramp Area and Buildings 151/165	Weston Solutions	2005	**Data included in Data Summary Report (tables and figures)**

Table 4-1
Summary of Available Data by Source
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Investigation Report/Source	Agency/Contractor	Report Date	Status of Data
Indoor Air Quality Report #10	Weston Solutions	2015	Not applicable
Draft Groundwater AOC 8, EPA Buildings Investigation	Weston Solutions	2005	Not applicable
Final Supplemental Groundwater Data Report	Weston Solutions	2006	**Data included in Data Summary Report (tables and figures)**
Management Action Plan for the Former Raritan Arsenal	Weston Solutions	2007	Not applicable; data not collected.
Final Baseline Ecological Risk Assessment Report	Weston Solutions	2008	**Soil and sediment sample collected in support of the BERA. Data included in Data Summary Report (tables and figures)**
Final Human Health Risk Assessment	Watermark Environmental	2009	Not applicable; data not collected.
Final Remedial Action Report, Building 165 and Area 18C Groundwater Treatment Pilot Systems	Shaw Environmental	2010	Not applicable; data not collected.
Final Supplemental Remedial Investigation Report, Area 18E	Weston Solutions	2011	**Data collected from the first phase of the investigation included in Summary Report (tables and figures). Data from second phase not available.**
Engineering Evaluation/Cost Analysis for Area 18E Removals Actions	H&S Environmental	2011	Not applicable; data not collected.
Final Remedial Action Completion Report	H&S Environmental	2013	**Post-excavation data collected and included in Summary Report (tables and figures).**
Supplemental Soil and Sediment Sampling in Area 18A and Area 18B Stream	Avatar Environmental	2013	**Data included in Summary Report (tables and figures).**

Table 4-2
Summary of Analytes Detected in Soil (0 to 10 ft bgs) and Comparison to Human Health Screening Criteria
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency[a]	EPA Regional Screening Levels[b] Industrial Soil	EPA Regional Screening Levels[b] Residential Soil	NJDEP[c] Soil Remediation Standards Industrial Soil	NJDEP[c] Soil Remediation Standards Residential Soil
83329	Acenaphthene	1.40E-02	1.30E+01	mg/kg	TP-18C72A	27/280	4.50E+04	3.60E+03	3.70E+04	3.40E+03
208968	Acenaphthylene	3.70E-02	1.40E+00	mg/kg	SS-18G15A	27/280	4.50E+04	3.60E+03	3.00E+05	NBA
67641	Acetone	5.70E-03	9.60E-01	mg/kg	SS-18E91A	69/353	6.70E+05	6.10E+04	NBA	7.00E+04
120127	Anthracene	1.50E-02	4.20E+01	mg/kg	TP-18C72A	60/280	2.30E+05	1.80E+04	3.00E+04	1.70E+04
12672296	Aroclor-1248	2.00E-01	2.00E-01	mg/kg	SS-18E45A	1/218	9.50E-01	2.30E-01	1.00E+00	2.00E-01
11097691	Aroclor-1254	1.20E-01	1.20E-01	mg/kg	PE-18C-175A	1/218	9.70E-01	2.40E-01	1.00E+00	2.00E-01
11096825	Aroclor-1260	2.50E-01	9.70E-01	mg/kg	TP-18E15A	4/222	9.90E-01	2.40E-01	1.00E+00	2.00E-01
71432	Benzene	4.50E-03	1.90E-01	mg/kg	SS-18E11	5/353	5.10E+00	1.20E+00	5.00E+00	2.00E+00
56553	Benzo(a)anthracene	2.60E-03	5.80E+01	mg/kg	TP-18C72A	116/280	2.10E+01	1.10E+00	1.70E+01	5.00E+00
50328	Benzo(a)pyrene	2.60E-03	4.70E+01	mg/kg	TP-18C72A	115/280	2.10E+00	1.10E-01	2.00E+00	5.00E-01
205992	Benzo(b)fluoranthene	4.10E-03	3.80E+01	mg/kg	TP-18C72A	118/280	2.10E+01	1.10E+00	1.70E+01	5.00E+00
191242	Benzo(g,h,i)perylene	2.40E-03	2.60E+01	mg/kg	TP-18C72A	91/280	NBA	NBA	3.00E+04	3.80E+05
207089	Benzo(k)fluoranthene	1.80E-03	4.10E+01	mg/kg	TP-18C72A	116/280	2.10E+02	1.10E+01	1.70E+02	4.50E+01
117817	Bis(2-ethylhexyl)phthalate	5.30E-02	3.40E+00	mg/kg	TP-18A08A	9/209	1.60E+02	3.90E+01	1.40E+02	3.50E+01
75252	Bromoform	6.00E-04	2.60E-03	mg/kg	PE-18C177A1	6/353	8.60E+01	1.90E+01	2.80E+02	8.10E+01
78933	2-Butanone	3.70E-03	1.50E+00	mg/kg	SS-18C125A	9/353	1.90E+05	2.70E+04	4.40E+04	3.10E+03
85687	Butylbenzylphthalate	2.40E-02	5.60E-02	mg/kg	SS-0105A	3/209	1.20E+03	2.90E+02	1.40E+04	1.20E+03
86748	Carbazole	3.90E-02	2.20E+01	mg/kg	TP-18C72A	26/209	NBA	NBA	9.60E+01	2.40E+01
75150	Carbon disulfide	1.60E-03	5.30E-01	mg/kg	TP-18E16A	4/353	3.50E+03	7.70E+02	1.10E+05	7.80E+03
5103719	alpha-Chlordane	3.70E-03	1.00E-01	mg/kg	SS-18C41A	3/173	7.70E+00	1.70E+00	1.00E+00	2.00E-01
5566347	gamma-Chlordane	2.90E-03	1.30E-01	mg/kg	SS-18C41A	3/172	7.70E+00	1.70E+00	1.00E+00	2.00E-01
108907	Chlorobenzene	1.90E-02	1.90E-02	mg/kg	TP-18C73B	1/353	1.30E+03	2.80E+02	7.40E+03	5.10E+02
67663	Chloroform	4.60E-02	3.50E+00	mg/kg	TP-18E16A	2/354	1.40E+00	3.20E-01	2.00E+00	6.00E-01
74873	Chloromethane	3.10E-03	6.20E-03	mg/kg	PE-18C195A	14/353	4.60E+02	1.10E+02	1.20E+01	4.00E+00
218019	Chrysene	3.40E-03	5.50E+01	mg/kg	TP-18C72A	123/280	2.10E+03	1.10E+02	1.70E+03	4.50E+02
110827	Cyclohexane	1.60E-03	1.60E-03	mg/kg	AREA3-6	1/81	2.70E+04	6.50E+03	NBA	NBA
72548	4,4-DDD	1.50E-03	1.60E-01	mg/kg	SS-18B05B	8/173	9.60E+00	1.90E+00	1.30E+01	3.00E+00
72559	4,4-DDE	4.00E-03	9.10E-02	mg/kg	TP-18C75A	20/172	9.30E+00	2.00E+00	9.00E+00	2.00E+00
50293	4,4-DDT	3.50E-03	3.80E+00	mg/kg	TP-18C72A	32/172	8.50E+00	1.90E+00	8.00E+00	2.00E+00
53703	Dibenz(a,h)anthracene	3.80E-02	1.00E+01	mg/kg	TP-18C72A	48/280	2.10E+00	1.10E-01	2.00E+00	5.00E-01
132649	Dibenzofuran	4.80E-02	1.20E+01	mg/kg	TP-18C72A	19/263	1.00E+03	7.30E+01	NBA	NBA
95501	1,2-Dichlorobenzene	2.60E+00	2.60E+00	mg/kg	TP-18A08A	1/291	9.30E+03	1.80E+03	5.90E+04	5.30E+03
540590	1,2-Dichloroethene	1.40E-03	2.60E+00	mg/kg	TP-18A08A	9/178	2.30E+03	1.60E+02	5.60E+02	2.30E+02
156592	cis-1,2-Dichloroethene	1.30E-01	1.40E+00	mg/kg	SS-18C107A	2/175	2.30E+03	1.60E+02	5.60E+02	2.30E+02
156605	trans-1,2-Dichloroethene	9.40E-02	9.40E-02	mg/kg	SS-18C107A	1/175	2.30E+04	1.60E+03	7.20E+02	3.00E+02
60571	Dieldrin	1.00E-02	4.10E-02	mg/kg	TP-18C70B	2/173	1.40E-01	3.40E-02	2.00E-01	4.00E-02
131113	Dimethyl phthalate	8.20E-02	1.40E-01	mg/kg	SS-0104B	4/209	NBA	NBA	NBA	NBA
84742	Di-n-butyl phthalate	3.20E-01	3.20E-01	mg/kg	SS-18C67A	1/209	8.20E+04	6.30E+03	6.80E+04	6.10E+03
117840	Di-n-octyl phthalate	6.70E-02	6.70E-02	mg/kg	SS-18G01A	1/209	8.20E+03	6.30E+02	2.70E+04	2.40E+03
33213659	Endosulfan II	1.70E-02	1.70E-02	mg/kg	SS-0103A	1/172	7.00E+03	4.70E+02	6.80E+03	4.70E+02
7421934	Endrin aldehyde	8.10E-03	1.90E-02	mg/kg	SS-18C37B	2/172	2.50E+02	1.90E+01	3.40E+02	2.30E+01
100414	Ethylbenzene	1.10E-02	1.00E+01	mg/kg	TP-18A08A	13/353	2.50E+01	5.80E+00	1.10E+05	7.80E+03
206440	Fluoranthene	6.00E-03	1.30E+02	mg/kg	TP-18C72A	131/280	3.00E+04	2.40E+03	2.40E+04	2.30E+03
86737	Fluorene	2.60E-02	1.80E+01	mg/kg	TP-18C72A	28/280	3.00E+04	2.40E+03	2.40E+04	2.30E+03
76448	Heptachlor	5.00E-02	5.00E-02	mg/kg	SS-18C41A	1/173	6.30E-01	1.30E-01	7.00E-01	1.00E-01
591786	2-Hexanone	1.50E-02	1.50E-02	mg/kg	PE-18C197A	1/353	1.30E+03	2.00E+02	NBA	NBA
193395	Indeno(1,2,3-c,d)pyrene	2.30E-03	2.60E+01	mg/kg	TP-18C72A	91/280	2.10E+01	1.10E+00	1.70E+01	5.00E+00
72435	Methoxychlor	9.60E-03	9.60E-03	mg/kg	SS18B81	1/173	4.10E+03	3.20E+02	5.70E+03	3.90E+02
75092	Methylene chloride	1.00E-03	1.70E-01	mg/kg	18C248A	59/353	1.00E+03	5.70E+01	2.30E+02	4.60E+01
91576	2-Methylnaphthalene	4.10E-02	1.60E+01	mg/kg	TP-18A08A	17/265	3.00E+03	2.40E+02	2.40E+03	2.30E+02
106445	4-Methylphenol	3.40E-01	3.40E-01	mg/kg	TP-18C72A	1/209	8.20E+04	6.30E+03	3.40E+02	3.10E+01
91203	Naphthalene	3.10E-02	1.10E+01	mg/kg	TP-18C72A	20/281	1.70E+01	3.80E+00	1.70E+01	6.00E+00
87865	Pentachlorophenol	1.90E+01	4.80E+01	mg/kg	SS-18C41A	1/209	4.00E+00	1.00E+00	3.00E+00	9.00E-01
Petroleum	Petroleum hydrocarbon	2.54E+01	2.54E+01	mg/kg	SS-18C125A	1/5	NBA	NBA	NBA	NBA
85018	Phenanthrene	2.50E-03	1.20E+02	mg/kg	TP-18C72A	117/280	NBA	NBA	3.00E+05	NBA
108952	Phenol	2.20E-02	2.50E-01	mg/kg	TP-18C72A	4/209	2.50E+05	1.90E+04	2.10E+05	1.80E+04
129000	Pyrene	5.10E-03	9.70E+01	mg/kg	TP-18C72A	132/280	2.30E+04	1.80E+03	1.80E+04	1.70E+03
100425	Styrene	1.00E-03	4.60E-03	mg/kg	SS-0104C	4/353	3.50E+04	6.00E+03	2.60E+02	9.00E+01
127184	Tetrachloroethylene	1.40E-03	1.80E+00	mg/kg	SS-AOC2MIP05-07	12/357	1.00E+02	2.40E+01	1.50E+03	4.30E+01
108883	Toluene	5.00E-04	6.40E+00	mg/kg	TP-18A08A	27/352	4.70E+04	4.90E+03	9.10E+04	6.30E+03
71556	1,1,1-Trichloroethane	3.00E-03	1.20E-02	mg/kg	TP-18C60A	3/353	3.60E+04	8.10E+03	NBA	1.60E+05
79016	Trichloroethylene	6.00E-04	6.10E+00	mg/kg	SS-AOC2MIP05-07	63/395	6.00E+00	9.40E-01	1.00E+01	3.00E+00
75694	Trichlorofluoromethane	5.10E-03	6.00E-03	mg/kg	AREA5-9	2/82	3.50E+05	2.30E+04	3.40E+05	2.30E+04
75014	Vinyl chloride	3.10E-03	4.80E-01	mg/kg	TP-18A08A	2/353	1.70E+00	5.90E-02	2.00E+00	7.00E-01
1330207	Xylenes, Total	1.00E-03	6.40E+01	mg/kg	TP-18A08A	24/258	2.50E+03	5.80E+02	1.70E+05	1.20E+04
179601231	m,p-Xylenes	5.20E-03	5.20E-03	mg/kg	AREA2-15-RE1	1/95	2.40E+03	5.50E+02	NBA	1.20E+04
7429905	Aluminum	1.31E+02	1.17E+04	mg/kg	SS-18E51Z	43/43	1.10E+06	7.70E+04	NBA	7.80E+04

Table 4-2
Summary of Analytes Detected in Soil (0 to 10 ft bgs) and Comparison to Human Health Screening Criteria
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency[a]	EPA Regional Screening Screening Levels[b] Industrial Soil	EPA Regional Screening Screening Levels[b] Residential Soil	NJDEP[c] Soil Remediation Standards Industrial Soil	NJDEP[c] Soil Remediation Standards Residential Soil
7440360	Antimony	3.10E-01	2.42E+02	mg/kg	SS-18G01B	143/334	4.70E+02	3.10E+01	4.50E+02	3.10E+01
7440382	Arsenic	2.20E-01	4.88E+02	mg/kg	SS-18F21B	420/487	3.00E+00	6.80E-01	1.90E+01	1.90E+01
7440393	Barium	5.30E-01	2.19E+02	mg/kg	SS-18A02A	157/170	2.20E+05	1.50E+04	5.90E+04	1.60E+04
7440417	Beryllium	1.00E-02	3.40E+00	mg/kg	SS-18E201A	124/332	2.30E+03	1.60E+02	1.40E+02	1.60E+01
7440439	Cadmium	5.00E-02	6.60E+00	mg/kg	SS-18F07B	194/403	9.80E+02	7.10E+01	7.80E+01	7.80E+01
7440702	Calcium	1.72E+01	2.44E+04	mg/kg	SS-18E51Z	32/40	NBA	NBA	NBA	NBA
7440473	Chromium	8.60E-01	6.85E+02	mg/kg	SS-18F07B	400/403	6.30E+00	3.00E-01	NBA	NBA
7440484	Cobalt	1.10E-01	1.01E+01	mg/kg	SS-18E123Z	36/44	3.50E+02	2.30E+01	5.90E+02	1.60E+03
7440508	Copper	1.00E+00	1.34E+03	mg/kg	SS-18F07B	302/328	4.70E+04	3.10E+03	4.50E+04	3.10E+03
7439896	Iron	3.24E+02	3.05E+04	mg/kg	SS-18E123A	44/44	8.20E+05	5.50E+04	NBA	NBA
7439921	Lead	1.40E-01	9.18E+03	mg/kg	SS-18F07B	489/516	8.00E+02	4.00E+02	8.00E+02	4.00E+02
7439954	Magnesium	1.06E+01	3.79E+03	mg/kg	SS-18E51Z	36/40	NBA	NBA	NBA	NBA
7439965	Manganese	9.00E-01	4.14E+02	mg/kg	SS-18E51Z	41/44	2.60E+04	1.80E+03	5.90E+03	1.10E+04
7439976	Mercury	2.00E-03	1.21E+01	mg/kg	SS-18E201A	190/398	3.50E+02	2.30E+01	6.50E+01	2.30E+01
7440020	Nickel	1.90E-01	6.07E+01	mg/kg	SS-18G01B	232/307	2.20E+04	1.50E+03	2.30E+04	1.60E+03
7440097	Potassium	1.86E+01	1.27E+03	mg/kg	SS-18E51Z	25/40	NBA	NBA	NBA	NBA
7782492	Selenium	2.70E-01	6.30E+00	mg/kg	SS-0102A	133/383	5.80E+03	3.90E+02	5.70E+03	3.90E+02
7440224	Silver	6.20E-02	2.18E+01	mg/kg	PE-18C-175A	72/398	5.80E+03	3.90E+02	5.70E+03	3.90E+02
7440235	Sodium	6.30E+00	2.25E+02	mg/kg	SS-18E51Z	16/44	NBA	NBA	NBA	NBA
7440280	Thallium	4.50E-01	1.70E+00	mg/kg	SS-18A28B	17/330	1.20E+01	7.80E-01	NBA	NBA
7440622	Vanadium	4.20E+00	1.01E+02	mg/kg	PE-18C187A	43/44	5.80E+03	3.90E+02	1.10E+03	7.80E+01
7440666	Zinc	1.50E+00	2.22E+03	mg/kg	SS-18G02B	214/319	3.50E+05	2.30E+04	1.10E+05	2.30E+04

[a] Number of sampling locations at which analyte was detected compared with total number of sampling locations; duplicates at a location were averaged and considered one sample.

[b] November 2017 RSL Table

[c] NJDEP, 2017

mg/kg = Milligrams per kilogram.

NA = Not applicable.

NBA = No benchmark available.

Shading indicates that the maximum detected concentration exceeded the screening level.

Table 4-2A
Additional Comparisons of Select Analytes to NJDEP Screening Criteria (Soil 0 to 10 ft bgs)
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Maximum Concentration	Location of Maximum Concentration	Detection Frequency[a]		Exposure Point Concentration[b]	NJDEP Soil Remediation Standards		Ratio of Maximum Detected Concentration to:		Ratio of EPC to:		Number of Exceedances[c]	
							Nonresidential	Residential	Nonresidential Soil SRS	Residential Soil SRS	Nonresidential Soil SRS	Residential Soil SRS	Nonresidential Soil SRS	Residential Soil SRS
PCBs														
11096825	Aroclor-1260	9.70E-01	TP-18E15A	4/222	2%	5.13E-02	1.00E+00	2.00E-01	0.97	4.9	0.051	0.26	0	4
PAHs														
56553	Benzo(a)anthracene	5.80E+01	TP-18C72A	116/280	41%	1.44E+00	1.70E+01	5.00E+00	3.4	12	0.08	0.29	1	4
50328	Benzo(a)pyrene	4.70E+01	TP-18C72A	115/280	41%	1.27E+00	2.00E+00	5.00E-01	24	94	0.63	2.5	9	36
205992	Benzo(b)fluoranthene	3.80E+01	TP-18C72A	118/280	42%	1.09E+00	1.70E+01	5.00E+00	2.2	7.6	0.064	0.22	1	3
53703	Dibenz(a,h)anthracene	1.00E+01	TP-18C72A	48/280	17%	2.58E-01	2.00E+00	5.00E-01	5.0	20	0.13	0.52	2	7
193395	Indeno(1,2,3-c,d)pyrene	2.60E+01	TP-18C72A	91/280	33%	5.00E-01	1.70E+01	5.00E+00	1.5	5.2	0.029	0.10	1	2
91203	Naphthalene	1.10E+01	TP-18C72A	20/281	7%	4.01E-01	1.70E+01	6.00E+00	0.65	1.8	0.024	0.067	0	2
Pesticides														
50293	4,4-DDT	3.80E+00	TP-18C72A	32/172	19%	1.36E-01	8.00E+00	2.00E+00	0.48	1.9	0.017	0.068	0	1
60571	Dieldrin	4.10E-02	TP-18C70B	2/173	1%	8.40E-03	2.00E-01	4.00E-02	0.21	1.0	0.042	0.21	0	1
VOCs/SVOCs														
67663	Chloroform	3.50E+00	TP-18E16A	2/354	1%	6.20E-03	2.00E+00	6.00E-01	1.8	5.8	0.0031	0.010	1	1
87865	Pentachlorophenol	4.80E+01	SS-18C41A	1/209	0.5%	2.00E+00	3.00E+00	9.00E-01	16	53	0.67	2.2	1	1
79016	Trichloroethylene	6.10E+00	SS-AOC2MIP05-07	63/395	16%	1.41E-01	1.00E+01	3.00E+00	0.6	2.0	0.014	0.047	0	1
Metals														
7440360	Antimony	2.42E+02	SS-18G01B	143/334	43%	3.92E+00	4.50E+02	3.10E+01	0.54	7.8	0.0087	0.13	0	2
7440382	Arsenic	4.88E+02	SS-18F21B	420/487	86%	2.16E+01	1.90E+01	1.90E+01	26	26	1.1	1.1	53	53
7439921	Lead	9.18E+03	SS-18F07B	489/516	95%	2.79E+02	8.00E+02	4.00E+02	11	23	0.35	0.70	20	29
7440622	Vanadium	1.01E+02	PE-18C187A	43/44	98%	3.62E+01	1.10E+03	7.80E+01	0.092	1.3	0.033	0.46	0	2

Units in milligrams per kilogram.

[a]Number of sampling locations at which analyte was detected compared with total number of sampling locations; duplicates at a location were averaged and considered one sample.

[b]See Table 6-5.

[c]Number of exceedances of screening criteria.

Shading indicates that the maximum detected concentration exceeded the screening level.

Table 4-3
Comparison of Site Arsenic with the Statewide Arsenic Background Level
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Statistic	EPA/GSA Area (Entire Area)*	EPA/GSA Area (Minus Investigation Areas 18E and 18F Railroad Track Samples)**
Mean:	13.6	4.7
Median:	3.1	2.1
Maximum:	488	111
90th Percentile:	20.1	8.7
95th Percentile:	80.1	13.8

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Units in mg/kg.

* Includes all soil data collected from the EPA/GSA Area with the expection of the soil data from the Asbestos Landfill, which is not being evaluated in this RI.
** Includes soil data collected from the EPA/GSA Area except for the data collected from the Asbestos Landfill and data collected along the former railroad tracks between former Buildings 202 and 203 at Investigation Areas 18E and 18F.

Table 4-4
Comparison of Site Surface Soil and Background Levels - Chromium
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Statistic	EPA/GSA Area (Entire Area)*	EPA/GSA Area (Minus Investigation Areas 18E and 18F Railroad Track Samples)**	NJ Background (BEM, 1998)
Mean:	25.4	11	18.7
Median:	10.1	8.3	11.8
Maximum:	685	175	171
90th Percentile:	39.0	18.9	34.7
95th Percentile:	94.9	25	39.8

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Units in mg/kg.

* Includes all soil data collected from the EPA/GSA Area with the expection of the soil data from the Asbestos Landfill, which is not being evaluated in this RI.

** Includes soil data collected from the EPA/GSA Area except for the data collected from the Asbestos Landfill and data collected along the former railroad tracks between former Buildings 202 and 203 at Investigation Areas 18E and 18F.

Table 4-5

Summary of Background Soil Levels of PAHs and Comparison with Site Levels
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Statistic	Benzo(a)pyrene	Benzo(a)anthracene	Benzo(b)fluoranthene	Benzo(b+j+k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Indeno(1,2,3-cd)pyrene
Statistic	**New Jersey Background Levels (BEM, 1998)**						
Mean:	0.14	0.14	0.35	0.35	0.15	0.030	0.070
Median:	0.020	0.040	0.19	0.19	0.050	0.010	0.010
Maximum:	1.8	1.8	4.1	4.1	1.8	0.29	0.57
90th Percentile:	0.42	0.43	0.66	0.66	0.47	0.020	0.23
95th Percentile:	0.67	0.57	1.2	1.2	0.70	0.13	0.37
Statistic	**EPA/GSA Area Levels (Surface Soil)***						
Mean:	0.43	0.41	0.49	0.42	0.47	0.35	0.38
Median:	0.36	0.36	0.36	0.36	0.36	0.36	0.36
Maximum:	3.3	2.7	4.9	3.1	3.1	2.0	2.5
90th Percentile:	0.93	0.7	1.1	0.85	1.0	0.42	0.61
95th Percentile:	1.3	1.4	2.0	1.4	1.7	0.46	0.89

Units in mg/kg.

* Includes all soil data collected from the EPA/GSA Area with the expection of the soil data from the Asbestos Landfill, which is not being evaluated in this RI.

Table 4-6
Point-by-Point Comparison to Human Health Screening Criteria - Soil (0 to 10 ft bgs)
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Analyte = Benzo(a)anthracene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	21	1.1	17	5
Area18A	Soil Sample	SS-18A01A	4/14/1994	0 - 0.5	1.8			X		
Area18A	Soil Sample	SS-18A02A	4/14/1994	0 - 0.5	2.6			X		
Area18A	Soil Sample	SS-18A33A	4/25/1996	0 - 0.5	1.3			X		
Area18C	Soil Sample	SS-18C12A	5/14/1996	0 - 0.5	1.4	J		X		
Area18C	Test Pit	TP-18C65A	7/8/1996	3.5 - 4	1.3			X		
Area18C	Test Pit	TP-18C71A	7/9/1996	3.5 - 4	5.9	J		X		X
Area18C	Test Pit	TP-18C151A	7/9/1996	3.5 - 4	1.8	J		X		
Area18C	Test Pit	TP-18C72A	7/9/1996	5.5 - 6	58		X	X	X	X
Area18C	Test Pit	TP-18C75A	7/11/1996	3.5 - 4	6.7			X		X
Area18C-DDA	Recovery well	PE-18C404A	3/25/1998	7 - 7.5	1.4	J		X		
Area18G	Soil Sample	SS-18G02B	5/17/1996	8.5 - 9	10			X		X
Area18G	Soil Sample	SS-18G13A	5/3/1996	0 - 0.5	2.3			X		
Area18G	Soil Sample	SS-18G14A	5/3/1996	0 - 0.5	2.2			X		
Area18G	Soil Sample	SS-18G15A	5/3/1996	0 - 0.5	2.7			X		
Area18G	Soil Sample	SS-18G17A	5/3/1996	0 - 0.5	1.9			X		
Area18G	Soil Sample	SS-18G18Z	5/6/1996	1 - 1.5	2.1			X		
Area18G	Soil Sample	SS-18G19A	5/6/1996	0 - 0.5	1.2			X		
Analyte = Benzo(a)pyrene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	2.1	0.11	2	0.5
Area1	Soil Sample	SS-0101A	8/5/1994	0 - 0.5	0.14	J		X		
Area1	Soil Sample	SS-0103A	8/5/1994	0 - 0.5	0.12	J		X		
Area18A	Soil Sample	SS-18A01A	4/14/1994	0 - 0.5	2.2		X	X	X	X
Area18A	Soil Sample	SS-18A02A	4/14/1994	0 - 0.5	2.7		X	X	X	X
Area18A	Soil Sample	SS-18A03A	4/14/1994	0 - 0.5	0.67			X		X
Area18A	Soil Sample	SS-18A04A	4/14/1994	0 - 0.5	0.82			X		X
Area18A	Soil Sample	SS-18A05A	5/2/1994	0 - 0.5	0.15	J		X		
Area18A	Soil Sample	SS-18A07A	5/4/1994	0 - 0.5	0.19	J		X		
Area18A	Soil Sample	SS-18A10A	5/2/1994	0 - 0.5	0.54			X		X
Area18A	Soil Sample	SS-18A23A	5/5/1994	0 - 0.5	0.29	J		X		
Area18A	Soil Sample	SS-18A24A	5/3/1994	0 - 0.5	0.14	J		X		
Area18A	Soil Sample	SS-18A30A	4/25/1996	0 - 0.5	0.21	J		X		
Area18A	Soil Sample	SS-18A31A	4/25/1996	0 - 0.5	0.34	J		X		
Area18A	Soil Sample	SS-18A32A	4/25/1996	0 - 0.5	0.23	J		X		
Area18A	Soil Sample	SS-18A33A	4/25/1996	0 - 0.5	1.3			X		X
Area18B	Soil Sample	SS-18B05A	5/9/1996	0 - 0.5	0.3	J		X		
Area18B	Soil Sample	SS-18B05B	5/14/1996	1 - 1.5	0.62			X		X
Area18B	Soil Sample	SS-18B05C	5/14/1996	3 - 3.5	0.34	J		X		
Area18B	Soil Sample	SS-18B06A	5/7/1996	0 - 0.5	0.21	J		X		
Area18B	Soil Sample	SS-18B07A	5/7/1996	0 - 0.5	1.1			X		X
Area18B	Soil Sample	SS-18B09A	5/6/1996	0 - 0.5	0.52			X		X
Area18B	Soil Sample	SS-18B10A	5/8/1996	0 - 0.5	0.33	J		X		
Area18B	Soil Sample	SS-18B11A	5/8/1996	0 - 0.5	0.2	J		X		
Area18B	Soil Sample	SS-18B13A	5/8/1996	0 - 0.5	0.13	J		X		
Area18B	Soil Sample	SS18B81	7/19/2005	0 - 0.5	0.13	J		X		
Area18C	Soil Sample	SS-18C11A	5/14/1996	0 - 0.5	0.14	J		X		
Area18C	Soil Sample	SS-18C12A	5/14/1996	0 - 0.5	1.1	J		X		X
Area18C	Soil Sample	SS-18C46A	5/14/1996	0 - 0.5	0.49	J		X		
Area18C	Soil Sample	SS-18C20A	5/2/1996	0 - 0.5	0.12	J		X		
Area18C	Soil Sample	SS-18C44A	5/2/1996	0 - 0.5	0.18	J		X		
Area18C	Soil Sample	SS-18C35A	7/18/1996	0 - 0.5	0.34	J		X		
Area18C	Soil Sample	SS-18C37A	7/16/1996	0 - 0.5	0.46			X		
Area18C	Soil Sample	SS-18C38A	7/18/1996	0 - 0.5	0.12	J		X		
Area18C	Soil Sample	SS-18C38B	7/18/1996	4 - 4.5	0.3	J		X		
Area18C	Soil Sample	SS-18C41A	7/17/1996	0 - 0.5	0.13	J		X		
Area18C	Test Pit	TP-18C55A	7/2/1996	3 - 3.5	0.52			X		X
Area18C	Test Pit	TP-18C55C	7/2/1996	9.5 - 10	0.7			X		X
Area18C	Test Pit	TP-18C56A	7/2/1996	1.5 - 2	0.26	J		X		
Area18C	Test Pit	TP-18C57A	7/3/1996	1.5 - 2	0.41			X		
Area18C	Test Pit	TP-18C62A	7/1/1996	4 - 4.5	0.16	J		X		
Area18C	Test Pit	TP-18C65A	7/8/1996	3.5 - 4	1.2			X		X
Area18C	Test Pit	TP-18C66A	7/3/1996	3 - 3.5	0.13	J		X		
Area18C	Test Pit	TP-18C70A	7/8/1996	3 - 3.5	0.32	J		X		
Area18C	Test Pit	TP-18C70B	7/8/1996	3.5 - 4	0.45			X		
Area18C	Test Pit	TP-18C71A	7/9/1996	3.5 - 4	5.2	J	X	X	X	X
Area18C	Test Pit	TP-18C151A	7/9/1996	3.5 - 4	1.7	J		X		X
Area18C	Test Pit	TP-18C72A	7/9/1996	5.5 - 6	47		X	X	X	X
Area18C	Test Pit	TP-18C73A	7/10/1996	1.5 - 2	0.21	J		X		
Area18C	Test Pit	TP-18C75A	7/11/1996	3.5 - 4	6.4		X	X	X	X

RSL = Regional Screening Level
SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value, potentially unreliable concentration
U = not detected

Table 4-6
Point-by-Point Comparison to Human Health Screening Criteria - Soil (0 to 10 ft bgs)
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Analyte = Benzo(a)pyrene (continued)				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	2.1	0.11	2	0.5
Area18C	Test Pit	TP-18C153B	7/11/1996	6.5 - 7	0.22	J		X		
Area18C-256	Remediation Floor Excavat	SA-18C-01	11/4/1997	0 - 0.5	0.68			X		X
Area18C-DDA	Recovery well	PE-18C223A	11/15/2002	5.5 - 6	0.42			X		
Area18C-DDA	Recovery well	PE-18C404A	3/25/1998	7 - 7.5	1.7	J		X		X
Area18G	Soil Sample	SS-18G01A	5/23/1996	1.5 - 2	0.77			X		X
Area18G	Soil Sample	SS-18G02B	5/17/1996	8.5 - 9	13		X	X	X	X
Area18G	Soil Sample	SS-18G03A	5/16/1996	0 - 0.5	0.13	J		X		
Area18G	Soil Sample	SS-18G03B	5/16/1996	3.5 - 4	0.23	J		X		
Area18G	Soil Sample	SS-18G04A	5/17/1996	0 - 0.5	1.2			X		X
Area18G	Soil Sample	SS-18G04B	5/17/1996	5 - 5.5	0.2	J		X		
Area18G	Soil Sample	SS-18G06A	5/2/1996	0 - 0.5	1			X		X
Area18G	Soil Sample	SS-18G07A	5/2/1996	0 - 0.5	0.2	J		X		
Area18G	Soil Sample	SS-18G08A	5/2/1996	0 - 0.5	0.17	J		X		
Area18G	Soil Sample	SS-18G10A	5/3/1996	0 - 0.5	1.1			X		X
Area18G	Soil Sample	SS-18G13A	5/3/1996	0 - 0.5	1.8			X		X
Area18G	Soil Sample	SS-18G14A	5/3/1996	0 - 0.5	2.8		X	X	X	X
Area18G	Soil Sample	SS-18G15A	5/3/1996	0 - 0.5	3.3		X	X	X	X
Area18G	Soil Sample	SS-18G15B	5/3/1996	1.5 - 2	0.7			X		X
Area18G	Soil Sample	SS-18G16A	5/3/1996	0 - 0.5	0.94			X		X
Area18G	Soil Sample	SS-18G17A	5/3/1996	0 - 0.5	1.7			X		X
Area18G	Soil Sample	SS-18G18Z	5/6/1996	1 - 1.5	2.2		X	X	X	X
Area18G	Soil Sample	SS-18G18A	5/3/1996	0 - 0.5	0.93			X		X
Area18G	Soil Sample	SS-18G18B	5/3/1996	1.5 - 2	0.59			X		X
Area18G	Soil Sample	SS-18G22A	5/3/1996	1.5 - 2	0.77			X		X
Area18G	Soil Sample	SS-18G19A	5/6/1996	0 - 0.5	1.2			X		X
Area18G	Soil Sample	SS-18G20A	5/6/1996	0 - 0.5	0.86			X		X
Analyte = Benzo(b)fluoranthene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	21	1.1	17	5
Area18A	Soil Sample	SS-18A01A	4/14/1994	0 - 0.5	2.3			X		
Area18A	Soil Sample	SS-18A02A	4/14/1994	0 - 0.5	2.5			X		
Area18A	Soil Sample	SS-18A33A	4/25/1996	0 - 0.5	1.2			X		
Area18B	Soil Sample	SS-18B07A	5/7/1996	0 - 0.5	1.3			X		
Area18C	Soil Sample	SS-18C12A	5/14/1996	0 - 0.5	1.7	J		X		
Area18C	Test Pit	TP-18C71A	7/9/1996	3.5 - 4	3.9	J		X		
Area18C	Test Pit	TP-18C151A	7/9/1996	3.5 - 4	1.3	J		X		
Area18C	Test Pit	TP-18C72A	7/9/1996	5.5 - 6	38		X	X	X	X
Area18C	Test Pit	TP-18C75A	7/11/1996	3.5 - 4	5.6			X		X
Area18C-DDA	Recovery well	PE-18C404A	3/25/1998	7 - 7.5	1.5	J		X		
Area18G	Soil Sample	SS-18G02B	5/17/1996	8.5 - 9	7.2			X		X
Area18G	Soil Sample	SS-18G10A	5/3/1996	0 - 0.5	2.1			X		
Area18G	Soil Sample	SS-18G13A	5/3/1996	0 - 0.5	2.1			X		
Area18G	Soil Sample	SS-18G14A	5/3/1996	0 - 0.5	4.9			X		
Area18G	Soil Sample	SS-18G15A	5/3/1996	0 - 0.5	3.6			X		
Area18G	Soil Sample	SS-18G16A	5/3/1996	0 - 0.5	1.4			X		
Area18G	Soil Sample	SS-18G17A	5/3/1996	0 - 0.5	1.9			X		
Area18G	Soil Sample	SS-18G18Z	5/6/1996	1 - 1.5	3.2			X		
Area18G	Soil Sample	SS-18G18A	5/3/1996	0 - 0.5	1.2			X		
Area18G	Soil Sample	SS-18G18B	5/3/1996	1.5 - 2	1.2			X		
Area18G	Soil Sample	SS-18G19A	5/6/1996	0 - 0.5	1.6			X		
Area18G	Soil Sample	SS-18G20A	5/6/1996	0 - 0.5	2.4			X		
Analyte = Benzo(k)fluoranthene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	210	11	170	45
Area18C	Test Pit	TP-18C72A	7/9/1996	5.5 - 6	41			X		
Analyte = Dibenz(a,h)anthracene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	2.1	0.11	2	0.5
Area18A	Soil Sample	SS-18A01A	4/14/1994	0 - 0.5	0.47			X		
Area18A	Soil Sample	SS-18A02A	4/14/1994	0 - 0.5	0.73			X		X
Area18A	Soil Sample	SS-18A03A	4/14/1994	0 - 0.5	0.18	J		X		
Area18A	Soil Sample	SS-18A04A	4/14/1994	0 - 0.5	0.26	J		X		
Area18A	Soil Sample	SS-18A10A	5/2/1994	0 - 0.5	0.12	J		X		
Area18A	Soil Sample	SS-18A33A	4/25/1996	0 - 0.5	0.28	J		X		
Area18B	Soil Sample	SS-18B07A	5/7/1996	0 - 0.5	0.24	J		X		
Area18B	Soil Sample	SS-18B09A	5/6/1996	0 - 0.5	0.13	J		X		
Area18C	Soil Sample	SS-18C12A	5/14/1996	0 - 0.5	0.29	J		X		
Area18C	Soil Sample	SS-18C37A	7/16/1996	0 - 0.5	0.13	J		X		
Area18C	Test Pit	TP-18C55C	7/2/1996	9.5 - 10	0.13	J		X		

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SRS = Soil Remediation Standard
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U = not detected

Table 4-6
Point-by-Point Comparison to Human Health Screening Criteria - Soil (0 to 10 ft bgs)
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Analyte = Dibenz(a,h)anthracene (continued)				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	2.1	0.11	2	0.5
Area18C	Test Pit	TP-18C65A	7/8/1996	3.5 - 4	0.23	J		X		
Area18C	Test Pit	TP-18C71A	7/9/1996	3.5 - 4	1	J		X		X
Area18C	Test Pit	TP-18C151A	7/9/1996	3.5 - 4	0.32	J		X		
Area18C	Test Pit	TP-18C72A	7/9/1996	5.5 - 6	10		X	X	X	X
Area18C	Test Pit	TP-18C75A	7/11/1996	3.5 - 4	1.4			X		X
Area18C-DDA	Recovery well	PE-18C404A	3/25/1998	7 - 7.5	0.32	J		X		
Area18G	Soil Sample	SS-18G01A	5/23/1996	1.5 - 2	0.22	J		X		
Area18G	Soil Sample	SS-18G02B	5/17/1996	8.5 - 9	2.4		X	X	X	X
Area18G	Soil Sample	SS-18G04A	5/17/1996	0 - 0.5	0.28	J		X		
Area18G	Soil Sample	SS-18G06A	5/2/1996	0 - 0.5	0.39			X		
Area18G	Soil Sample	SS-18G10A	5/3/1996	0 - 0.5	0.44			X		
Area18G	Soil Sample	SS-18G13A	5/3/1996	0 - 0.5	0.33	J		X		
Area18G	Soil Sample	SS-18G14A	5/3/1996	0 - 0.5	0.93			X		X
Area18G	Soil Sample	SS-18G15A	5/3/1996	0 - 0.5	0.83			X		X
Area18G	Soil Sample	SS-18G16A	5/3/1996	0 - 0.5	0.34	J		X		
Area18G	Soil Sample	SS-18G17A	5/3/1996	0 - 0.5	0.32	J		X		
Area18G	Soil Sample	SS-18G18Z	5/6/1996	1 - 1.5	0.28	J		X		
Area18G	Soil Sample	SS-18G18A	5/3/1996	0 - 0.5	0.21	J		X		
Area18G	Soil Sample	SS-18G22A	5/3/1996	1.5 - 2	0.14	J		X		
Area18G	Soil Sample	SS-18G19A	5/6/1996	0 - 0.5	0.22	J		X		
Area18G	Soil Sample	SS-18G20A	5/6/1996	0 - 0.5	0.24	J		X		
Analyte = Indeno(1,2,3-cd)pyrene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	21	1.1	17	5
Area18A	Soil Sample	SS-18A01A	4/14/1994	0 - 0.5	1.6			X		
Area18A	Soil Sample	SS-18A02A	4/14/1994	0 - 0.5	1.7			X		
Area18C	Test Pit	TP-18C71A	7/9/1996	3.5 - 4	2.8	J		X		
Area18C	Test Pit	TP-18C72A	7/9/1996	5.5 - 6	26		X	X	X	X
Area18C	Test Pit	TP-18C75A	7/11/1996	3.5 - 4	3.2			X		
Area18G	Soil Sample	SS-18G02B	5/17/1996	8.5 - 9	5.6			X		X
Area18G	Soil Sample	SS-18G10A	5/3/1996	0 - 0.5	1.2			X		
Area18G	Soil Sample	SS-18G14A	5/3/1996	0 - 0.5	2.5			X		
Area18G	Soil Sample	SS-18G15A	5/3/1996	0 - 0.5	2.1			X		
Analyte = Naphthalene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	17	3.8	17	6
Area18A	Soil Sample	TP-18A08A	6/5/1996	3.5 - 4	8.4			X		X
Area18C	Test Pit	TP-18C72A	7/9/1996	5.5 - 6	11			X		X
Analyte = 4,4-DDT				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	8.5	1.9	8	2
Area18C	Test Pit	TP-18C72A	7/9/1996	5.5 - 6	3.8			X		X
Analyte = Dieldrin				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	0.14	0.034	0.2	0.04
Area18C	Test Pit	TP-18C70B	7/8/1996	3.5 - 4	0.041			X		X
Analyte = Aroclor-1260				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	0.99	0.24	1	0.2
Area18A	Soil Sample	SS-18A04A	4/14/1994	0 - 0.5	0.47			X		X
Area18C	Test Pit	TP-18C71A	7/9/1996	3.5 - 4	0.37			X		X
Area18C	Test Pit	TP-18C151A	7/9/1996	3.5 - 4	0.25			X		X
Area18E	Test Pit	TP-18E13A	10/28/1997	4 - 4.5	0.31			X		X
Area18E	Test Pit	TP-18E15A	10/28/1997	5 - 5.5	0.97			X		X
Analyte = Chloroform				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	1.4	0.32	2	0.6
Area18E	Test Pit	TP-18E16A	10/28/1997	5.5 - 6	3.5		X	X	X	X
Analyte = Ethylbenzene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	25	5.8	110000	7800
Area18A	Soil Sample	TP-18A08A	6/5/1996	3.5 - 4	10	J		X		
Area18C	Test Pit	TP-18C58B	6/28/1996	9.5 - 10	8.8			X		
Analyte = Pentachlorophenol				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	4	1	3	0.9
Area18C	Soil Sample	SS-18C41A	7/17/1996	0 - 0.5	48		X	X	X	X
Area18C	Soil Sample	SS-18C67A	7/17/1996	0 - 0.5	19	J	X	X	X	X

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SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value, potentially unreliable concentration
U = not detected

Table 4-6
Point-by-Point Comparison to Human Health Screening Criteria - Soil (0 to 10 ft bgs)
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Analyte = Trichloroethylene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	6	0.94	10	3
Area18C	Soil Sample	SS-18C107A	9/2/1999	0 - 0.5	1.5			X		
Area18E	Test Pit	TP-18E16A	10/28/1997	5.5 - 6	2.1			X		
Area18C	Geoprobe boring	SS-AOC2MIP05-07	10/27/2004	7 - 7.5	6.1		X	X		X
Analyte = Vinyl chloride				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	1.7	0.059	2	0.7
Area18A	Soil Sample	TP-18A08A	6/5/1996	3.5 - 4	0.48	J		X		
Analyte = Antimony				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	470	31	450	31
Area18F	Soil Sample	SS-18F07A	5/6/1996	0 - 0.5	89.7			X		X
Area18G	Soil Sample	SS-18G01B	5/23/1996	6 - 6.5	242			X		X
Analyte = Arsenic				Sample Interval	Result				NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier			19	19
Area18B	Soil Sample	SS-18B23A	4/26/1996	0 - 0.5	22.3				X	X
Area18C	Soil Sample	SS-18C14B	4/30/1996	1.5 - 2	111				X	X
Area18C	Soil Sample	SS-18C28A	4/30/1996	0 - 0.5	94.8				X	X
Area18C	Soil Sample	SS-18C29A	4/30/1996	0 - 0.5	28.4				X	X
Area18E	Soil Sample	SS-18E08A	10/3/1997	0 - 0.5	95.2				X	X
Area18E	Soil Sample	SS-18E201A	10/3/1997	0 - 0.5	101				X	X
Area18E	Soil boring	SS-18E102A	8/12/2009	4 - 4.5	69.6				X	X
Area18E	Soil boring	SS-18E123A	8/20/2009	0 - 0.5	260				X	X
Area18E	Soil boring	SS-18E123B	8/20/2009	3.5 - 4	138				X	X
Area18E	Soil boring	SS-18E123C	8/20/2009	5 - 5.5	236				X	X
Area18E	Soil boring	SS-18E123Z	8/20/2009	0 - 0.5	176				X	X
Area18E	Test Pit	TP-18E13A	10/28/1997	4 - 4.5	103				X	X
Area18E	Soil Sample	SS-18E138B	12/22/2009	6 - 6.5	35.9				X	X
Area18E	Test Pit	TP-18E15A	10/28/1997	5 - 5.5	101				X	X
Area18E	Geoprobe boring	SS-18E47A	10/25/2004	4 - 4.5	29.9				X	X
Area18E	Soil Sample	AREA1-1	12/13/2011	4 - 4.5	32.5				X	X
Area18E	Soil Sample	AREA1-2	12/13/2011	3.5 - 4	61.4				X	X
Area18E	Soil Sample	AREA1-3	12/13/2011	3.5 - 4	28.0				X	X
Area18E	Soil Sample	AREA1-4	12/13/2011	3.5 - 4	39.5				X	X
Area18E	Soil Sample	AREA1-5	12/13/2011	4 - 4.5	21.1				X	X
Area18E	Soil Sample	AREA1-E-1	12/13/2011	4 - 4.5	24.4				X	X
Area18E	Soil Sample	AREA1-6	12/13/2011	4 - 4.5	51.7				X	X
Area18E	Soil Sample	AREA1-7	12/13/2011	4 - 4.5	35.8				X	X
Area18E	Soil Sample	AREA1-8	12/13/2011	4 - 4.5	29.8				X	X
Area18E	Soil Sample	AREA1-E-2	12/13/2011	4 - 4.5	25.1				X	X
Area18F	Soil Sample	SS-18F01A	5/14/1996	0 - 0.5	37.1				X	X
Area18F	Soil Sample	SS-18F01B	5/14/1996	1.5 - 2	43.9				X	X
Area18F	Soil Sample	SS-18F02A	5/14/1996	0 - 0.5	20.1				X	X
Area18F	Soil Sample	SS-18F02B	5/14/1996	1.5 - 2	83.9				X	X
Area18F	Soil Sample	SS-18F03A	5/7/1996	0 - 0.5	57.10				X	X
Area18F	Soil Sample	SS-18F03B	5/7/1996	1.5 - 2	151				X	X
Area18F	Soil Sample	SS-18F05B	5/6/1996	1.5 - 2	83				X	X
Area18F	Soil Sample	SS-18F19B	5/6/1996	1.5 - 2	77.7				X	X
Area18F	Soil Sample	SS-18F06B	5/6/1996	1.5 - 2	207				X	X
Area18F	Soil Sample	SS-18F07B	5/6/1996	1.5 - 2	409				X	X
Area18F	Soil Sample	SS-18F09A	5/6/1996	0 - 0.5	185				X	X
Area18F	Soil Sample	SS-18F10A	5/14/1996	0 - 0.5	119				X	X
Area18F	Soil Sample	SS-18F10B	5/14/1996	1.5 - 2	216				X	X
Area18F	Soil Sample	SS-18F11A	5/14/1996	0 - 0.5	54.5				X	X
Area18F	Soil Sample	SS-18F11B	5/14/1996	1.5 - 2	120				X	X
Area18F	Soil Sample	SS-18F12A	5/7/1996	0 - 0.5	42.3				X	X
Area18F	Soil Sample	SS-18F12B	5/7/1996	1.5 - 2	170				X	X
Area18F	Soil Sample	SS-18F13B	5/7/1996	1.5 - 2	49.4				X	X
Area18F	Soil Sample	SS-18F17B	5/7/1996	1.5 - 2	175				X	X
Area18F	Soil Sample	SS-18F18A	5/7/1996	0 - 0.5	121				X	X
Area18F	Soil Sample	SS-18F21A	8/13/1999	0 - 0.5	80.1				X	X
Area18F	Soil Sample	SS-18F21B	9/7/1999	1.5 - 2	488				X	X
Area18F	Soil Sample	SS-18F22A	8/13/1999	0 - 0.5	99.4				X	X
Area18F	Soil Sample	SS-18F22B	9/7/1999	1.5 - 2	69				X	X
Area18F	Soil Sample	SS-18F23A	8/13/1999	0 - 0.5	84.8				X	X
Area18F	Soil Sample	SS-18F23B	8/13/1999	1.5 - 2	147				X	X
Area18F	Soil Sample	SS-18F24A	8/13/1999	0 - 0.5	27				X	X
Area18G	Soil Sample	SS-18G18Z	5/6/1996	1 - 1.5	21.2				X	X

RSL = Regional Screening Level
SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value, potentially unreliable concentration
U = not detected

Table 4-6
Point-by-Point Comparison to Human Health Screening Criteria - Soil (0 to 10 ft bgs)
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Analyte = Lead				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	800	400	800	400
Area18A	Soil Sample	SS-18A02A	4/14/1994	0 - 0.5	576	J		X		X
Area18A	Soil Sample	SS-18A04A	4/14/1994	0 - 0.5	1800		X	X	X	X
Area18B	Soil Sample	SS-18B25A	4/26/1996	0 - 0.5	416			X		X
Area18B	Test Pit	TP-18B69B	8/30/1999	1.5 - 2	1000		X	X	X	X
Area18C	Test Pit	TP-18C70B	7/8/1996	3.5 - 4	576	J		X		X
Area18C	Test Pit	TP-18C72A	7/9/1996	5.5 - 6	461	J		X		X
Area18E	Soil Sample	SS-18E08A	10/3/1997	0 - 0.5	3890		X	X	X	X
Area18E	Soil Sample	SS-18E201A	10/3/1997	0 - 0.5	3780		X	X	X	X
Area18E	Test Pit	TP-18E13A	10/28/1997	4 - 4.5	1470		X	X	X	X
Area18E	Test Pit	TP-18E15A	10/28/1997	5 - 5.5	2300		X	X	X	X
Area18F	Soil Sample	SS-18F03A	5/7/1996	0 - 0.5	649	J		X		X
Area18F	Soil Sample	SS-18F04A	5/6/1996	0 - 0.5	1170		X	X	X	X
Area18F	Soil Sample	SS-18F05B	5/6/1996	1.5 - 2	898		X	X	X	X
Area18F	Soil Sample	SS-18F06B	5/6/1996	1.5 - 2	2830		X	X	X	X
Area18F	Soil Sample	SS-18F07A	5/6/1996	0 - 0.5	1070		X	X	X	X
Area18F	Soil Sample	SS-18F07B	5/6/1996	1.5 - 2	9180		X	X	X	X
Area18F	Soil Sample	SS-18F09A	5/6/1996	0 - 0.5	3460		X	X	X	X
Area18F	Soil Sample	SS-18F10A	5/14/1996	0 - 0.5	1520		X	X	X	X
Area18F	Soil Sample	SS-18F10B	5/14/1996	1.5 - 2	1340		X	X	X	X
Area18F	Soil Sample	SS-18F11B	5/14/1996	1.5 - 2	702			X		X
Area18F	Soil Sample	SS-18F13A	5/7/1996	0 - 0.5	428	J		X		X
Area18F	Soil Sample	SS-18F16A	5/7/1996	0 - 0.5	491	J		X		X
Area18F	Soil Sample	SS-18F16B	5/7/1996	1.5 - 2	451	J		X		X
Area18F	Soil Sample	SS-18F17B	5/7/1996	1.5 - 2	1190	J	X	X	X	X
Area18F	Soil Sample	SS-18F18A	5/7/1996	0 - 0.5	1550	J	X	X	X	X
Area18F	Soil Sample	SS-18F23A	8/13/1999	0 - 0.5	1620		X	X	X	X
Area18F	Soil Sample	SS-18F23B	8/13/1999	1.5 - 2	2190		X	X	X	X
Area18G	Soil Sample	SS-18G01B	5/23/1996	6 - 6.5	1470		X	X	X	X
Area18G	Soil Sample	SS-18G02B	5/17/1996	8.5 - 9	2470		X	X	X	X
Analyte = Thallium				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential		
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	12	0.78		
Area18A	Soil Sample	SS-18A28B	4/15/1994	4.5 - 6	1.7	J		X		
Area18E	Soil Sample	SS-18E02A	10/2/1997	0 - 0.5	0.8			X		
Area18E	Soil Sample	SS-18E09A	10/3/1997	0 - 0.5	1.2			X		
Area18E	Soil Sample	SS-18E11	10/24/1997	1.5 - 2	1.2			X		
Area18E	Test Pit	TP-18E13A	10/28/1997	4 - 4.5	1			X		
Analyte = Vanadium				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	5800	390	1100	78
Area18C-DDA	Recovery well	PE-18C187A	10/21/2002	6.5 - 7	101					X
Area18C-DDA	Remediation Floor Excavat	PE-18C191A	10/21/2002	6.5 - 7	95					X

RSL = Regional Screening Level
SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value, potentially unreliable concentration
U = not detected

Table 4-7
Summary of Analytes Detected in Deep Soil (>10 ft bgs) and Comparison to Human Health Screening Criteria
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Sample Interval (ft)	Detection Frequency[a]	EPA Regional Screening Screening Levels[b] Industrial Soil	EPA Regional Screening Screening Levels[b] Residential Soil	NJDEP[c] Soil Remediation Standards Industrial Soil	NJDEP[c] Soil Remediation Standards Residential Soil
83329	Acenaphthene	2.80E-02	7.40E+00	mg/kg	SS-18G03C	16.6 - 17.1	8/56	4.50E+04	3.60E+03	3.70E+04	3.40E+03
208968	Acenaphthylene	4.80E-02	2.50E+00	mg/kg	SS-18G03C	16.6 - 17.1	2/56	4.50E+04	3.60E+03	3.00E+05	NBA
67641	Acetone	1.30E-02	2.30E-01	mg/kg	18C247B	21 - 21.5	25/221	6.70E+05	6.10E+04	NBA	7.00E+04
120127	Anthracene	2.60E-02	3.00E+01	mg/kg	SS-18G03C	16.6 - 17.1	5/56	2.30E+05	1.80E+04	3.00E+04	1.70E+04
11097691	Aroclor-1254	5.90E-02	6.70E-02	mg/kg	SS-18E200A	10 - 10.5	1/63	9.70E-01	2.40E-01	1.00E+00	2.00E-01
71432	Benzene	1.00E-03	1.50E-01	mg/kg	18C245B-27.5-28.0	22.5 - 23	4/220	5.10E+00	1.20E+00	5.00E+00	2.00E+00
56553	Benzo(a)anthracene	2.00E-02	4.00E+01	mg/kg	SS-18G03C	16.6 - 17.1	9/56	2.10E+01	1.10E+00	1.70E+01	5.00E+00
50328	Benzo(a)pyrene	4.00E-02	3.50E+01	mg/kg	SS-18G03C	16.6 - 17.1	5/56	2.10E+00	1.10E-01	2.00E+00	5.00E-01
205992	Benzo(b)fluoranthene	4.50E-02	2.70E+01	mg/kg	SS-18G03C	16.6 - 17.1	5/56	2.10E+01	1.10E+00	1.70E+01	5.00E+00
191242	Benzo(g,h,i)perylene	7.50E-01	2.00E+01	mg/kg	SS-18G03C	16.6 - 17.1	2/56	NBA	NBA	3.00E+04	3.80E+05
207089	Benzo(k)fluoranthene	2.60E-02	3.00E+01	mg/kg	SS-18G03C	16.6 - 17.1	5/56	2.10E+02	1.10E+01	1.70E+02	4.50E+01
75252	Bromoform	8.00E-04	1.10E-03	mg/kg	PE-18C232A	27.5 - 28	2/220	8.60E+01	1.90E+01	2.80E+02	8.10E+01
78933	2-Butanone	1.00E-03	1.40E-02	mg/kg	PE-18C3307A	12 - 12.5	5/220	1.90E+05	2.70E+04	4.40E+04	3.10E+03
135988	sec-Butylbenzene	7.60E-02	1.40E+00	mg/kg	18C245B-18.5-19.0	27.5 - 28	2/42	1.20E+05	7.80E+03	NBA	NBA
98066	tert-Butylbenzene	2.20E-01	2.20E-01	mg/kg	18C245B-18.5-19.0	27.5 - 28	1/42	1.20E+05	7.80E+03	NBA	NBA
86748	Carbazole	2.40E-01	2.00E+01	mg/kg	SS-18G03C	16.6 - 17.1	2/47	NBA	NBA	9.60E+01	2.40E+01
75150	Carbon disulfide	8.00E-04	4.70E-02	mg/kg	SS-AOC2TS02-38.0	38 - 40	14/220	3.50E+03	7.70E+02	1.10E+05	7.80E+03
74873	Chloromethane	3.00E-03	4.10E-03	mg/kg	PE-18C200A	12 - 12.5	3/220	4.60E+02	1.10E+02	1.20E+01	4.00E+00
218019	Chrysene	3.50E-02	3.80E+01	mg/kg	SS-18G03C	16.6 - 17.1	9/56	2.10E+03	1.10E+02	1.70E+03	4.50E+02
53703	Dibenz(a,h)anthracene	4.40E-02	6.80E+00	mg/kg	SS-18G03C	16.6 - 17.1	3/56	2.10E+00	1.10E-01	2.00E+00	5.00E-01
132649	Dibenzofuran	9.50E-02	9.60E+00	mg/kg	SS-18G03C	16.6 - 17.1	5/52	1.00E+03	7.30E+01	NBA	NBA
75354	1,1-Dichloroethene	2.00E-03	8.30E-01	mg/kg	18C245B-27.5-28.0	22.5 - 23	2/220	1.00E+03	2.30E+02	1.50E+02	1.10E+01
540590	1,2-Dichloroethene	2.70E-03	7.90E-01	mg/kg	TP-18C79A	11 - 11.5	6/42	2.30E+03	1.60E+02	5.60E+02	2.30E+02
156592	cis-1,2-Dichloroethene	1.00E-03	6.70E+01	mg/kg	18C245B-27.5-28.0	22.5 - 23	86/179	2.30E+03	1.60E+02	5.60E+02	2.30E+02
156605	trans-1,2-Dichloroethene	6.00E-04	1.00E+00	mg/kg	18C245B-27.5-28.0	22.5 - 23	9/178	2.30E+04	1.60E+03	7.20E+02	3.00E+02
100414	Ethylbenzene	1.40E-03	1.40E+01	mg/kg	PE-18A215A	10 - 10.5	16/221	2.50E+01	5.80E+00	1.10E+05	7.80E+03
206440	Fluoranthene	1.20E-02	1.00E+02	mg/kg	SS-18G03C	16.6 - 17.1	14/56	3.00E+04	2.40E+03	2.40E+04	2.30E+03
86737	Fluorene	5.50E-02	1.80E+01	mg/kg	SS-18G03C	16.6 - 17.1	8/56	3.00E+04	2.40E+03	2.40E+04	2.30E+03
193395	Indeno(1,2,3-c,d)pyrene	3.30E-02	1.80E+01	mg/kg	SS-18G03C	16.6 - 17.1	3/56	2.10E+01	1.10E+00	1.70E+01	5.00E+00
98828	Isopropylbenzene	1.20E-01	3.90E-01	mg/kg	18C245B-18.5-19.0	27.5 - 28	2/47	9.90E+03	1.90E+03	NBA	NBA
99876	4-Isopropyltoluene	1.00E-02	1.40E+00	mg/kg	18C245B-18.5-19.0	27.5 - 28	3/42	NBA	NBA	NBA	NBA
75092	Methylene chloride	1.40E-03	5.80E-03	mg/kg	SS-18E100C	10 - 10.5	3/221	1.00E+03	5.70E+01	2.30E+02	4.60E+01
91576	2-Methylnaphthalene	3.80E-02	9.00E+00	mg/kg	PE-18A215A	10 - 10.5	9/52	3.00E+03	2.40E+02	2.40E+03	2.30E+02
108101	4-Methyl-2-pentanone	5.70E-02	5.70E-02	mg/kg	PE-18C3307A	12 - 12.5	1/220	1.40E+05	3.30E+04	NBA	NBA
91203	Naphthalene	4.70E-02	1.30E+01	mg/kg	PE-18A215A	10 - 10.5	11/98	1.70E+01	3.80E+00	1.70E+01	6.00E+00
87865	Pentachlorophenol	8.00E-02	8.00E-02	mg/kg	SS-18C41C	12 - 12.5	1/48	4.00E+00	1.00E+00	3.00E+00	9.00E-01
85018	Phenanthrene	1.00E-02	1.20E+02	mg/kg	SS-18G03C	16.6 - 17.1	14/56	NBA	NBA	3.00E+05	NBA
108952	Phenol	2.40E-02	2.40E-02	mg/kg	SS-18C110B	14 - 14	1/48	2.50E+05	1.90E+04	2.10E+05	1.80E+04
103651	n-Propylbenzene	6.30E-02	9.50E-01	mg/kg	18C245B-18.5-19.0	27.5 - 28	3/42	2.40E+04	3.80E+03	NBA	NBA
129000	Pyrene	8.80E-03	8.40E+01	mg/kg	SS-18G03C	16.6 - 17.1	16/56	2.30E+04	1.80E+03	1.80E+04	1.70E+03
127184	Tetrachloroethylene	1.00E-03	5.90E+00	mg/kg	SS-AOC2TS02-28.0	28 - 30.5	54/222	1.00E+02	2.40E+01	1.50E+03	4.30E+01
108883	Toluene	8.00E-04	4.30E+00	mg/kg	PE-18A219A	11.5 - 12	16/221	4.70E+04	4.90E+03	9.10E+04	6.30E+03
79016	Trichloroethylene	1.00E-03	5.90E+02	mg/kg	18C245B-27.5-28.0	22.5 - 23	131/230	6.00E+00	9.40E-01	1.00E+01	3.00E+00
95636	1,2,4-Trimethylbenzene	1.50E-01	8.80E+00	mg/kg	18C245B-18.5-19.0	27.5 - 28	4/42	1.80E+03	3.00E+02	NBA	NBA
108678	1,3,5-Trimethylbenzene	7.30E-02	3.20E+00	mg/kg	18C245B-18.5-19.0	27.5 - 28	3/42	1.50E+03	2.70E+02	NBA	NBA
75014	Vinyl chloride	1.50E-03	9.60E+00	mg/kg	18C245B-27.5-28.0	22.5 - 23	18/221	1.70E+00	5.90E-02	2.00E+00	7.00E-01
1330207	Xylenes, Total	4.00E-03	9.60E+01	mg/kg	PE-18A219A	11.5 - 12	22/176	2.50E+03	5.80E+02	1.70E+05	1.20E+04
179601231	m,p-Xylenes	2.80E-03	7.20E-01	mg/kg	18C245B-18.5-19.0	27.5 - 28	5/45	2.40E+03	5.50E+02	NBA	1.20E+04
95476	o-Xylene	6.00E-02	7.60E-01	mg/kg	18C245B-18.5-19.0	27.5 - 28	3/45	2.80E+03	6.50E+02	NBA	NBA
7429905	Aluminum	1.06E+03	9.83E+03	mg/kg	SS-18E123D	12 - 12.5	6/6	1.10E+06	7.70E+04	NBA	7.80E+04
7440360	Antimony	4.10E-01	1.30E+00	mg/kg	TP-18C87A	15 - 15.5	7/65	4.70E+02	3.10E+01	4.50E+02	3.10E+01
7440382	Arsenic	2.60E-01	2.75E+01	mg/kg	SS-18E123D	12 - 12.5	40/66	3.00E+00	6.80E-01	1.90E+01	1.90E+01
7440393	Barium	6.30E-01	1.57E+01	mg/kg	SS-18E123D	12 - 12.5	13/13	2.20E+05	1.50E+04	5.90E+04	1.60E+04
7440417	Beryllium	2.00E-02	6.70E-01	mg/kg	SS-18E123D	12 - 12.5	25/63	2.30E+03	1.60E+02	1.40E+02	1.60E+01
7440439	Cadmium	4.00E-02	1.70E+00	mg/kg	SS-18G03C	16.6 - 17.1	23/66	9.80E+02	7.10E+01	7.80E+01	7.80E+01
7440702	Calcium	3.69E+01	2.74E+02	mg/kg	SS-18E123D	12 - 12.5	5/7	NBA	NBA	NBA	NBA
7440473	Chromium	1.40E+00	3.07E+01	mg/kg	SS-18G03C	16.6 - 17.1	60/62	6.30E+00	3.00E-01	NBA	NBA
7440484	Cobalt	3.40E-01	1.22E+01	mg/kg	PE-18C200A	12 - 12.5	6/7	3.50E+02	2.30E+01	5.90E+02	1.60E+03
7440508	Copper	1.40E+00	1.07E+02	mg/kg	SS-18G03C	16.6 - 17.1	52/62	4.70E+04	3.10E+03	4.50E+04	3.10E+03
7439896	Iron	2.18E+03	2.59E+04	mg/kg	SS-18E123D	12 - 12.5	7/7	8.20E+05	5.50E+04	NBA	NBA
7439921	Lead	2.70E-01	1.45E+02	mg/kg	SS-18G03C	16.6 - 17.1	74/78	8.00E+02	4.00E+02	8.00E+02	4.00E+02
7439954	Magnesium	1.67E+01	3.48E+02	mg/kg	SS-18E123D	12 - 12.5	7/7	NBA	NBA	NBA	NBA
7439965	Manganese	1.40E+00	1.46E+02	mg/kg	SS-18E123D	12 - 12.5	7/7	2.60E+04	1.80E+03	5.90E+03	1.10E+04

Table 4-7
Summary of Analytes Detected in Deep Soil (>10 ft bgs) and Comparison to Human Health Screening Criteria
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Sample Interval (ft)	Detection Frequency[a]	EPA Regional Screening Screening Levels[b]		NJDEP[c] Soil Remediation Standards	
								Industrial Soil	Residential Soil	Industrial Soil	Residential Soil
7439976	Mercury	4.00E-02	5.90E-01	mg/kg	PE-18C229A	27 - 27.5	5/66	3.50E+02	2.30E+01	6.50E+01	2.30E+01
7440020	Nickel	2.10E-01	1.18E+01	mg/kg	PE-18C234A	27.5 - 28	47/65	2.20E+04	1.50E+03	2.30E+04	1.60E+03
7440097	Potassium	3.42E+01	5.45E+02	mg/kg	SS-18E123D	12 - 12.5	3/7	NBA	NBA	NBA	NBA
7782492	Selenium	4.20E-01	1.60E+00	mg/kg	SS-18G03C	16.6 - 17.1	10/60	5.80E+03	3.90E+02	5.70E+03	3.90E+02
7440224	Silver	5.20E-01	5.20E-01	mg/kg	SS-18C106B	14 - 14	1/66	5.80E+03	3.90E+02	5.70E+03	3.90E+02
7440235	Sodium	5.36E+01	5.93E+01	mg/kg	PE-18C201A	12 - 12.5	1/7	NBA	NBA	NBA	NBA
7440280	Thallium	2.80E-01	8.30E-01	mg/kg	TP-18C87A	15 - 15.5	3/66	1.20E+01	7.80E-01	NBA	NBA
7440622	Vanadium	1.18E+01	5.93E+01	mg/kg	PE-18C201A	12 - 12.5	7/7	5.80E+03	3.90E+02	1.10E+03	7.80E+01
7440666	Zinc	1.60E+00	3.13E+02	mg/kg	SS-18G03C	16.6 - 17.1	35/60	3.50E+05	2.30E+04	1.10E+05	2.30E+04

[a]Number of sampling locations at which analyte was detected compared with total number of sampling locations; duplicates at a location were averaged and considered one sample.

[b] November 2017 RSL Table

[c] NJDEP, 2017

mg/kg = Milligrams per kilogram.

NA = Not applicable.

NBA = No benchmark available.

Shading indicates that the maximum detected concentration exceeded the screening level.

Table 4-7A
Additional Comparisons of Select Analytes to NJDEP Screening Criteria (Soil >10 ft bgs)
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Maximum Concentration	Location of Maximum Concentration	Sample Interval (ft)	Detection Frequency[a]		NJDEP Soil Remediation Standards		Ratio of Maximum Detected Concentration to:		Number of Exceedances[b]	
							Nonresidential	Residential	Nonresidential Soil SRS	Residential Soil SRS	Nonresidential Soil SRS	Residential Soil SRS
PAHs												
56553	Benzo(a)anthracene	4.00E+01	SS-18G03C	16.6 - 17.1	9/56	16%	1.70E+01	5.00E+00	2.4	8	1	1
50328	Benzo(a)pyrene	3.50E+01	SS-18G03C	16.6 - 17.1	5/56	9%	2.00E+00	5.00E-01	18	70	1	2
205992	Benzo(b)fluoranthene	2.70E+01	SS-18G03C	16.6 - 17.1	5/56	9%	1.70E+01	5.00E+00	1.6	5.4	1	1
207089	Benzo(k)fluoranthene	3.00E+01	SS-18G03C	16.6 - 17.1	5/56	9%	1.70E+02	4.50E+01	0.18	0.67	0	0
53703	Dibenz(a,h)anthracene	6.80E+00	SS-18G03C	16.6 - 17.1	3/56	5%	2.00E+00	5.00E-01	3.4	14	1	1
193395	Indeno(1,2,3-c,d)pyrene	1.80E+01	SS-18G03C	16.6 - 17.1	3/56	5%	1.70E+01	5.00E+00	1.1	3.6	1	1
91203	Naphthalene	1.30E+01	PE-18A215A	10 - 10.5	11/98	11%	1.70E+01	6.00E+00	0.76	2.2	0	2
VOCs												
127184	Tetrachloroethylene	5.90E+00	SS-AOC2TS02-28.0	28 - 30.5	54/222	24%	1.50E+03	4.30E+01	0.0039	0.14	0	0
79016	Trichloroethylene	5.90E+02	18C245B-27.5-28.0	22.5 - 23	131/230	57%	1.00E+01	3.00E+00	59	197	8	19
75014	Vinyl chloride	9.60E+00	18C245B-27.5-28.0	22.5 - 23	18/221	8%	2.00E+00	7.00E-01	4.8	14	1	2
Metals												
7440382	Arsenic	2.75E+01	SS-18E123D	12 - 12.5	40/66	61%	1.90E+01	1.90E+01	1.4	1.4	1	1

Units in milligrams per kilogram.

[a]Number of sampling locations at which analyte was detected compared with total number of sampling locations; duplicates at a location were averaged and considered one sample.

[b]Number of exceedances of screening criteria.

Shading indicates that the maximum detected concentration exceeded the screening level.

Table 4-8
Point-by-Point Comparison to Human Health Screening Criteria - Deep Soil (>10 ft bgs)
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Analyte = Benzo(a)anthracene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	21	1.1	17	5
Area18C	Test Pit	TP-18C72B	7/9/1996	13.5 - 14	1.6			X		
Area18G	Soil Sample	SS-18G03C	5/17/1996	16.6 - 17.1	40		X	X	X	X
Analyte = Benzo(a)pyrene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	2.1	0.11	2	0.5
Area18C	Test Pit	TP-18C72B	7/9/1996	13.5 - 14	1.4			X		X
Area18C	Test Pit	TP-18C79A	6/19/1996	11 - 11.5	0.26	J		X		
Area18G	Soil Sample	SS-18G03C	5/17/1996	16.6 - 17.1	35		X	X	X	X
Analyte = Benzo(b)fluoranthene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	21	1.1	17	5
Area18G	Soil Sample	SS-18G03C	5/17/1996	16.6 - 17.1	27		X	X	X	X
Analyte = Benzo(k)fluoranthene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	210	11	170	45
Area18G	Soil Sample	SS-18G03C	5/17/1996	16.6 - 17.1	30			X		
Analyte = Dibenz(a,h)anthracene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	2.1	0.11	2	0.5
Area18C	Test Pit	TP-18C72B	7/9/1996	13.5 - 14	0.23	J		X		
Area18G	Soil Sample	SS-18G03C	5/17/1996	16.6 - 17.1	6.8		X	X	X	X
Analyte = Indeno(1,2,3-cd)pyrene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	21	1.1	17	5
Area18G	Soil Sample	SS-18G03C	5/17/1996	16.6 - 17.1	18			X	X	X
Analyte = Naphthalene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	17	3.8	17	6
Area18C	Test Pit	TP-18C79A	6/19/1996	11 - 11.5	4			X		
Area18G	Soil Sample	SS-18G03C	5/17/1996	16.6 - 17.1	11			X		X
Area18A	Remediation Floor Excavat	PE-18A215A	5/6/1998	10 - 10.5	13	D		X		X
Analyte = Ethylbenzene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	25	5.8	110000	7800
Area18A	Remediation Floor Excavat	PE-18A112A	4/16/1998	10 - 10.5	6.7	J		X		
Area18A	Remediation Floor Excavat	PE-18A215A	5/6/1998	10 - 10.5	14			X		
Area18A	Remediation Floor Excavat	PE-18A219A	5/26/1998	11.5 - 12	12	J		X		
Analyte = Trichloroethylene				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	6	0.94	10	3
Area18C-RAMP	Geoprobe boring	18C236B2	8/5/2003	29 - 29.5	20		X	X	X	X
Area18C-RAMP	Geoprobe boring	18C237B2	7/31/2003	29 - 29.5	0.95			X		
Area18C-RAMP	Geoprobe boring	18C244A	7/30/2003	15 - 15.5	33		X	X	X	X
Area18C-RAMP	Geoprobe boring	18C245B-27.5-28.0	7/31/2003	22.5 - 23	590		X	X	X	X
Area18C-RAMP	Geoprobe boring	18C249A	7/31/2003	15.5 - 16	2.1			X		
Area18C-RAMP	Geoprobe boring	18C251A	7/31/2003	14.5 - 15	7.3		X	X		X
Area18C	Test Pit	TP-18C78A	6/18/1996	13.5 - 14	4			X		X
Area18C	Test Pit	TP-18C79A	6/19/1996	11 - 11.5	110		X	X	X	X
Area18C	Test Pit	TP-18C82A	6/20/1996	10 - 10.5	3.7			X		X
Area18C	Geoprobe boring	SS-AOC2MIP01-17	10/25/2004	19.5 - 20	1.8			X		
Area18C	Geoprobe boring	SS-AOC2TS-01-31.5	3/21/2005	31.5 - 32	26		X	X	X	X
Area18C	Geoprobe boring	SS-AOC2TS02-32.0	3/22/2005	32 - 34	16		X	X	X	X
Area18C	Geoprobe boring	SS-AOC2TS02-28.0	3/22/2005	28 - 30.5	35		X	X	X	X
Area18C	Geoprobe boring	SS-AOC2TS02-22.5	3/22/2005	22.5 - 24.5	15		X	X	X	X
Area18C	Geoprobe boring	SS-AOC2TS02-36.0	3/22/2005	36 - 38	2.8			X		
Area18A	Recovery well	PE-18A106A	4/14/1998	10 - 10.5	1	D		X		
Area18A	Recovery well	PE-18A208A	5/6/1998	10 - 10.5	3.8			X		X
Area18A	Remediation Floor Excavat	PE-18A215A	5/6/1998	10 - 10.5	2.9			X		
Area18C-256	Recovery well	PE-18C06A	3/16/1998	15 - 15.5	1.6			X		
Area18C-256	Recovery well	PE-18C07A	3/17/1998	15 - 15.5	2.6			X		
Area18C-256	Remediation Floor Excavat	PE-18C08A	3/16/1998	15 - 15.5	7.4		X	X		X
Area18C-256	Remediation Floor Excavat	PE-18C11A	3/17/1998	15 - 15.5	9.5		X	X		X
Area18C-RAMP	Recovery well	PE-18C225A	11/20/2002	27.5 - 28	4.8			X		X
Area18C-RAMP	Recovery well	PE-18C226A	11/20/2002	27.5 - 28	1.3			X		
Area18C-RAMP	Recovery well	PE-18C228A	11/20/2002	27 - 27.5	7.2		X	X		X
Area18C-RAMP	Recovery well	PE-18C229A	11/21/2002	27 - 27.5	6.4		X	X		X
Area18C-RAMP	Recovery well	PE-18C230A	11/21/2002	27 - 27.5	4.6			X		X
Area18C-RAMP	Recovery well	PE-18C231A	11/21/2002	27 - 27.5	2.5			X		
Area18C-256	Remediation Floor Excavat	PE-18C24A	3/24/1998	16.5 - 17	4.9			X		X
Area18C-256	Recovery well	PE-18C28A	4/6/1998	15 - 15.5	2.6	D		X		

RSL = Regional Screening Level
SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value, potentially unreliable concentration
U = not detected

Table 4-8
Point-by-Point Comparison to Human Health Screening Criteria - Deep Soil (>10 ft bgs)
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Analyte = Vinyl chloride				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	1.7	0.059	2	0.7
Area18C-RAMP	Geoprobe boring	18C245B-27.5-28.0	7/31/2003	22.5 - 23	9.6		X	X	X	X
Area18C-RAMP	Geoprobe boring	18C245B-18.5-19.0	7/30/2003	27.5 - 28	0.53			X		
Area18C-RAMP	Geoprobe boring	18C245B-22.5-23.0	7/30/2003	18.5 - 19	1.3			X		X
Area18C	Test Pit	TP-18C79B	6/19/1996	17.5 - 18	0.15			X		
Area18C	Geoprobe boring	SS-AOC2TS-01-22.5	3/21/2005	22.5 - 25.5	0.11	J		X		
Area18C	Geoprobe boring	SS-AOC2TS-01-28.0	3/21/2005	28 - 31.5	0.077	J		X		
Analyte = Arsenic				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	3	0.68	19	19
Area18E	Soil boring	SS-18E123D	8/20/2009	12 - 12.5	27.5		X	X	X	X
Analyte = Thallium				Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential		
Investigation Area	Sample Type	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	12	0.78		
Area18C	Test Pit	TP-18C87A	6/24/1996	15 - 15.5	0.83			X		

RSL = Regional Screening Level
SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value, potentially unreliable concentration
U = not detected

Table 4-9
Summary of Analytes Detected in Surface Soil and Comparison to Ecological Benchmarks
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Soil Benchmark[a]	Units	SS18A41	SS18A42	SS18A43	SS18B81	SS-18A44A
72548	4,4-DDD	0.76	mg/kg	---	---	0.0015 J	---	---
72559	4,4-DDE	0.60	mg/kg	---	---	0.0040 J	0.023 D	---
50293	4,4-DDT	0.0035	mg/kg	---	---	0.0040 J	0.028 V	---
83329	Acenaphthene	20	mg/kg	---	---	---	---	---
208968	Acenaphthylene	682	mg/kg	---	---	---	---	---
120127	Anthracene	1480	mg/kg	---	---	---	0.035 J	---
56553	Benzo(a)anthracene	5.21	mg/kg	0.044 J	---	0.072 J	0.14 J	0.0026 J
50328	Benzo(a)pyrene	1.52	mg/kg	0.043 J	---	0.067 J	0.13 J	0.0026 J
205992	Benzo(b)fluoranthene	59.8	mg/kg	0.052 J	---	0.080 J	0.11 J	0.0041 J
191242	Benzo(g,h,i)perylene	119	mg/kg	0.042 J	0.025 J	0.069 J	0.065 J	0.0024 J
207089	Benzo(k)fluoranthene	148	mg/kg	0.050 J	---	0.073 J	0.20 J	0.0018 J
117817	Bis(2-ethylhexyl)phthalate	0.93	mg/kg	---	---	0.053 J	0.091 J	---
86748	Carbazole	NA	mg/kg	---	---	---	---	---
218019	Chrysene	4.73	mg/kg	0.075 J	0.042 J	0.12 J	0.18 J	0.0034 J
2051243	Decachlorobiphenyl	NA	mg/kg	0.022 V	0.011 V	0.012 V	0.017 V	---
53703	Dibenz(a,h)anthracene	18.4	mg/kg	---	---	---	---	---
117840	Di-n-octyl phthalate	709	mg/kg	---	---	---	---	---
206440	Fluoranthene	122	mg/kg	0.12 J	0.061 J	0.19 J	0.31 J	0.0060 J
86737	Fluorene	30	mg/kg	---	---	---	---	---
193395	Indeno(1,2,3-c,d)pyrene	109	mg/kg	0.041 J	0.023 J	0.063 J	0.066 J	0.0023 J
72435	Methoxychlor	0.020	mg/kg	---	---	---	0.010 V	---
91203	Naphthalene	0.099	mg/kg	---	---	---	---	---
85018	Phenanthrene	45.7	mg/kg	0.050 J	---	0.086 J	0.17 J	0.0025 J
129000	Pyrene	78.5	mg/kg	0.10 J	0.051 J	0.15 J	0.31 J	0.0051 J
877098	Tetrachloro-m-xylene	NA	mg/kg	0.012 V	0.013 V	0.011 V	0.021 V	---
7429905	Aluminum	600	mg/kg	4180 J	792 J	1020 J	1730 J	---
7440360	Antimony	0.27	mg/kg	0.62 J	0.36 J	0.52 J	1.6 J	---
7440382	Arsenic	19	mg/kg	1.7 J	0.55 J	0.89 J	4.9 J	---
7440393	Barium	330	mg/kg	6.3 J	1.4 J	4.2 J	7.5 J	---
7440417	Beryllium	21	mg/kg	0.060 J	---	0.030 J	0.010 J	---
7440439	Cadmium	0.36	mg/kg	0.24 J	0.10 J	0.19 J	0.22 J	---
7440702	Calcium	NA	mg/kg	51.6 J	17.2 J	63.8 J	267 J	---
7440473	Chromium	26	mg/kg	12.4 J	4.4 J	8.8 J	5.7 J	---
7440484	Cobalt	13	mg/kg	0.83 J	0.22 J	0.77 J	0.52 V	---
7440508	Copper	28	mg/kg	13.6 V	2.9 V	5.1 V	28.5 J	---
7439896	Iron	200	mg/kg	6720 J	3300 J	6040 J	7670 J	---
7439921	Lead	11	mg/kg	30.2 J	18.4 J	25.5 J	57.7 J	---
7439954	Magnesium	NA	mg/kg	212 J	29.8 J	105 J	131 J	---
7439965	Manganese	220	mg/kg	15.5 J	4.7 J	23 J	20.4 J	---
7439976	Mercury	0.000051	mg/kg	0.047 V	---	---	0.21 V	---
7440020	Nickel	38	mg/kg	2.4 J	0.42 J	1.4 J	2.9 V	---
7440097	Potassium	NA	mg/kg	121 J	18.6 J	74.4 J	121 J	---
7782492	Selenium	0.52	mg/kg	0.45 J	0.27 J	0.29 J	1.0 J	---
7440224	Silver	4.2	mg/kg	0.090 J	---	---	0.34 J	---
7440235	Sodium	NA	mg/kg	---	---	---	---	---
7440622	Vanadium	7.8	mg/kg	26.7 J	15.2 J	18.9 J	22.9 J	---
7440666	Zinc	46	mg/kg	9.0 J	2.1 J	7.1 J	12.4 J	---

[a]Lowest available benchmark based on: EPA Region V, 2003, EPA, 2005b through 2005j, 2006a, 2007a through 2007e, and 2008, Efroymson et al., 1997a, Efroymson et al., 1997b, or Efroymson et al., 1997c

J - estimated vaue, potentially unreliable concentration.

mg/kg = Milligrams per kilogram.

NA = Not available.

"---" = Analyte either not analyzed or not detected.

Shading indicates that the detected concentration exceeds the screening level.

Table 4-10
Summary of Analytes Detected in Sediment and Comparison to Human Health Screening Criteria
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Sample Interval (ft)	Detection Frequency[a]	EPA Regional Screening Screening Levels[b] Industrial Soil	EPA Regional Screening Screening Levels[b] Residential Soil	NJDEP[c] Soil Remediation Standards Industrial Soil	NJDEP[c] Soil Remediation Standards Residential Soil
83329	Acenaphthene	2.10E-01	1.40E+02	mg/kg	SD-1822B	1 - 1.5	10/22	4.50E+04	3.60E+03	3.70E+04	3.40E+03
208968	Acenaphthylene	4.60E-02	5.30E+00	mg/kg	SD-1822B	1 - 1.5	9/22	4.50E+04	3.60E+03	3.00E+05	NBA
67641	Acetone	2.10E-02	2.10E-02	mg/kg	SD-1803	0 - 0.5	1/20	6.70E+05	6.10E+04	NBA	7.00E+04
309002	Aldrin	3.20E-01	6.90E-01	mg/kg	SD-1803	0 - 0.5	3/22	1.80E-01	3.90E-02	2.00E-01	4.00E-02
120127	Anthracene	3.50E-02	2.70E+02	mg/kg	SD-1822B	1 - 1.5	13/22	2.30E+05	1.80E+04	3.00E+04	1.70E+04
56553	Benzo(a)anthracene	1.80E-03	4.20E+02	mg/kg	SD-1822B	1 - 1.5	18/22	2.10E+01	1.10E+00	1.70E+01	5.00E+00
50328	Benzo(a)pyrene	1.70E-03	3.80E+02	mg/kg	SD-1822B	1 - 1.5	18/22	2.10E+00	1.10E-01	2.00E+00	5.00E-01
205992	Benzo(b)fluoranthene	2.50E-03	5.20E+02	mg/kg	SD-1822B	1 - 1.5	18/22	2.10E+01	1.10E+00	1.70E+01	5.00E+00
191242	Benzo(g,h,i)perylene	5.50E-02	2.40E+02	mg/kg	SD-1822B	1 - 1.5	16/22	NBA	NBA	3.00E+04	3.80E+05
207089	Benzo(k)fluoranthene	4.40E-02	2.30E+02	mg/kg	SD-1822B	1 - 1.5	17/22	2.10E+02	1.10E+01	1.70E+02	4.50E+01
319868	delta-BHC	4.60E-03	4.60E-03	mg/kg	SD1812	0 - 0.5	1/23	NBA	NBA	NBA	NBA
117817	Bis(2-ethylhexyl)phthalate	8.00E-02	2.20E+00	mg/kg	SD-1803	0 - 0.5	12/26	1.60E+02	3.90E+01	1.40E+02	3.50E+01
78933	2-Butanone	9.90E-01	9.90E-01	mg/kg	SD-1803	0 - 0.5	1/20	1.90E+05	2.70E+04	4.40E+04	3.10E+03
85687	Butylbenzylphthalate	8.50E+00	8.50E+00	mg/kg	SD-1815	0 - 0.5	1/26	1.20E+03	2.90E+02	1.40E+04	1.20E+03
86748	Carbazole	1.20E-01	2.60E+02	mg/kg	SD-1803	0 - 0.5	15/26	NBA	NBA	9.60E+01	2.40E+01
5566347	gamma-Chlordane	2.40E-01	2.40E-01	mg/kg	SD1812	0 - 0.5	1/23	7.70E+00	1.70E+00	1.00E+00	2.00E-01
218019	Chrysene	2.20E-03	4.90E+02	mg/kg	SD-1822B	1 - 1.5	19/22	2.10E+03	1.10E+02	1.70E+03	4.50E+02
57125	Cyanide, total	2.00E-01	6.80E-01	mg/kg	SD-1806	0 - 0.5	4/10	1.50E+02	2.30E+01	6.80E+02	4.70E+01
72548	4,4-DDD	8.10E-04	8.60E-02	mg/kg	SD-1811	0 - 0.5	7/24	9.60E+00	1.90E+00	1.30E+01	3.00E+00
72559	4,4-DDE	1.50E-03	1.60E-01	mg/kg	SD-1803	0 - 0.5	6/22	9.30E+00	2.00E+00	9.00E+00	2.00E+00
50293	4,4-DDT	9.50E-04	2.20E-01	mg/kg	SD-1811	0 - 0.5	9/24	8.50E+00	1.90E+00	8.00E+00	2.00E+00
53703	Dibenz(a,h)anthracene	2.40E-02	6.20E+01	mg/kg	SD-1822B	1 - 1.5	13/22	2.10E+00	1.10E-01	2.00E+00	5.00E-01
132649	Dibenzofuran	6.50E-02	7.20E+01	mg/kg	SD-1804	0 - 0.5	14/26	1.00E+03	7.30E+01	NBA	NBA
540590	1,2-Dichloroethene	2.00E-03	8.00E-03	mg/kg	SD-0101	0 - 0.5	2/20	2.30E+03	1.60E+02	5.60E+02	2.30E+02
60571	Dieldrin	2.90E-04	8.30E-03	mg/kg	SD1816	0 - 0.5	2/24	1.40E-01	3.40E-02	2.00E-01	4.00E-02
105679	2,4-Dimethylphenol	3.50E-01	3.50E-01	mg/kg	SD-1803	0 - 0.5	1/26	1.60E+04	1.30E+03	1.40E+04	1.20E+03
33213659	Endosulfan II	9.40E-04	1.80E-01	mg/kg	SD-1803	0 - 0.5	6/25	7.00E+03	4.70E+02	6.80E+03	4.70E+02
7421934	Endrin aldehyde	3.10E-03	6.80E-03	mg/kg	SD1816	0 - 0.5	1/23	2.50E+02	1.90E+01	3.40E+02	2.30E+01
53494705	Endrin ketone	5.30E-03	2.30E-01	mg/kg	SD-1803	0 - 0.5	4/24	2.50E+02	1.90E+01	3.40E+02	2.30E+01
206440	Fluoranthene	3.60E-03	1.30E+03	mg/kg	SD-1822B	1 - 1.5	20/22	3.00E+04	2.40E+03	2.40E+04	2.30E+03
86737	Fluorene	1.90E-01	1.20E+02	mg/kg	SD-1822B	1 - 1.5	10/22	3.00E+04	2.40E+03	2.40E+04	2.30E+03
76448	Heptachlor	3.40E-03	3.50E-03	mg/kg	SD1812	0 - 0.5	2/24	6.30E-01	1.30E-01	7.00E-01	1.00E-01
1024573	Heptachlor epoxide	1.20E-03	3.60E+00	mg/kg	SD-1803	0 - 0.5	15/23	3.30E-01	7.00E-02	3.00E-01	7.00E-02
193395	Indeno(1,2,3-c,d)pyrene	5.50E-02	2.60E+02	mg/kg	SD-1822B	1 - 1.5	16/22	2.10E+01	1.10E+00	1.70E+01	5.00E+00
72435	Methoxychlor	3.50E-02	1.00E+00	mg/kg	SD1812	0 - 0.5	7/25	4.10E+03	3.20E+02	5.70E+03	3.90E+02
90120	1-Methylnaphthalene	4.10E-02	3.40E+01	mg/kg	SD-1822B	1 - 1.5	9/11	7.30E+01	1.80E+01	NBA	NBA
91576	2-Methylnaphthalene	4.80E-02	3.50E+01	mg/kg	SD-1822B	1 - 1.5	10/22	3.00E+03	2.40E+02	2.40E+03	2.30E+02
95487	2-Methylphenol	2.40E-01	2.40E-01	mg/kg	SD-1803	0 - 0.5	1/26	4.10E+04	3.20E+03	3.40E+03	3.10E+02
106445	4-Methylphenol	8.90E-01	8.90E-01	mg/kg	SD-1803	0 - 0.5	1/26	8.20E+04	6.30E+03	3.40E+02	3.10E+01
91203	Naphthalene	1.30E-01	8.40E+01	mg/kg	SD-1822B	1 - 1.5	10/22	1.70E+01	3.80E+00	1.70E+01	6.00E+00
85018	Phenanthrene	4.60E-02	1.10E+03	mg/kg	SD-1822B	1 - 1.5	17/22	NBA	NBA	3.00E+05	NBA
108952	Phenol	6.20E-01	6.20E-01	mg/kg	SD-1803	0 - 0.5	1/26	2.50E+05	1.90E+04	2.10E+05	1.80E+04
129000	Pyrene	3.20E-03	1.00E+03	mg/kg	SD-1822B	1 - 1.5	20/22	2.30E+04	1.80E+03	1.80E+04	1.70E+03
108883	Toluene	6.00E-03	1.50E-02	mg/kg	SD-1803	0 - 0.5	2/20	4.70E+04	4.90E+03	9.10E+04	6.30E+03
71556	1,1,1-Trichloroethane	8.00E-03	8.00E-03	mg/kg	SD-1815	0 - 0.5	1/20	3.60E+04	8.10E+03	NBA	1.60E+05
79016	Trichloroethylene	2.00E-03	1.50E-02	mg/kg	SD-0101	0 - 0.5	4/20	6.00E+00	9.40E-01	1.00E+01	3.00E+00
7429905	Aluminum	4.13E+02	3.13E+03	mg/kg	SD1811	0 - 0.5	10/10	1.10E+06	7.70E+04	NBA	7.80E+04
7440360	Antimony	8.50E-02	3.10E+00	mg/kg	SD-1801	0 - 0.5	20/26	4.70E+02	3.10E+01	4.50E+02	3.10E+01
7440382	Arsenic	2.50E-01	3.29E+01	mg/kg	SD-1810	0 - 0.5	23/26	3.00E+00	6.80E-01	1.90E+01	1.90E+01
7440393	Barium	7.20E-01	4.01E+01	mg/kg	SD-1810	0 - 0.5	26/26	2.20E+05	1.50E+04	5.90E+04	1.60E+04
7440417	Beryllium	3.00E-02	1.00E+00	mg/kg	SD-1807	0 - 0.5	16/26	2.30E+03	1.60E+02	1.40E+02	1.60E+01
7440439	Cadmium	2.10E-02	6.10E-01	mg/kg	SD-1803	0 - 0.5	22/26	9.80E+02	7.10E+01	7.80E+01	7.80E+01
7440702	Calcium	3.94E+01	1.70E+03	mg/kg	SD-1812	0 - 0.5	10/10	NBA	NBA	NBA	NBA
7440473	Chromium	2.80E+00	2.58E+01	mg/kg	SD-1813	0 - 0.5	26/26	6.30E+00	3.00E-01	NBA	NBA
7440484	Cobalt	3.00E-01	5.20E+00	mg/kg	SD1811	0 - 0.5	9/10	3.50E+02	2.30E+01	5.90E+02	1.60E+03
7440508	Copper	1.90E+00	8.41E+01	mg/kg	SD-1803	0 - 0.5	26/26	4.70E+04	3.10E+03	4.50E+04	3.10E+03
7439896	Iron	1.44E+03	1.57E+04	mg/kg	SD-1803	0 - 0.5	10/10	8.20E+05	5.50E+04	NBA	NBA
7439921	Lead	2.30E+00	5.86E+02	mg/kg	SD-1801	0 - 0.5	26/26	8.00E+02	4.00E+02	8.00E+02	4.00E+02
7439954	Magnesium	2.77E+01	8.81E+02	mg/kg	SD-1812	0 - 0.5	10/10	NBA	NBA	NBA	NBA
7439965	Manganese	1.60E+00	1.03E+02	mg/kg	SD1811	0 - 0.5	10/10	2.60E+04	1.80E+03	5.90E+03	1.10E+04
7439976	Mercury	3.30E-02	9.40E-01	mg/kg	SD-1807	0 - 0.5	5/26	3.50E+02	2.30E+01	6.50E+01	2.30E+01
7440020	Nickel	3.90E-01	1.40E+01	mg/kg	SD-1803	0 - 0.5	17/26	2.20E+04	1.50E+03	2.30E+04	1.60E+03
7440097	Potassium	1.81E+01	2.24E+02	mg/kg	SD1811	0 - 0.5	8/10	NBA	NBA	NBA	NBA

Table 4-10
Summary of Analytes Detected in Sediment and Comparison to Human Health Screening Criteria
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Sample Interval (ft)	Detection Frequency[a]	EPA Regional Screening Screening Levels[b]		NJDEP[c] Soil Remediation Standards	
								Industrial Soil	Residential Soil	Industrial Soil	Residential Soil
7782492	Selenium	2.40E-01	8.60E-01	mg/kg	SD-1801	0 - 0.5	5/26	5.80E+03	3.90E+02	5.70E+03	3.90E+02
7440224	Silver	1.20E-01	1.90E+00	mg/kg	SD-1807	0 - 0.5	6/26	5.80E+03	3.90E+02	5.70E+03	3.90E+02
7440235	Sodium	3.10E+01	8.90E+01	mg/kg	SD-1803	0 - 0.5	7/10	NBA	NBA	NBA	NBA
7440622	Vanadium	8.40E+00	2.72E+01	mg/kg	SD-1803	0 - 0.5	10/10	5.80E+03	3.90E+02	1.10E+03	7.80E+01
7440666	Zinc	3.30E+00	2.44E+02	mg/kg	SD-1803	0 - 0.5	25/26	3.50E+05	2.30E+04	1.10E+05	2.30E+04

[a] Number of sampling locations at which analyte was detected compared with total number of sampling locations; duplicates at a location were averaged and considered one sample.

[b] November 2017 RSL Table

[c] NJDEP, 2017

mg/kg = Milligrams per kilogram.

NA = Not applicable.

NBA = No benchmark available.

Shading indicates that the maximum detected concentration exceeded the screening level.

Table 4-10A
Additional Comparisons of Select Analytes to NJDEP Screening Criteria (Sediment)
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Maximum Concentration	Location of Maximum Concentration	Detection Frequency[a]		Exposure Point Concentration[b]	NJDEP Soil Remediation Standards		Ratio of Maximum Detected Concentration to:		Ratio of EPC to:		Number of Exceedances[c]	
							Nonresidential	Residential	Nonresidential Soil SRS	Residential Soil SRS	Nonresidential Soil SRS	Residential Soil SRS	Nonresidential Soil SRS	Residential Soil SRS
PAHs														
56553	Benzo(a)anthracene	4.20E+02	SD-1822B	18/22	82%	1.25E+02	1.70E+01	5.00E+00	25	84	7.3	25	6	8
50328	Benzo(a)pyrene	3.80E+02	SD-1822B	18/22	82%	1.11E+02	2.00E+00	5.00E-01	190	760	55	222	10	11
205992	Benzo(b)fluoranthene	5.20E+02	SD-1822B	18/22	82%	1.49E+02	1.70E+01	5.00E+00	31	104	8.7	30	6	8
207089	Benzo(k)fluoranthene	2.30E+02	SD-1822B	17/22	77%	6.83E+01	1.70E+02	4.50E+01	1.4	5.1	0.40	1.5	1	3
218019	Chrysene	4.90E+02	SD-1822B	19/22	86%	1.41E+02	1.70E+03	4.50E+02	0.29	1.1	0.083	0.31	0	1
53703	Dibenz(a,h)anthracene	6.20E+01	SD-1822B	13/22	59%	1.04E+01	2.00E+00	5.00E-01	31	124	5.2	21	6	9
193395	Indeno(1,2,3-c,d)pyrene	2.60E+02	SD-1822B	16/22	73%	7.30E+01	1.70E+01	5.00E+00	15	52	4.3	15	4	7
91203	Naphthalene	8.40E+01	SD-1822B	10/22	45%	1.46E+01	1.70E+01	6.00E+00	4.9	14	0.86	2.4	2	6
Pesticides														
309002	Aldrin	6.90E-01	SD-1803	3/22	14%	5.43E-02	2.00E-01	4.00E-02	3.5	17	0.27	1.4	3	3
5566347	gamma-Chlordane	2.40E-01	SD1812	1/23	4%	2.40E-01	1.00E+00	2.00E-01	0.24	1.2	0.24	1.2	0	1
1024573	Heptachlor epoxide	3.60E+00	SD-1803	15/23	65%	2.22E+00	3.00E-01	7.00E-02	12	51	7.4	32	3	5
SVOCs														
86748	Carbazole	2.60E+02	SD-1803	15/26	58%	1.34E+02	9.60E+01	2.40E+01	2.7	11	1.4	5.6	2	2
Metals														
7440382	Arsenic	3.29E+01	SD-1810	23/26	88%	1.13E+01	1.90E+01	1.90E+01	1.7	1.7	0.60	0.60	1	1
7439921	Lead	5.86E+02	SD-1801	26/26	100%	1.02E+02	8.00E+02	4.00E+02	0.73	1.5	0.13	0.26	0	1

Units in milligrams per kilogram.

[a]Number of sampling locations at which analyte was detected compared with total number of sampling locations; duplicates at a location were averaged and considered one sample.

[b]See Table 6-6.

[c]Number of exceedances of screening criteria.

Shading indicates that the maximum detected concentration exceeded the screening level.

Table 4-11
Point-by-Point Comparison to Human Health Screening Criteria - Sediment (0 to 2 ft bgs)
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Analyte = Benzo(a)anthracene			Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	21	1.1	17	5
Area 18B	SD-1820	10/1/2013	0 - 0.5	36		X	X	X	X
Area 18B	SD-1821A	10/1/2013	0 - 0.5	180		X	X	X	X
Area 18B	SD-1821B	10/1/2013	1 - 1.5	30		X	X	X	X
Area18C	SD-1810	8/1/1994	0 - 0.5	6.4			X		X
Area 18B	SD-1822A	10/1/2013	0 - 0.5	63		X	X	X	X
Area 18B	SD-1822B	10/1/2013	1 - 1.5	420		X	X	X	X
Area 18B	SD-1824A-DUP	10/1/2013	0 - 0.5	42		X	X	X	X
Area 18B	SD-1825	10/1/2013	0 - 0.5	5.4			X		X
Area 18B	SD-1826	10/1/2013	0 - 0.5	4.8			X		
Area 18B	SD-1827-DUP	10/1/2013	0 - 0.5	2.2			X		
Analyte = Benzo(a)pyrene			Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	2.1	0.11	2	0.5
Area1	SD-0101	8/2/1994	0 - 0.5	0.19	J		X		
Area 18B	SD-1820	10/1/2013	0 - 0.5	30		X	X	X	X
Area 18B	SD-1821A	10/1/2013	0 - 0.5	150		X	X	X	X
Area 18B	SD-1821B	10/1/2013	1 - 1.5	26		X	X	X	X
Area18	SD-1801	8/2/1994	0 - 0.5	0.71			X		X
Area18	SD-1802	8/2/1994	0 - 0.5	0.35	J		X		
Area18B	SD-1809	8/2/1994	0 - 0.5	0.17	J		X		
Area18C	SD-1810	8/1/1994	0 - 0.5	4.7		X	X	X	X
Area 18B	SD-1822A	10/1/2013	0 - 0.5	55		X	X	X	X
Area 18B	SD-1822B	10/1/2013	1 - 1.5	380		X	X	X	X
Area 18B	SD-1824A-DUP	10/1/2013	0 - 0.5	35		X	X	X	X
Area 18B	SD-1825	10/1/2013	0 - 0.5	6		X	X	X	X
Area 18B	SD-1826	10/1/2013	0 - 0.5	4.4		X	X	X	X
Area 18B	SD-1827-DUP	10/1/2013	0 - 0.5	2.1			X	X	X
Analyte = Benzo(b)fluoranthene			Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	21	1.1	17	5
Area 18B	SD-1820	10/1/2013	0 - 0.5	36		X	X	X	X
Area 18B	SD-1821A	10/1/2013	0 - 0.5	190		X	X	X	X
Area 18B	SD-1821B	10/1/2013	1 - 1.5	28		X	X	X	X
Area18C	SD-1810	8/1/1994	0 - 0.5	4.4			X		
Area 18B	SD-1822A	10/1/2013	0 - 0.5	62		X	X	X	X
Area 18B	SD-1822B	10/1/2013	1 - 1.5	520		X	X	X	X
Area 18B	SD-1824A-DUP	10/1/2013	0 - 0.5	46		X	X	X	X
Area 18B	SD-1825	10/1/2013	0 - 0.5	9.1			X		X
Area 18B	SD-1826	10/1/2013	0 - 0.5	6			X		X
Area 18B	SD-1827-DUP	10/1/2013	0 - 0.5	3			X		
Analyte = Benzo(k)fluoranthene			Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	210	11	170	45
Area 18B	SD-1820	10/1/2013	0 - 0.5	24			X		
Area 18B	SD-1821A	10/1/2013	0 - 0.5	86			X		X
Area 18B	SD-1821B	10/1/2013	1 - 1.5	22			X		
Area 18B	SD-1822A	10/1/2013	0 - 0.5	53			X		X
Area 18B	SD-1822B	10/1/2013	1 - 1.5	230		X	X	X	X
Area 18B	SD-1824A-DUP	10/1/2013	0 - 0.5	22			X		
Analyte = Chrysene			Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	2100	110	1700	450
Area 18B	SD-1821A	10/1/2013	0 - 0.5	180			X		
Area 18B	SD-1822B	10/1/2013	1 - 1.5	490			X		X
Analyte = Dibenz(a,h)anthracene			Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	2.1	0.11	2	0.5
Area 18B	SD-1820	10/1/2013	0 - 0.5	5.4		X	X	X	X
Area 18B	SD-1821A	10/1/2013	0 - 0.5	26		X	X	X	X
Area18C	SD-1810	8/1/1994	0 - 0.5	0.58			X		X
Area 18B	SD-1821B	10/1/2013	1 - 1.5	4.4		X	X	X	X
Area 18B	SD-1822A	10/1/2013	0 - 0.5	10		X	X	X	X
Area 18B	SD-1822B	10/1/2013	1 - 1.5	62		X	X	X	X
Area 18B	SD-1824A-DUP	10/1/2013	0 - 0.5	6.2		X	X	X	X
Area 18B	SD-1825	10/1/2013	0 - 0.5	1.1			X		X
Area 18B	SD-1826	10/1/2013	0 - 0.5	0.98			X		X
Area 18B	SD-1827-DUP	10/1/2013	0 - 0.5	0.34			X		

NBA = no benchmark available
RSL = Regional Screening Level
SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value, potentially unreliable concentration
U = not detected

Table 4-11
Point-by-Point Comparison to Human Health Screening Criteria - Sediment (0 to 2 ft bgs)
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Analyte = Indeno(1,2,3-cd)pyrene			Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	21	1.1	17	5
Area 18B	SD-1820	10/1/2013	0 - 0.5	17			X		X
Area 18B	SD-1821A	10/1/2013	0 - 0.5	80		X	X	X	X
Area 18B	SD-1821B	10/1/2013	1 - 1.5	14			X		X
Area18C	SD-1810	8/1/1994	0 - 0.5	2.5			X		
Area 18B	SD-1822A	10/1/2013	0 - 0.5	32		X	X	X	X
Area 18B	SD-1822B	10/1/2013	1 - 1.5	260		X	X	X	X
Area 18B	SD-1824A-DUP	10/1/2013	0 - 0.5	20			X	X	X
Area 18B	SD-1825	10/1/2013	0 - 0.5	5.2			X		X
Area 18B	SD-1826	10/1/2013	0 - 0.5	4.2			X		
Area 18B	SD-1827-DUP	10/1/2013	0 - 0.5	1.6			X		
Analyte = 1-Methylnaphthalene			Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	73	18	NBA	NBA
Area 18B	SD-1822B	10/1/2013	1 - 1.5	34	J		X		
Analyte = Naphthalene			Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	17	3.8	17	6
Area 18B	SD-1820	10/1/2013	0 - 0.5	6.9			X		X
Area 18B	SD-1821A	10/1/2013	0 - 0.5	41		X	X	X	X
Area 18B	SD-1821B	10/1/2013	1 - 1.5	8.1			X		X
Area 18B	SD-1822A	10/1/2013	0 - 0.5	10			X		X
Area 18B	SD-1822B	10/1/2013	1 - 1.5	84		X	X	X	X
Area 18B	SD-1824A-DUP	10/1/2013	0 - 0.5	6.2			X		X
Analyte = Aldrin			Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	0.18	0.039	0.2	0.04
Area18B	SD-1803	8/2/1994	0 - 0.5	0.69	J	X	X	X	X
Area18B	SD-1804	8/2/1994	0 - 0.5	0.35	J	X	X	X	X
Area18B	SD-1805	8/2/1994	0 - 0.5	0.32	J	X	X	X	X
Analyte = gamma-Chlordane			Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	7.7	1.7	1	0.2
Area18	SD1812	7/19/2005	0 - 0.5	0.24	J				X
Analyte = Heptachlor Epoxide			Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	0.33	0.07	0.3	0.07
Area18B	SD-1803	8/2/1994	0 - 0.5	3.6		X	X	X	X
Area18B	SD-1804	8/2/1994	0 - 0.5	2		X	X	X	X
Area18B	SD-1805	8/2/1994	0 - 0.5	1.8		X	X	X	X
Area18C	SD-1810	8/1/1994	0 - 0.5	0.087			X		X
Area18C	SD-1815	8/1/1994	0 - 0.5	0.084			X		X
Analyte = Carbazole			Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	NBA	NBA	96	24
Area18B	SD-1803	8/2/1994	0 - 0.5	260				X	X
Area18B	SD-1804	8/2/1994	0 - 0.5	160				X	X
Analyte = Arsenic			Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	3	0.68	19	19
Area18C	SD-1810	8/1/1994	0 - 0.5	32.9	J	X	X	X	X
Analyte = Lead			Sample Interval	Result		EPA RSL Industrial	EPA RSL Residential	NJDEP SRS Industrial	NJDEP SRS Residential
Investigation Area	Sample ID	Sample Date	(ft)	(mg/kg)	Qualifier	800	400	800	400
Area18	SD-1801	8/2/1994	0 - 0.5	586			X		X

NBA = no benchmark available
RSL = Regional Screening Level
SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value, potentially unreliable concentration
U = not detected

Table 4-12
Summary of Analytes Detected in Surface Sediment and Comparison to Ecological Benchmarks
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Sediment Benchmark[a]	Units	SD1810 7/19/2005	SD1811 7/19/2005	SD1827 10/1/2013	SD1827-DUP 10/1/2013	SD1812 7/19/2005	SD1820 10/1/2013	SD1813 7/19/2005	SD1821A 10/1/2013	SD1814 7/19/2005	SD1822A 10/1/2013	SD1815 7/19/2005	SD1823A 10/1/2013	SD1816 7/19/2005	SD1819 10/1/2013
72548	4,4-DDD	0.0049	mg/kg	0.0048 V	---	---	---	---	---	---	---	---	---	0.027 J	---	---	---
72559	4,4-DDE	0.0032	mg/kg	0.0015 V	---	---	---	---	---	---	---	---	---	---	---	---	---
50293	4,4-DDT	0.0042	mg/kg	0.0021 J	0.010 J	---	---	---	---	0.00095 J	---	0.0025 J	---	---	---	0.0022 J	---
83329	Acenaphthene	0.0067	mg/kg	---	[b]	0.21	0.47	[b]	12	[b]	79	[b]	15	[b]	---	[b]	---
208968	Acenaphthylene	0.0059	mg/kg	---	[b]	0.046 J	0.046 J	[b]	0.45 J	[b]	1.7 J	[b]	0.84 J	[b]	---	[b]	---
120127	Anthracene	0.027	mg/kg	---	[b]	0.43	0.78	[b]	13	[b]	150	[b]	23	[b]	---	[b]	0.035 J
56553	Benzo(a)anthracene	0.11	mg/kg	0.049 J	[b]	1.5	2.2	[b]	36	[b]	180	[b]	63	[b]	0.0018 J	[b]	0.11
50328	Benzo(a)pyrene	0.14	mg/kg	0.043 J	[b]	1.5	2.1	[b]	30	[b]	150	[b]	55	[b]	0.0017 J	[b]	0.11
205992	Benzo(b)fluoranthene	NA	mg/kg	---	[b]	2.2	3	[b]	36	[b]	190	[b]	62	[b]	0.0025 J	[b]	0.17
191242	Benzo(g,h,i)perylene	0.17	mg/kg	---	[b]	1.1	1.5	[b]	19	[b]	93	[b]	37	[b]	---	[b]	0.1
207089	Benzo(k)fluoranthene	0.24	mg/kg	0.044 J	[b]	0.99	1.2	[b]	24	[b]	86	[b]	53	[b]	---	[b]	0.077
218019	Chrysene	0.17	mg/kg	0.065 J	[b]	2	2.7	[b]	38	[b]	180	[b]	69	[b]	0.0022 J	[b]	0.15
53703	Dibenz(a,h)anthracene	0.033	mg/kg	---	[b]	0.26	0.34	[b]	5.4	[b]	26	[b]	10	[b]	---	[b]	0.024 J
206440	Fluoranthene	0.42	mg/kg	0.10 J	[b]	4.2	5.5	[b]	98	[b]	500	[b]	180	[b]	0.0036 J	[b]	0.26
86737	Fluorene	0.077	mg/kg	---	[b]	0.19	0.47	[b]	12	[b]	77	[b]	14	[b]	---	[b]	---
193395	Indeno(1,2,3-c,d)pyrene	0.017	mg/kg	---	[b]	1.2	1.6	[b]	17	[b]	80	[b]	32	[b]	---	[b]	0.084
91576	2-Methylnaphthalene	0.020	mg/kg	---	[b]	0.048 J	0.14	[b]	3.4	[b]	20	[b]	3.4 J	[b]	---	[b]	---
91203	Naphthalene	0.18	mg/kg	---	[b]	0.13	0.36	[b]	6.9	[b]	41	[b]	10	[b]	---	[b]	---
85018	Phenanthrene	0.20	mg/kg	0.046 J	[b]	2.5	4.7	[b]	99	[b]	470	[b]	130	[b]	---	[b]	0.082
129000	Pyrene	0.20	mg/kg	0.084 J	[b]	3.4	4.9	[b]	77	[b]	400	[b]	140	[b]	0.0032 J	[b]	0.22
	Total PAHs	4	mg/kg	0.43	[b]	22	32	[b]	527	[b]	2724	[b]	897	[b]		[b]	1.4
117817	Bis(2-ethylhexyl)phthalate	0.18	mg/kg	0.12 J	0.10 J	---	---	0.14 J	---	0.084 J	---	---	---	---	---	---	---
86748	Carbazole	NA	mg/kg	---	0.60 J	---	---	3.2 V	---	1.5 V	---	7.3 D	---	15 D	---	9.8 D	---
2051243	Decachlorobiphenyl	NA	mg/kg	0.020 V	---	---	---	1.5 P	---	0.032 P	---	---	---	---	---	---	---
319868	delta-BHC	0.00020	mg/kg	---	---	---	---	0.0046 P	---	---	---	---	---	---	---	---	---
132649	Dibenzofuran	0.42	mg/kg	---	0.16 J	---	---	1.5 V	---	0.89 V	---	2.9 JD	---	9.5 JD	---	6.9 JD	---
60571	Dieldrin	0.00060	mg/kg	---	---	---	---	---	---	0.00029 J	---	0.0036 J	---	---	---	0.0083 J	---
33213659	Endosulfan II	0.014	mg/kg	---	0.010 J	---	---	0.027 J	---	0.00094 J	---	---	---	0.031 J	---	---	---
7421934	Endrin aldehyde	0.00050	mg/kg	---	---	---	---	---	---	---	---	0.0031 J	---	---	---	0.0068 J	---
53494705	Endrin ketone	0.00050	mg/kg	---	---	---	---	---	---	---	---	0.0053 J	---	---	---	---	---
5103742	gamma-Chlordane	NA	mg/kg	---	---	---	---	0.24 J	---	---	---	---	---	---	---	---	---
76448	Heptachlor	0.00030	mg/kg	---	---	---	---	0.0035 J	---	---	---	---	---	0.0034 J	---	---	---
1024573	Heptachlor epoxide	0.0025	mg/kg	---	---	---	---	---	---	---	---	---	---	---	---	0.0013 J	---
72435	Methoxychlor	0.019	mg/kg	---	---	---	---	1.0 J	---	0.035 J	---	0.071 J	---	0.49 J	---	0.33 J	---
877098	Tetrachloro-m-xylene	NA	mg/kg	0.019 V	0.015 V	---	---	0.075 P	---	0.016 V	---	0.014 V	---	0.075 P	---	0.038 P	---
7429905	Aluminum	NA	mg/kg	463 V	3130 J	---	---	1540 J	---	726 J	---	1630 J	---	1040 J	---	1460 J	---
7440360	Antimony	2.0	mg/kg	0.38 J	0.7 J	---	---	0.57 J	---	0.27 J	---	0.44 J	---	0.4 J	---	0.49 J	---
7440382	Arsenic	6.0	mg/kg	1.4 J	5.4 J	---	---	1.7 J	---	0.62 J	---	1.4 J	---	1.1 J	---	1.2 J	---
7440393	Barium	NA	mg/kg	1.6 J	12.5 J	---	---	7.9 J	---	2.7 J	---	7.3 J	---	5.3 J	---	6.3 J	---
7440417	Beryllium	NA	mg/kg	0.030 J	0.27 J	---	---	0.16 J	---	0.060 J	---	0.21 J	---	0.13 J	---	0.20 J	---
7440439	Cadmium	0.60	mg/kg	0.050 J	0.51 V	---	---	0.26 J	---	0.090 J	---	0.23 J	---	0.15 J	---	0.22 J	---
7440702	Calcium	NA	mg/kg	39.4 J	1060 J	---	---	358 J	---	81.8 J	---	352 J	---	224 J	---	506 J	---
7440473	Chromium	26	mg/kg	4.7 J	8.9 J	---	---	8.2 J	---	4.5 J	---	8.9 J	---	5.8 J	---	9.6 J	---
7440484	Cobalt	50	mg/kg	0.3 J	5.2 V	---	---	2.5 V	---	0.55 V	---	1.5 V	---	1.1 V	---	1.6 V	---
7440508	Copper	16	mg/kg	3.1 J	53.9 J	---	---	16.3 J	---	3.1 J	---	11.8 J	---	9.0 J	---	17.7 J	---
7439896	Iron	20000	mg/kg	2510 J	6260 J	---	---	8120 J	---	3490 J	---	6330 J	---	4790 J	---	5920 J	---

Table 4-12
Summary of Analytes Detected in Surface Sediment and Comparison to Ecological Benchmarks
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Sediment Benchmark[a]	Units	SD1810 7/19/2005	SD1811 7/19/2005	SD1827 10/1/2013	SD1827-DUP 10/1/2013	SD1812 7/19/2005	SD1820 10/1/2013	SD1813 7/19/2005	SD1821A 10/1/2013	SD1814 7/19/2005	SD1822A 10/1/2013	SD1815 7/19/2005	SD1823A 10/1/2013	SD1816 7/19/2005	SD1819 10/1/2013
7439921	Lead	31	mg/kg	7.5 J	37.2 J	---	---	23.5 J	---	4.8 J	---	14.1 J	---	59.5 J	---	15.6 J	---
7439954	Magnesium	NA	mg/kg	30.6 J	367 J	---	---	212.0 J	---	101 J	---	220 J	---	157 J	---	189 J	---
7439965	Manganese	460	mg/kg	1.6 J	103 J	---	---	61.0 J	---	8.4 J	---	20.6 J	---	18.2 J	---	19 J	---
7439976	Mercury	0.18	mg/kg	0.033 J	0.079 V	---	---	---	---	---	---	---	---	---	---	---	---
7440020	Nickel	16	mg/kg	0.39 J	5.4 V	---	---	4.0 V	---	0.85 J	---	3.2 V	---	2.3 J	---	3.2 V	---
7440097	Potassium	NA	mg/kg	18 J	224 J	---	---	121 J	---	60.7 J	---	116 J	---	81.2 J	---	108 J	---
7782492	Selenium	2.0	mg/kg	---	0.74 J	---	---	---	---	---	---	0.38 J	---	0.36 J	---	---	---
7440224	Silver	0.50	mg/kg	---	0.12 J	---	---	---	---	---	---	---	---	---	---	---	---
7440235	Sodium	NA	mg/kg	---	66.6 J	---	---	52.9 J	---	31 J	---	52.6 J	---	45.8 J	---	55.9 J	---
7440622	Vanadium	NA	mg/kg	13 J	22.4 J	---	---	16.4 J	---	12.5 J	---	19.5 J	---	12.4 J	---	17 J	---
7440666	Zinc	120	mg/kg	4 J	57.5 J	---	---	49.4 J	---	10.6 J	---	36.4 J	---	27.9 J	---	46.7 J	---

[a]Lowest available benchmark based on: Jones et al., 1997, EPA, 1996, EPA, 2006b, Fletcher et al., 2008, MacDonald et al., 2000, and Persaud et al., 1996.

[b]This sample location has been resampled. The results are presented in the 10/1/2013 sample column.

J - estimated vaue, potentially unreliable concentration.

mg/kg = Milligrams per kilogram.

NA = Not available.

"---" = Analyte either not analyzed or not detected.

Shading indicates that the detected concentration exceeds the screening level.

Table 4-12
Summary of Analytes Detected in Surface Sediment and Comparison to Ecological Benchmarks
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Sediment Benchmark[a]	Units	SD1824A 10/1/2013	SD1824A-DUP 10/1/2013	SD1825 10/1/2013	SD1826 10/1/2013
72548	4,4-DDD	0.0049	mg/kg	---	---	---	---
72559	4,4-DDE	0.0032	mg/kg	---	---	---	---
50293	4,4-DDT	0.0042	mg/kg	---	---	---	---
83329	Acenaphthene	0.0067	mg/kg	5.4	12	0.49	1.4
208968	Acenaphthylene	0.0059	mg/kg	---	---	0.19	0.083 J
120127	Anthracene	0.027	mg/kg	14	16	1.2	2.4
56553	Benzo(a)anthracene	0.11	mg/kg	25	42	5.4	4.8
50328	Benzo(a)pyrene	0.14	mg/kg	19	35	6	4.4
205992	Benzo(b)fluoranthene	NA	mg/kg	25	46	9.1	6.0
191242	Benzo(g,h,i)perylene	0.17	mg/kg	14	23	4.9	4.0
207089	Benzo(k)fluoranthene	0.24	mg/kg	15	22	4	2.4
218019	Chrysene	0.17	mg/kg	26	43	7	5.5
53703	Dibenz(a,h)anthracene	0.033	mg/kg	3.7	6.2	1.1	0.98
206440	Fluoranthene	0.42	mg/kg	62	110	14	12
86737	Fluorene	0.077	mg/kg	5.2	10	0.53	0.99
193395	Indeno(1,2,3-c,d)pyrene	0.017	mg/kg	12	20	5.2	4.2
91576	2-Methylnaphthalene	0.020	mg/kg	1.3 J	2.6 J	0.11 J	0.33
91203	Naphthalene	0.18	mg/kg	3.5	6.2	0.24	0.84
85018	Phenanthrene	0.20	mg/kg	43	98	6.1	9.9
129000	Pyrene	0.20	mg/kg	50	90	11	10
	Total PAHs	4	mg/kg	324	582	77	70
117817	Bis(2-ethylhexyl)phthalate	0.18	mg/kg	---	---	---	---
86748	Carbazole	NA	mg/kg	---	---	---	---
2051243	Decachlorobiphenyl	NA	mg/kg	---	---	---	---
319868	delta-BHC	0.00020	mg/kg	---	---	---	---
132649	Dibenzofuran	0.42	mg/kg	---	---	---	---
60571	Dieldrin	0.00060	mg/kg	---	---	---	---
33213659	Endosulfan II	0.014	mg/kg	---	---	---	---
7421934	Endrin aldehyde	0.00050	mg/kg	---	---	---	---
53494705	Endrin ketone	0.00050	mg/kg	---	---	---	---
5103742	gamma-Chlordane	NA	mg/kg	---	---	---	---
76448	Heptachlor	0.00030	mg/kg	---	---	---	---
1024573	Heptachlor epoxide	0.0025	mg/kg	---	---	---	---
72435	Methoxychlor	0.019	mg/kg	---	---	---	---
877098	Tetrachloro-m-xylene	NA	mg/kg	---	---	---	---
7429905	Aluminum	NA	mg/kg	---	---	---	---
7440360	Antimony	2.0	mg/kg	---	---	---	---
7440382	Arsenic	6.0	mg/kg	---	---	---	---
7440393	Barium	NA	mg/kg	---	---	---	---
7440417	Beryllium	NA	mg/kg	---	---	---	---
7440439	Cadmium	0.60	mg/kg	---	---	---	---
7440702	Calcium	NA	mg/kg	---	---	---	---
7440473	Chromium	26	mg/kg	---	---	---	---
7440484	Cobalt	50	mg/kg	---	---	---	---
7440508	Copper	16	mg/kg	---	---	---	---
7439896	Iron	20000	mg/kg	---	---	---	---

Table 4-12
Summary of Analytes Detected in Surface Sediment and Comparison to Ecological Benchmarks
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Sediment Benchmark[a]	Units	SD1824A 10/1/2013	SD1824A-DUP 10/1/2013	SD1825 10/1/2013	SD1826 10/1/2013
7439921	Lead	31	mg/kg	---	---	---	---
7439954	Magnesium	NA	mg/kg	---	---	---	---
7439965	Manganese	460	mg/kg	---	---	---	---
7439976	Mercury	0.18	mg/kg	---	---	---	---
7440020	Nickel	16	mg/kg	---	---	---	---
7440097	Potassium	NA	mg/kg	---	---	---	---
7782492	Selenium	2.0	mg/kg	---	---	---	---
7440224	Silver	0.50	mg/kg	---	---	---	---
7440235	Sodium	NA	mg/kg	---	---	---	---
7440622	Vanadium	NA	mg/kg	---	---	---	---
7440666	Zinc	120	mg/kg	---	---	---	---

[a]Lowest available benchmark based on: Jones et al., 1997, EPA, 1996, EPA,

[b]This sample location has been resampled. The results are presented in the 1

J - estimated vaue, potentially unreliable concentration.

mg/kg = Milligrams per kilogram.

NA = Not available.

"---" = Analyte either not analyzed or not detected.

Shading indicates that the detected concentration exceeds the screening level

Table 4-13
AOC 2 Analytical Results Summary - September/November 2017
U.S. EPA and GSA Property Area
Former Raritan Arsenal

	Location ID:	MW-114	MW-139	MW-140	MW-160-1	MW-311	MW-314		MW-317	MW-318		MW-CP-IV-1	MW-320
	Field Sample ID:	GW22-MW-114	GW5-MW-139	GW7-MW-140	GW6-MW-160-1	GW12-MW-311	GW7-MW-314	GW-FD-01	GW2-MW-317	GW2-MW-318	GW2-MW-318-DUP	GW5-MW-CP-IV-1	GW1-MW-320
	Lab Sample ID:	280-101630-5	280-101566-3	280-101566-5	280-101566-4	280-101566-2	280-101566-6	280-101566-8	280-103931-1	280-103931-2	280-103931-3	280-101566-1	280-103931-4
	Sampling Date:	9/26/2017	9/25/2017	9/25/2017	9/25/2017	9/25/2017	9/25/2017	9/25/2017	11/21/2017	11/21/2017	11/21/2017	9/25/2017	11/20/2017
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Compound	NJDEP GWQS (µg/L)												
1,1,1,2-Tetrachloroethane	1	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,1,1-Trichloroethane	30	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,1,2,2-Tetrachloroethane	1	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,1,2-Trichloroethane	3	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,1-Dichloroethane	50	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,1-Dichloroethene	1	0.36 J	0.36 J	0.38 J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,1-Dichloropropene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,2,3-Trichlorobenzene	NA	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,2,3-Trichloropropane	0.03	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,2,4-Trichlorobenzene	9	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,2,4-Trimethylbenzene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,2-Dibromo-3-Chloropropane	0.02	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U
1,2-Dichlorobenzene	600	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,2-Dichloroethane	2	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,2-Dichloroethene, Total	NA	100	54	50	5.9	28	5.4	5.5	1.9	1.3	1.2	2.7	3.6
1,2-Dichloropropane	1	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,3,5-Trimethylbenzene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,3-Dichlorobenzene	600	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,3-Dichloropropane	NA	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,4-Dichlorobenzene	75	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,4-Dioxane	NA	0.5 U	0.24 J	0.5 U	0.5 U	0.5 U	14	14	0.4 U	0.4 U	0.4 U	0.5 U	0.5 U
2,2-Dichloropropane	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.5 U	0.5 U	0.5 U	0.4 U	0.4 U
2-Butanone (MEK)	300	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U
2-Chlorotoluene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
2-Hexanone	NA	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U
4-Chlorotoluene	NA	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
4-Isopropyltoluene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
4-Methyl-2-pentanone (MIBK)	NA	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U
Acetone	6000	3 J	6.4 U	6.4 U	6.4 U	6.4 U	6.4 U	6.4 U	6.4 U	6.4 U	6.4 U	6.4 U	6.4 U
Benzene	1	0.22 J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U
Bromobenzene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Bromochloromethane	NA	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Bromodichloromethane	1	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Bromoform	4	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Bromomethane	10	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Carbon disulfide	700	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U
Carbon tetrachloride	1	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Chlorobenzene	50	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Chloroethane	NA	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U
Chloroform	70	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.72 J	0.49 J
Chloromethane	NA	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
cis-1,2-Dichloroethene	70	100 D	54	49	5.9	28	5.4	5.5	1.9	1.3	1.2	2.7	3.6
cis-1,3-Dichloropropene	1	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Dibromochloromethane	1	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Dibromomethane	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Dichlorodifluoromethane	1000	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Ethylbenzene	700	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Ethylene Dibromide	0.03	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Hexachlorobutadiene	1	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Isopropylbenzene	700	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U

Table 4-13
AOC 2 Analytical Results Summary - September/November 2017
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Location ID:		MW-114	MW-139	MW-140	MW-160-1	MW-311	MW-314		MW-317	MW-318		MW-CP-IV-1	MW-320
Field Sample ID:		GW22-MW-114	GW5-MW-139	GW7-MW-140	GW6-MW-160-1	GW12-MW-311	GW7-MW-314	GW-FD-01	GW2-MW-317	GW2-MW-318	GW2-MW-318-DUP	GW5-MW-CP-IV-1	GW1-MW-320
Lab Sample ID:		280-101630-5	280-101566-3	280-101566-5	280-101566-4	280-101566-2	280-101566-6	280-101566-8	280-103931-1	280-103931-2	280-103931-3	280-101566-1	280-103931-4
Sampling Date:		9/26/2017	9/25/2017	9/25/2017	9/25/2017	9/25/2017	9/25/2017	9/25/2017	11/21/2017	11/21/2017	11/21/2017	9/25/2017	11/20/2017
Units:		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Compound	NJDEP GWQS (µg/L)												
Methyl tert-butyl ether	70	1.5 J	0.8 U	0.8 U	0.8 U	0.9 J	0.53 J	0.47 J	0.85 J	0.25 J	0.8 U	0.8 U	0.8 U
Methylene Chloride	3	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
m-Xylene & p-Xylene	1000	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Naphthalene	300	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
n-Butylbenzene	NA	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
N-Propylbenzene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
o-Xylene	1000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
sec-Butylbenzene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Styrene	100	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
tert-Butylbenzene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Tetrachloroethene	1	0.42 J	3	0.84 J	0.29 J	0.23 J	0.21 J	0.22 J	0.4 U	0.4 U	0.4 U	1.1	0.36 J
Toluene	600	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
trans-1,2-Dichloroethene	100	0.18 J	0.45 J	0.57 J	0.4 U	0.32 J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
trans-1,3-Dichloropropene	1	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Trichloroethene	1	9.1	57	29	5.9	5	1.6	1.7	0.48 J	0.53 J	0.47 J	7.5	5
Trichlorofluoromethane	2000	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Vinyl chloride	1	76 D	7.1	9.6	0.75 J	17	1.1 J	1.2 J	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Xylenes, Total	1000	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U

NOTES:

D - The reported value is from a dilution.
ID - Identifier.
J - Estimated concentration.
NA - Not available.
R - Rejected results.
U - Not detected at reporting limit.
U J - Not detected, estimated concentration
ug/L - micrograms per liter

Shaded text box indicates that the concentration exceeds the NJDEP GWQS

Table 4-14
AOC 4 Analytical Results Summary - September/November 2017
U.S. EPA and GSA Property Area
Former Raritan Arsenal

	Location ID:	MW-46A	MW-120	MW-122	MW-EPA-2A	OB-7A	MW-321
	Field Sample ID:	GW14-MW-46A	GW12-MW-120	GW12-MW-122	GW13-MW-EPA-2A	GW4-OB-7A	GW1-MW-321
	Lab Sample ID:	280-101718-3	280-101566-9	280-101777-5	280-101630-13	280-101566-7	280-103931-5
	Sampling Date:	9/27/2017	9/25/2017	9/28/2017	9/26/2017	9/25/2017	11/20/2017
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Compound	NJDEP GWQS (µg/L)						
1,1,1,2-Tetrachloroethane	1	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,1,1-Trichloroethane	30	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,1,2,2-Tetrachloroethane	1	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,1,2-Trichloroethane	3	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,1-Dichloroethane	50	0.8 U J	0.36 J	0.8 U	0.8 U	0.8 U	0.8 U
1,1-Dichloroethene	1	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,1-Dichloropropene	NA	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,2,3-Trichlorobenzene	NA	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,2,3-Trichloropropane	0.03	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,2,4-Trichlorobenzene	9	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,2,4-Trimethylbenzene	NA	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,2-Dibromo-3-Chloropropane	0.02	1.6 U J	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U
1,2-Dichlorobenzene	600	0.4 U J	0.4 U	0.4 U	0.26 J	0.4 U	0.4 U
1,2-Dichloroethane	2	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,2-Dichloroethene, Total	NA	12 J	12	0.81 J	2.4 J	3.8	0.2 U
1,2-Dichloropropane	1	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,3,5-Trimethylbenzene	NA	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,3-Dichlorobenzene	600	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,3-Dichloropropane	NA	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
1,4-Dichlorobenzene	75	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,4-Dioxane	NA	0.5 U J	0.5 U	0.5 U	0.5 U	0.5 U	0.4 U
2,2-Dichloropropane	NA	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.5 U
2-Butanone (MEK)	300	4 U J	4 U	4 U	4 U	4 U	4 U
2-Chlorotoluene	NA	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
2-Hexanone	NA	4 U J	4 U	4 U	4 U	4 U	4 U
4-Chlorotoluene	NA	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
4-Isopropyltoluene	NA	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
4-Methyl-2-pentanone (MIBK)	NA	3.2 U J	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U
Acetone	6000	6.4 U J	6.4 U	5.6 J	6.4 U	6.4 U	6.4 U
Benzene	1	0.87 J	0.45 J	0.23 J	0.71 J	0.4 U	0.4 U
Bromobenzene	NA	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Bromochloromethane	NA	0.2 U J	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Bromodichloromethane	1	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Bromoform	4	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Bromomethane	10	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Carbon disulfide	700	1.6 U J	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U
Carbon tetrachloride	1	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Chlorobenzene	50	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Chloroethane	NA	1.6 U J	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U
Chloroform	70	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Chloromethane	NA	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
cis-1,2-Dichloroethene	70	12 J	12	0.81 J	2.4 J	3.8	0.4 U
cis-1,3-Dichloropropene	1	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Dibromochloromethane	1	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Dibromomethane	NA	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Dichlorodifluoromethane	1000	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Ethylbenzene	700	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Ethylene Dibromide	0.03	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Hexachlorobutadiene	1	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Isopropylbenzene	700	0.4 U J	0.4 U	0.4 U	0.42 J	0.4 U	0.4 U
Methyl tert-butyl ether	70	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Methylene Chloride	3	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
m-Xylene & p-Xylene	1000	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Naphthalene	300	0.8 U J	0.8 U	0.35 J	0.8 U	0.8 U	0.8 U
n-Butylbenzene	NA	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
N-Propylbenzene	NA	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
o-Xylene	1000	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
sec-Butylbenzene	NA	0.4 U J	0.4 U	0.4 U	0.76 J	0.4 U	0.4 U
Styrene	100	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
tert-Butylbenzene	NA	0.4 U J	0.4 U	0.4 U	0.38 J	0.4 U	0.4 U
Tetrachloroethene	1	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Toluene	600	0.4 U J	0.4 U	0.18 J	0.4 U	0.4 U	0.4 U
trans-1,2-Dichloroethene	100	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
trans-1,3-Dichloropropene	1	0.4 U J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Trichloroethene	1	5 J	1.5	0.37 J	0.4 U	0.89 J	0.4 U
Trichlorofluoromethane	2000	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Vinyl chloride	1	0.92 J	4.3	0.77 J	1 J	0.6 J	0.2 U
Xylenes, Total	1000	0.8 U J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U

NOTES:

ID - Identifier.
J - Estimated concentration.
NA - Not available.
R - Rejected results.
U - Not detected at reporting limit.
ug/L - micrograms per liter

Shaded text box indicates that the concentration exceeds the NJDEP GWQS

Table 4-15
AOC 8 Analytical Results Summary - September 2017
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Location ID:		MW-8	MW-87A	MW-88A		MW-89A	MW-106A	MW-121	MW-125	MW-134	MW-136	MW-153	MW-156	MW-EPA-10A
Field Sample ID:		GW14-MW-8	GW15-MW-87A	GW16-MW-88A	GW-FD-02	GW15-MW-89A	GW14-MW-106A	GW13-MW-121	GW12-MW-125	GW5-MW-134	GW5-MW-136	GW5-MW-153	GW5-MW-156	GW5-MW-EPA-10A
Lab Sample ID:		280-101630-1	280-101630-12	280-101630-4	280-101630-10	280-101718-11	280-101630-2	280-101630-11	280-101630-3	280-101630-8	280-101718-2	280-101630-6	280-101630-9	280-101630-7
Sampling Date:		9/26/2017	9/26/2017	9/26/2017	9/26/2017	9/27/2017	9/26/2017	9/26/2017	9/26/2017	9/26/2017	9/27/2017	9/26/2017	9/26/2017	9/26/2017
Units:		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Compound	NJDEP GWQS (µg/L)													
1,1,1,2-Tetrachloroethane	1	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
1,1,1-Trichloroethane	30	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
1,1,2,2-Tetrachloroethane	1	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
1,1,2-Trichloroethane	3	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
1,1-Dichloroethane	50	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
1,1-Dichloroethene	1	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.5 J	0.8 U	0.8 U
1,1-Dichloropropene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
1,2,3-Trichlorobenzene	NA	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
1,2,3-Trichloropropane	0.03	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
1,2,4-Trichlorobenzene	9	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
1,2,4-Trimethylbenzene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
1,2-Dibromo-3-Chloropropane	0.02	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U J	1.6 U	1.6 U	1.6 U
1,2-Dichlorobenzene	600	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
1,2-Dichloroethane	2	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
1,2-Dichloroethene, Total	NA	8.5	0.2 U	2.1	2.1	0.2 U	1.1	0.78 J	0.18 J	0.2 U	0.2 U J	11	2.5 J	0.2 U
1,2-Dichloropropane	1	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
1,3,5-Trimethylbenzene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
1,3-Dichlorobenzene	600	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
1,3-Dichloropropane	NA	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
1,4-Dichlorobenzene	75	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
1,4-Dioxane	NA	0.5 U	5 U	0.29 J	0.32 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U J	0.5 U	0.5 U	0.48 J
2,2-Dichloropropane	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
2-Butanone (MEK)	300	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U J	4 U	4 U	4 U
2-Chlorotoluene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
2-Hexanone	NA	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U J	4 U	4 U	4 U
4-Chlorotoluene	NA	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
4-Isopropyltoluene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
4-Methyl-2-pentanone (MIBK)	NA	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U J	3.2 U	3.2 U	3.2 U
Acetone	6000	4.8 U	6.4 U	5.6 U	7.8 U	6.4 U	5.2 U	4.9 J	5.2 J	6.8 U	6.4 U J	4.5 U	4.8 U	2.2 U
Benzene	1	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
Bromobenzene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
Bromochloromethane	NA	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U J	0.2 U	0.2 U	0.2 U
Bromodichloromethane	1	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	2.1 J	0.4 U	0.4 U	0.4 U
Bromoform	4	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
Bromomethane	10	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
Carbon disulfide	700	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U J	1.6 U	1.6 U	1.6 U
Carbon tetrachloride	1	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
Chlorobenzene	50	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
Chloroethane	NA	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U J	1.6 U	1.6 U	1.6 U
Chloroform	70	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.21 J	0.4 U	0.4 U	4.8 J	0.4 U	0.33 J	0.4 U
Chloromethane	NA	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
cis-1,2-Dichloroethene	70	8	0.4 U	1.9	1.9	0.4 U	1.1	0.78 J	0.18 J	0.4 U	0.4 U J	9.7	2.3 J	0.4 U
cis-1,3-Dichloropropene	1	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
Dibromochloromethane	1	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.57 J	0.4 U	0.4 U	0.4 U
Dibromomethane	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
Dichlorodifluoromethane	1000	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
Ethylbenzene	700	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
Ethylene Dibromide	0.03	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Hexachlorobutadiene	1	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
Isopropylbenzene	700	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U

Table 4-15
AOC 8 Analytical Results Summary - September 2017
U.S. EPA and GSA Property Area
Former Raritan Arsenal

	Location ID:	MW-8	MW-87A	MW-88A		MW-89A	MW-106A	MW-121	MW-125	MW-134	MW-136	MW-153	MW-156	MW-EPA-10A
	Field Sample ID:	GW14-MW-8	GW15-MW-87A	GW16-MW-88A	GW-FD-02	GW15-MW-89A	GW14-MW-106A	GW13-MW-121	GW12-MW-125	GW5-MW-134	GW5-MW-136	GW5-MW-153	GW5-MW-156	GW5-MW-EPA-10A
	Lab Sample ID:	280-101630-1	280-101630-12	280-101630-4	280-101630-10	280-101718-11	280-101630-2	280-101630-11	280-101630-3	280-101630-8	280-101718-2	280-101630-6	280-101630-9	280-101630-7
	Sampling Date:	9/26/2017	9/26/2017	9/26/2017	9/26/2017	9/27/2017	9/26/2017	9/26/2017	9/26/2017	9/26/2017	9/27/2017	9/26/2017	9/26/2017	9/26/2017
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Compound	NJDEP GWQS (µg/L)													
1,1,1,2-Tetrachloroethane	1	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
Methyl tert-butyl ether	70	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.45 J	0.8 U
Methylene Chloride	3	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
m-Xylene & p-Xylene	1000	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
Naphthalene	300	0.8 U	0.8 U	0.8 U	0.36 J	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
n-Butylbenzene	NA	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
N-Propylbenzene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
o-Xylene	1000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
sec-Butylbenzene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
Styrene	100	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
tert-Butylbenzene	NA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
Tetrachloroethene	1	0.31 J	0.4 U	0.4 U	0.4 U	0.4 U	0.23 J	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
Toluene	600	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
trans-1,2-Dichloroethene	100	0.47 J	0.4 U	0.2 J	0.22 J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	1.4	0.17 J	0.4 U
trans-1,3-Dichloropropene	1	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U J	0.4 U	0.4 U	0.4 U
Trichloroethene	1	98.0 D	1.1	0.4 U	0.4 U	0.4 U	5.8	50.0	18.0	0.4 J	1.7 J	34.0	130.0 J	1.9
Trichlorofluoromethane	2000	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U
Vinyl chloride	1	2.7	0.2 U	2.1	2.1	0.2 U	0.76 J	0.2 U	0.2 U	0.2 U	0.2 U J	0.2 U	0.2 U	0.2 U
Xylenes, Total	1000	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U J	0.8 U	0.8 U	0.8 U

NOTES:

D - The reported value is from a dilution.
ID - Identifier.
J - Estimated concentration.
NA - Not available.
R - Rejected results.
U - Not detected at reporting limit.
U J - Not detected, estimated concentration.
µg/L - micrograms per liter
Shaded text box indicates that the concentration exceeds the NJDEP GWQS

Section 5 Table

Table 5-1
Physical Properties of Organic Contaminants
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Chemical	Density (g/cc)	Solubility (mg/L)	Sorption	Mobility	Volatility	Chemical Class.
Volatile Organics						
1,2 Dichloroethane	1.25	8,690	W	V	High	HHC
Chloroform	1.49	8,220	W	V	High	HHC
trans 1,2 Dichloroethene	1.26	6,300	W	V	High	HHC
cis 1,2 Dichloroethene	1.28	3,500	W	V	High	HHC
Vinyl Chloride	0.91	1,100	VW	H-V	High	HHC
Trichloroethene (TCE)	1.46	1,000	W	H	High	HHC
1,1 Dichloroethene	1.22	400	W	H	High	HHC
Tetrachloroethene (PCE)	1.62	150	M	M	High	HHC
Benzene	0.88	1,780	W	H V	High	AHC
Ethylbenzene	0.87	152	M	M	High	AHC
Semivolatile Organics						
Naphthalene	1.15	32	M	L-M	Mod	PAH
Indeno(1,2,3 cd)pyrene		0.06	VS	I	Non	PAH
Benzo(a)anthracene	1.27	0.01	VS	I	Low	PAH
Benzo(a)pyrene	1.35	0.004	VS	I	Low	PAH
Benzo(b)fluoranthene		0.001	VS	I	Mod	PAH
Benzo(k)fluoranthene		0.0006	VS	I	High	PAH
Dibenzo(a,h)anthracene	1.28	0.0005	VS	I	Non	PAH
Pentachlorophenol	1.98	14	MS	L-M	Low	PHE
Carbazole	1.1	0.0005	S	L	Low	NSV
Acrolein (acraldehyde)l	0.839	212,000	V	V	Mod	OSV
Pesticides						
Heptachlor Epoxide		0.27	S	I-S	Mod	PES
Dieldrin	1.75	0.19	S	S	Mod	PES
Aldrin	1.7	0.18	S	I	Mod	PES
gamma Chlordane (trans)		0.051	VS	I	High	PES
4 4' DDE		0.04	VS	I	Low	PES
4 4' DDT	0.98	0.003	VS	I	Low	PES
PCBs						
PCB 1254 (Aroclor 1254)	1.51	0.05	VS	I	Mod	PCB
PCB 1260 (Aroclor 1260)	1.57	0.014	VS	I	Mod	PCB

Sorption qualifiers: VW very weakly sorbed, W weak, M moderate, MS moderate to strong, S strong, VS very strong

Chemical Classification: HHC halogenated aliphatic hydrocarbons, AHC aromatic hydrocarbons, OVC oxygenated volatile compound, SVC sulfur containing compound, PAH polycyclic aromatic hydrocarbon, PHE phenols, OSV oxygenated semivolatiles, NSV nitrogenated semivolatiles, PES pesticides, and PCB Polychlorinated biphenyls.

Property	Range	Qualitative Description
Sorption Soil adsorption coefficient (K_{OC})	< 10	very weakly sorbed
	10 100	weakly sorbed
	100 1000	moderately sorbed
	1000 10,000	moderately to strongly sorbed
	10,000 100,000	strongly sorbed
	>100,000	very strongly sorbed
Mobility Based on a combination of solubility (s) (mg/L) and soil adsorption (K_{OC})	s > 3500 & Koc < 50	very high mobility
	3500>s>850 & 50< Koc< 150	high mobility
	800>s>150 & 150<Koc< 500	moderate mobility
	150>s>15 & 500<Koc<2000	low mobility
	15>s>0.2 & 2000<Koc<20,000	slight mobility
	s<0.2 & Koc>20,000	immobile
Volatility Henry's Law Constant (H) (atm m^3/mol)	$H < 3x10^{-7}$	nonvolatile
	$3x10^{-7} < H < 10^{-5}$	low volatility
	$10^{-5} < H < 10^{-3}$	moderate volatility
	$H > 10^{-3}$	high volatility

Section 6 Tables

Table 6-1
Summary of Analytes Detected in Surface Soil (0 to 2 ft bgs) - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency[a]	Limits of Quantitation[b]	Arithmetic Mean[c]	EPA Regional Screening Level[d]	Ratio of Maximum Concentration to EPA RSL	NJDEP Residential Soil Remediation Standard[e]	Ratio of Maximum Concentration to NJDEP RSR	COPC
83329	Acenaphthene	4.20E-02	3.60E-01	mg/kg	SS-18G18Z	16/152	6.70E-03 - 2.00E+00	3.59E-01	3.60E+02 n	0.0010	3.40E+03 n	0.0001	
208968	Acenaphthylene	3.90E-02	1.40E+00	mg/kg	SS-18G14A	20/152	6.70E-03 - 2.00E+00	3.77E-01	3.60E+02 n	0.0039	NBA	---	
120127	Anthracene	3.50E-02	8.70E-01	mg/kg	SS-18G15A	41/152	6.70E-03 - 2.00E+00	3.43E-01	1.80E+03 n	0.00048	1.70E+04 n	0.00005	
12672296	Aroclor-1248	2.00E-01	2.00E-01	mg/kg	SS-18E45A	1/102	3.50E-02 - 7.90E-01	7.09E-02	2.30E-01 c	0.87	2.00E-01 c	1.0	X
11096825	Aroclor-1260	4.70E-01	4.70E-01	mg/kg	SS-18A04A	1/106	3.30E-02 - 7.90E-01	7.98E-02	2.40E-01 c	2.0	2.00E-01 c	2.4	X
71432	Benzene	1.90E-01	1.90E-01	mg/kg	SS-18E11	1/112	8.00E-04 - 7.40E-01	6.01E-02	1.20E+00 c	0.16	2.00E+00 c	0.095	
56553	Benzo(a)anthracene	2.60E-03	2.70E+00	mg/kg	SS-18G15A	88/152	3.50E-02 - 2.00E+00	4.06E-01	1.10E+00 c	2.5	6.00E-01 c	4.5	X
50328	Benzo(a)pyrene	2.60E-03	3.30E+00	mg/kg	SS-18G15A	87/152	3.50E-02 - 2.00E+00	4.28E-01	1.10E-01 c	30	2.00E-01 c	17	X
205992	Benzo(b)fluoranthene	4.10E-03	4.90E+00	mg/kg	SS-18G14A	89/152	3.50E-02 - 2.00E+00	4.85E-01	1.10E+00 c	4.5	6.00E-01 c	8.2	X
191242	Benzo(g,h,i)perylene	2.40E-03	2.80E+00	mg/kg	SS-18G14A	68/152	3.20E-01 - 2.00E+00	4.01E-01	NBA	--	3.80E+05 c	0.0000074	
207089	Benzo(k)fluoranthene	1.80E-03	3.10E+00	mg/kg	SS-18G15A	88/152	3.50E-02 - 2.00E+00	4.22E-01	1.10E+01 c	0.3	6.00E+00 c	0.52	
117817	Bis(2-ethylhexyl)phthalate	5.30E-02	9.10E-02	mg/kg	SS18B81	2/101	2.40E-01 - 2.00E+00	3.88E-01	3.90E+01 c	0.0023	3.50E+01 c	0.0026	
78933	2-Butanone	1.50E+00	1.50E+00	mg/kg	SS-18C125A	1/112	4.00E-03 - 1.50E+00	2.55E-01	2.70E+03 n	0.00056	3.10E+03 n	0.0005	
85687	Butylbenzylphthalate	2.40E-02	5.60E-02	mg/kg	SS-0105A	3/101	3.20E-01 - 2.00E+00	3.84E-01	2.90E+02 c	0.00019	1.20E+03 n	0.00005	
86748	Carbazole	3.90E-02	6.10E-01	mg/kg	SS-18G18Z	17/101	3.20E-01 - 2.00E+00	3.56E-01	NBA	--	2.40E+01 c	0.025	
5103719	alpha-Chlordane	3.70E-03	1.00E-01	mg/kg	SS-18C41A	2/83	8.80E-04 - 1.00E-01	1.49E-02	1.70E+00 c	0.059	2.00E-01 c	0.50	
5566347	gamma-Chlordane	2.90E-03	1.30E-01	mg/kg	SS-18C41A	2/82	4.50E-04 - 1.00E-01	1.54E-02	1.70E+00 c	0.076	2.00E-01 c	0.65	
218019	Chrysene	3.40E-03	3.10E+00	mg/kg	SS-18G18Z	93/152	3.20E-01 - 2.00E+00	4.72E-01	1.10E+02 c	0.03	6.20E+01 c	0.050	
72548	4,4-DDD	1.50E-03	1.60E-01	mg/kg	SS-18B05B	6/83	1.80E-03 - 7.90E-02	9.79E-03	1.90E-01 n	0.84	3.00E+00 c	0.053	
72559	4,4-DDE	4.00E-03	5.10E-02	mg/kg	SS-18G18Z	15/82	8.80E-04 - 7.90E-02	1.01E-02	2.00E+00 c	0.026	2.00E+00 c	0.026	
50293	4,4-DDT	3.50E-03	1.30E-01	mg/kg	SS-18G18Z	25/82	2.70E-03 - 7.90E-02	1.24E-02	1.90E+00 c	0.068	2.00E+00 c	0.065	
53703	Dibenz(a,h)anthracene	3.80E-02	9.30E-01	mg/kg	SS-18G14A	35/152	6.70E-03 - 2.00E+00	3.49E-01	1.10E-01 c	8.5	2.00E-01 c	4.7	X
132649	Dibenzofuran	4.80E-02	2.30E-01	mg/kg	SS-18G18Z	11/151	3.20E-01 - 2.00E+00	3.67E-01	7.30E+00 n	0.032	NBA	---	
156592	cis-1,2-Dichloroethene	1.40E+00	1.40E+00	mg/kg	SS-18C107A	1/45	1.10E-03 - 8.40E-01	5.07E-01	1.60E+01 n	0.088	2.30E+02 n	0.006	
156605	trans-1,2-Dichloroethene	9.40E-02	9.40E-02	mg/kg	SS-18C107A	1/45	1.10E-03 - 8.40E-01	4.78E-01	1.60E+02 n	0.00059	3.00E+02 n	0.0003	
131113	Dimethyl phthalate	8.20E-02	9.60E-02	mg/kg	SS-0105A	2/101	3.20E-01 - 2.00E+00	3.87E-01	NBA	--	NBA	---	
84742	Di-n-butyl phthalate	3.20E-01	3.20E-01	mg/kg	SS-18C67A	1/101	3.30E-01 - 1.10E+00	4.07E-01	6.30E+02 n	0.00051	6.10E+03 n	0.00005	
117840	Di-n-octyl phthalate	6.70E-02	6.70E-02	mg/kg	SS-18G01A	1/101	3.20E-01 - 2.00E+00	3.90E-01	6.30E+01 n	0.0011	2.40E+03 n	0.00003	
33213659	Endosulfan II	1.70E-02	1.70E-02	mg/kg	SS-0103A	1/82	1.80E-03 - 7.90E-02	7.76E-03	4.70E+01 n	0.00036	4.70E+02 n	0.00004	
7421934	Endrin aldehyde	8.10E-03	8.10E-03	mg/kg	SS-18C34A	1/82	1.80E-03 - 7.90E-02	7.80E-03	1.90E+00 n	0.0043	2.30E+01 n	0.0004	
206440	Fluoranthene	6.00E-03	5.70E+00	mg/kg	SS-18A02A	96/152	3.20E-01 - 2.00E+00	6.76E-01	2.40E+02 n	0.024	2.30E+03 n	0.002	
86737	Fluorene	3.80E-02	3.90E-01	mg/kg	SS-18G18Z	17/152	6.70E-03 - 2.00E+00	3.57E-01	2.40E+02 n	0.0016	2.30E+03 n	0.0002	
76448	Heptachlor	5.00E-02	5.00E-02	mg/kg	SS-18C41A	1/83	4.50E-04 - 3.90E-02	4.05E-03	1.30E-01 c	0.38	1.00E-01 c	0.50	
193395	Indeno(1,2,3-c,d)pyrene	2.30E-03	2.50E+00	mg/kg	SS-18G14A	68/152	3.50E-02 - 2.00E+00	3.78E-01	1.10E+00 c	2.3	6.00E-01 c	4.2	X
72435	Methoxychlor	9.60E-03	9.60E-03	mg/kg	SS18B81	1/83	4.40E-03 - 3.90E-01	3.92E-02	3.20E+01 n	0.00030	3.90E+02 n	0.00002	
75092	Methylene chloride	1.90E-03	4.90E-03	mg/kg	SS-18E123Z	1/112	9.00E-04 - 2.00E+00	1.75E-01	3.50E+01 n	0.00014	3.40E+01 c	0.00014	
91576	2-Methylnaphthalene	4.10E-02	2.40E-01	mg/kg	SS-18G20A	9/152	6.70E-03 - 2.00E+00	3.68E-01	2.40E+01 n	0.010	2.30E+02 n	0.001	
91203	Naphthalene	4.20E-02	2.00E-01	mg/kg	SS-18G20A	11/152	6.70E-03 - 2.00E+00	3.64E-01	3.80E+00 c	0.053	6.00E+00 c	0.033	
87865	Pentachlorophenol	1.90E+01	4.80E+01	mg/kg	SS-18C41A	1/101	7.00E-01 - 3.10E+00	2.28E+00	1.00E+00 c	48	3.00E+00 c	16	X
Petroleum	Petroleum Hydrocarbon	2.54E+01	2.54E+01	mg/kg	SS-18C125A	1/5	3.50E+00 - 2.50E+01	2.08E+01	NBA	--	NBA	---	
85018	Phenanthrene	2.50E-03	4.00E+00	mg/kg	SS-18G15A	84/152	3.20E-01 - 2.00E+00	4.58E-01	1.80E+02 n	0.022	NBA	---	
108952	Phenol	2.20E-02	2.70E-02	mg/kg	SS-18C111A	3/101	3.20E-01 - 2.00E+00	3.83E-01	1.90E+03 n	0.000014	1.80E+04 n	0.000002	
129000	Pyrene	5.10E-03	5.20E+00	mg/kg	SS-18A02A	96/152	3.20E-01 - 2.00E+00	6.17E-01	1.80E+02 n	0.029	1.70E+03 n	0.003	
100425	Styrene	1.00E-03	1.00E-03	mg/kg	SS-18B08C	1/112	1.10E-03 - 8.40E-01	2.23E-01	6.00E+02 n	0.0000017	9.00E+01 n	0.00001	
127184	Tetrachloroethylene	1.40E-03	7.00E-03	mg/kg	SS-18B41A	6/114	8.00E-04 - 7.40E-01	6.35E-02	8.10E+00 n	0.00086	2.00E+00 c	0.0035	
108883	Toluene	5.00E-04	9.00E-03	mg/kg	SS-18B41A	7/111	4.00E-03 - 8.40E-01	2.19E-01	4.90E+02 n	0.000018	6.30E+03 n	0.000001	
79016	Trichloroethylene	9.00E-04	1.50E+00	mg/kg	SS-18C107A	11/118	9.00E-04 - 7.40E-01	8.32E-02	4.10E-01 n	3.7	7.00E+00 c	0.21	X
1330207	Xylenes, Total	1.00E-03	1.40E-01	mg/kg	SS-18E36A	5/112	3.30E-03 - 8.40E-01	2.18E-01	5.80E+01 n	0.0024	1.20E+04 n	0.00001	

Table 6-1
Summary of Analytes Detected in Surface Soil (0 to 2 ft bgs) - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency[a]	Limits of Quantitation[b]	Arithmetic Mean[c]	EPA Regional Screening Level[d]	Ratio of Maximum Concentration to EPA RSL	NJDEP Residential Soil Remediation Standard[e]	Ratio of Maximum Concentration to NJDEP RSR	COPC
7429905	Aluminum	3.22E+02	1.17E+04	mg/kg	SS-18E51Z	19/19	NA	3.93E+03	7.70E+03 n	1.5	7.80E+04 n	0.2	X
7440360	Antimony	3.30E-01	8.97E+01	mg/kg	SS-18F07A	118/208	2.20E-01 - 2.20E+00	2.40E+00	3.10E+00 n	29	3.10E+01 n	3	X
7440382	Arsenic	2.50E-01	4.88E+02	mg/kg	SS-18F21B	231/261	2.60E-01 - 1.50E+00	1.80E+01	6.80E-01 c	718	1.90E+01	26	X
7440393	Barium	1.00E+00	2.19E+02	mg/kg	SS-18A02A	42/43	1.30E+00 - 1.30E+00	2.04E+01	1.50E+03 n	0.15	1.60E+04 n	0.01	
7440417	Beryllium	1.00E-02	3.40E+00	mg/kg	SS-18E201A	68/204	1.00E-02 - 7.10E-01	2.59E-01	1.60E+01 n	0.21	1.60E+01 n	0.2	
7440439	Cadmium	5.00E-02	6.60E+00	mg/kg	SS-18F07B	132/213	4.00E-02 - 5.10E-01	6.39E-01	7.10E+00 n	0.93	7.80E+01 n	0.08	
7440702	Calcium	1.72E+01	2.44E+04	mg/kg	SS-18E51Z	16/19	3.81E+01 - 1.08E+02	1.85E+03	NUT	---	NUT	---	
7440473	Chromium	8.60E-01	6.85E+02	mg/kg	SS-18F07B	204/205	2.20E+00 - 2.20E+00	2.54E+01	3.00E-01 c	2283	NBA	---	X
7440484	Cobalt	2.20E-01	1.01E+01	mg/kg	SS-18E123Z	17/19	3.90E-01 - 4.00E-01	2.68E+00	2.30E+00 n	4.4	1.60E+03 n	0.006	X
7440508	Copper	1.00E+00	1.34E+03	mg/kg	SS-18F07B	199/204	5.00E-01 - 3.10E+00	4.31E+01	3.10E+02 n	4.3	3.10E+03 n	0.4	X
7439896	Iron	2.31E+03	3.05E+04	mg/kg	SS-18E123A	19/19	NA	1.10E+04	NUT	---	NUT	---	
7439921	Lead	3.10E-01	9.18E+03	mg/kg	SS-18F07B	300/307	6.20E-01 - 2.33E+01	1.73E+02	4.00E+02	23	4.00E+02	23	X
7439954	Magnesium	1.20E+01	3.79E+03	mg/kg	SS-18E51Z	19/19	NA	4.71E+02	NUT	---	NUT	---	
7439965	Manganese	3.70E+00	4.14E+02	mg/kg	SS-18E51Z	19/19	NA	8.70E+01	1.80E+02 n	2.3	1.10E+04 n	0.04	X
7439976	Mercury	1.00E-02	1.21E+01	mg/kg	SS-18E201A	93/202	1.70E-02 - 7.30E-02	1.33E-01	1.10E+00 n	11	2.30E+01 n	0.5	X
7440020	Nickel	2.60E-01	4.88E+01	mg/kg	SS-18E201A	149/182	1.90E-01 - 4.30E+00	4.95E+00	1.50E+02 n	0.33	1.60E+03 n	0.03	
7440097	Potassium	1.86E+01	1.27E+03	mg/kg	SS-18E51Z	12/19	8.91E+01 - 1.01E+02	3.30E+02	NUT	---	NUT	---	
7782492	Selenium	2.70E-01	6.30E+00	mg/kg	SS-0102A	86/196	2.50E-01 - 2.10E+00	6.54E-01	3.90E+01 n	0.16	3.90E+02 n	0.02	
7440224	Silver	9.00E-02	3.10E+00	mg/kg	SS-18E201A	52/202	7.00E-02 - 8.30E-01	3.06E-01	3.90E+01 n	0.079	3.90E+02 n	0.008	
7440235	Sodium	2.30E+01	2.25E+02	mg/kg	SS-18E51Z	5/19	1.30E+01 - 8.46E+01	6.03E+01	NUT	---	NUT	---	
7440280	Thallium	4.50E-01	1.20E+00	mg/kg	SS-18E09A	11/202	2.10E-01 - 2.10E+00	5.36E-01	7.80E-02 n	15	5.00E+00 n	0.2	X
7440622	Vanadium	1.05E+01	3.66E+01	mg/kg	SS-18E123A	19/19	NA	2.12E+01	3.90E+01 n	0.94	7.80E+01 n	0.5	
7440666	Zinc	1.60E+00	2.15E+03	mg/kg	SS-18F07B	141/199	4.50E-01 - 1.07E+01	8.83E+01	2.30E+03 n	0.93	2.30E+04 n	0.093	

[a]Number of sampling locations at which analyte was detected compared with total number of sampling locations; duplicates at a location were averaged and considered one sample.

[b]Based on nondetected samples.

[c]Nondetects were included at the full detection limit.

[d]Risk-based residential soil concentrations obtained from the Regional Screening Level (RSL) Table (Nov, 2017).

Surrogate screening values used:

- Acenaphthene value used for acenaphthylene.
- Chlordane used for alpha- and gamma-chlordane.
- Endosulfan used for endosulfan II.
- Endrin used for endrin aldehyde.
- Pyrene used for phenanthrene.

[e]NJDEP, 2012.

c = Cancer based, target risk equals 1E-06.
mg/kg = Milligrams per kilogram.
NA = Not applicable.
NBA = No benchmark available.
n = Noncancer based, target hazard quotient equals 0.1 for RSLs.
NUT = Essential nutrient.

Table 6-2
Summary of Analytes Detected in Aggregate Soil (0 to 10 ft bgs) - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency[a]	Limits of Quantitation[b]	Arithmetic Mean[c]	EPA Regional Screening Level[d]	Ratio of Maximum Concentration to EPA RSL	NJDEP Residential Soil Remediation Standard[e]	Ratio of Maximum Concentration to NJDEP RSR	COPC
83329	Acenaphthene	1.40E-02	1.30E+01	mg/kg	TP-18C72A	27/280	6.70E-03 - 5.50E+00	4.54E-01	3.60E+02 n	0.036	3.40E+03 n	0.004	
208968	Acenaphthylene	3.70E-02	1.40E+00	mg/kg	SS-18G15A	27/280	6.70E-03 - 5.50E+00	4.26E-01	3.60E+02 n	0.0039	NBA	---	
67641	Acetone	5.70E-03	9.60E-01	mg/kg	SS-18E91A	69/353	4.30E-03 - 1.40E+01	2.01E-01	6.10E+03 n	0.00016	7.00E+04 n	0.00001	
120127	Anthracene	1.50E-02	4.20E+01	mg/kg	TP-18C72A	60/280	6.70E-03 - 5.50E+00	5.50E-01	1.80E+03 n	0.023	1.70E+04 n	0.002	
12672296	Aroclor-1248	2.00E-01	2.00E-01	mg/kg	SS-18E45A	1/218	3.50E-02 - 4.00E+00	8.50E-02	2.30E-01 c	0.87	2.00E-01 c	1.0	X
11097691	Aroclor-1254	1.20E-01	1.20E-01	mg/kg	PE-18C-175A	1/218	3.50E-02 - 4.00E+00	9.41E-02	1.20E-01 n	1.0	2.00E-01 c	0.60	X
11096825	Aroclor-1260	2.50E-01	9.70E-01	mg/kg	TP-18E15A	4/222	3.30E-02 - 4.00E+00	9.74E-02	2.40E-01 c	4.0	2.00E-01 c	4.9	X
71432	Benzene	4.50E-03	1.90E-01	mg/kg	SS-18E11	5/353	8.00E-04 - 6.90E+00	6.65E-02	1.20E+00 c	0.16	2.00E+00 c	0.095	
56553	Benzo(a)anthracene	2.60E-03	5.80E+01	mg/kg	TP-18C72A	116/280	6.80E-03 - 5.50E+00	6.94E-01	1.10E+00 c	53	6.00E-01 c	97	X
50328	Benzo(a)pyrene	2.60E-03	4.70E+01	mg/kg	TP-18C72A	115/280	6.80E-03 - 5.50E+00	6.73E-01	1.10E-01 c	427	2.00E-01 c	235	X
205992	Benzo(b)fluoranthene	4.10E-03	3.80E+01	mg/kg	TP-18C72A	118/280	6.80E-03 - 3.40E+00	6.24E-01	1.10E+00 c	35	6.00E-01 c	63	X
191242	Benzo(g,h,i)perylene	2.40E-03	2.60E+01	mg/kg	TP-18C72A	91/280	6.80E-03 - 5.50E+00	5.53E-01	NBA	--	3.80E+05 c	0.000068	
207089	Benzo(k)fluoranthene	1.80E-03	4.10E+01	mg/kg	TP-18C72A	116/280	6.80E-03 - 5.50E+00	6.27E-01	1.10E+01 c	3.7	6.00E+00 c	6.8	X
117817	Bis(2-ethylhexyl)phthalate	5.30E-02	3.40E+00	mg/kg	TP-18A08A	9/209	2.40E-01 - 3.40E+00	4.34E-01	3.90E+01 c	0.087	3.50E+01 c	0.097	
75252	Bromoform	6.00E-04	2.60E-03	mg/kg	PE-18C177A1	6/353	9.10E-04 - 6.90E+00	1.11E-01	1.90E+01 c	0.00014	8.10E+01 c	0.000032	
78933	2-Butanone	3.70E-03	1.50E+00	mg/kg	SS-18C125A	9/353	4.00E-03 - 1.40E+01	1.92E-01	2.70E+03 n	0.00056	3.10E+03 n	0.0005	
85687	Butylbenzylphthalate	2.40E-02	5.60E-02	mg/kg	SS-0105A	3/209	3.20E-01 - 5.50E+00	4.41E-01	2.90E+02 c	0.00019	1.20E+03 n	0.00005	
86748	Carbazole	3.90E-02	2.20E+01	mg/kg	TP-18C72A	26/209	3.20E-01 - 5.50E+00	5.28E-01	NBA	--	2.40E+01 c	0.92	
75150	Carbon disulfide	1.60E-03	5.30E-01	mg/kg	TP-18E16A	4/353	9.10E-04 - 6.90E+00	1.24E-01	7.70E+01 n	0.0069	7.80E+03 n	0.00007	
5103719	alpha-Chlordane	3.70E-03	1.00E-01	mg/kg	SS-18C41A	3/173	8.80E-04 - 2.00E-01	1.58E-02	1.70E+00 c	0.059	2.00E-01 c	0.50	
5566347	gamma-Chlordane	2.90E-03	1.30E-01	mg/kg	SS-18C41A	3/172	4.50E-04 - 2.00E-01	1.61E-02	1.70E+00 c	0.076	2.00E-01 c	0.65	
108907	Chlorobenzene	1.90E-02	1.90E-02	mg/kg	TP-18C73B	1/353	9.10E-04 - 6.90E+00	1.24E-01	2.80E+01 n	0.00068	5.10E+02 n	0.00004	
67663	Chloroform	4.60E-02	3.50E+00	mg/kg	TP-18E16A	2/354	9.10E-04 - 6.90E+00	1.31E-01	3.20E-01 c	11	6.00E-01 c	5.8	X
74873	Chloromethane	3.10E-03	6.20E-03	mg/kg	PE-18C195A	14/353	9.10E-04 - 1.40E+01	1.42E-01	1.10E+01 n	0.00056	4.00E+00 c	0.0016	
218019	Chrysene	3.40E-03	5.50E+01	mg/kg	TP-18C72A	123/280	6.80E-03 - 3.40E+00	7.20E-01	1.10E+02 c	0.50	6.20E+01 c	0.89	
110827	Cyclohexane	1.60E-03	1.60E-03	mg/kg	AREA3-6	1/81	9.10E-04 - 1.00E-01	6.19E-03	6.50E+02 n	0.0000025	NBA	---	
72548	4,4-DDD	1.50E-03	1.60E-01	mg/kg	SS-18B05B	8/173	1.80E-03 - 4.00E-01	1.11E-02	1.90E-01 n	0.84	3.00E+00 c	0.053	
72559	4,4-DDE	4.00E-03	9.10E-02	mg/kg	TP-18C75A	20/172	8.80E-04 - 4.00E-01	1.16E-02	2.00E+00 c	0.046	2.00E+00 c	0.046	
50293	4,4-DDT	3.50E-03	3.80E+00	mg/kg	TP-18C72A	32/172	2.70E-03 - 7.90E-02	3.92E-02	1.90E+00 c	2.0	2.00E+00 c	1.9	X
53703	Dibenz(a,h)anthracene	3.80E-02	1.00E+01	mg/kg	TP-18C72A	48/280	6.70E-03 - 5.50E+00	4.26E-01	1.10E-01 c	91	2.00E-01 c	50	X
132649	Dibenzofuran	4.80E-02	1.20E+01	mg/kg	TP-18C72A	19/263	3.20E-01 - 5.50E+00	4.62E-01	7.30E+00 n	1.6	NBA	---	X
95501	1,2-Dichlorobenzene	2.60E+00	2.60E+00	mg/kg	TP-18A08A	1/291	9.10E-04 - 3.40E+00	3.12E-01	1.80E+02 n	0.014	5.30E+03 n	0.0005	
540590	1,2-Dichloroethene	1.40E-03	2.60E+00	mg/kg	TP-18A08A	9/178	5.00E-03 - 6.90E+00	1.21E-01	1.60E+01 n	0.16	2.30E+02 n	0.01	
156592	cis-1,2-Dichloroethene	1.30E-01	1.40E+00	mg/kg	SS-18C107A	2/175	9.10E-04 - 8.40E-01	1.45E-01	1.60E+01 n	0.088	2.30E+02 n	0.006	
156605	trans-1,2-Dichloroethene	9.40E-02	9.40E-02	mg/kg	SS-18C107A	1/175	9.10E-04 - 8.40E-01	1.39E-01	1.60E+02 n	0.00059	3.00E+02 n	0.0003	
60571	Dieldrin	1.00E-02	4.10E-02	mg/kg	TP-18C70B	2/173	8.80E-04 - 4.00E-01	1.12E-02	3.40E-02 c	1.2	4.00E-02 c	1.0	X
131113	Dimethyl phthalate	8.20E-02	1.40E-01	mg/kg	SS-0104B	4/209	3.20E-01 - 5.50E+00	4.49E-01	NBA	--	NBA	---	
84742	Di-n-butyl phthalate	3.20E-01	3.20E-01	mg/kg	SS-18C67A	1/209	3.30E-01 - 5.50E+00	4.73E-01	6.30E+02 n	0.00051	6.10E+03 n	0.00005	
117840	Di-n-octyl phthalate	6.70E-02	6.70E-02	mg/kg	SS-18G01A	1/209	3.20E-01 - 5.50E+00	4.52E-01	6.30E+01 n	0.0011	2.40E+03 n	0.00003	
33213659	Endosulfan II	1.70E-02	1.70E-02	mg/kg	SS-0103A	1/172	1.80E-03 - 4.00E-01	9.62E-03	4.70E+01 n	0.00036	4.70E+02 n	0.00004	
7421934	Endrin aldehyde	8.10E-03	1.90E-02	mg/kg	SS-18C37B	2/172	1.80E-03 - 4.00E-01	9.67E-03	1.90E+00 n	0.010	2.30E+01 n	0.0008	
100414	Ethylbenzene	1.10E-02	1.00E+01	mg/kg	TP-18A08A	13/353	9.10E-04 - 8.20E-01	1.58E-01	5.80E+00 c	1.7	7.80E+03 n	0.001	X
206440	Fluoranthene	6.00E-03	1.30E+02	mg/kg	TP-18C72A	131/280	6.80E-03 - 3.40E+00	1.15E+00	2.40E+02 n	0.54	2.30E+03 n	0.06	
86737	Fluorene	2.60E-02	1.80E+01	mg/kg	TP-18C72A	28/280	6.70E-03 - 5.50E+00	4.72E-01	2.40E+02 n	0.075	2.30E+03 n	0.008	

Table 6-2
Summary of Analytes Detected in Aggregate Soil (0 to 10 ft bgs) - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency[a]	Limits of Quantitation[b]	Arithmetic Mean[c]	EPA Regional Screening Level[d]	Ratio of Maximum Concentration to EPA RSL	NJDEP Residential Soil Remediation Standard[e]	Ratio of Maximum Concentration to NJDEP RSR	COPC
76448	Heptachlor	5.00E-02	5.00E-02	mg/kg	SS-18C41A	1/173	4.50E-04 - 2.00E-01	4.89E-03	1.30E-01 c	0.38	1.00E-01 c	0.50	
591786	2-Hexanone	1.50E-02	1.50E-02	mg/kg	PE-18C197A	1/353	4.00E-03 - 1.40E+01	1.89E-01	2.00E+01 n	0.00075	NBA	---	
193395	Indeno(1,2,3-c,d)pyrene	2.30E-03	2.60E+01	mg/kg	TP-18C72A	91/280	6.80E-03 - 5.50E+00	5.20E-01	1.10E+00 c	24	6.00E-01 c	43	X
72435	Methoxychlor	9.60E-03	9.60E-03	mg/kg	SS18B81	1/173	4.40E-03 - 2.00E+00	4.82E-02	3.20E+01 n	0.00030	3.90E+02 n	0.00002	
75092	Methylene chloride	1.00E-03	1.70E-01	mg/kg	18C248A	59/353	7.00E-04 - 1.40E+01	1.41E-01	3.50E+01 n	0.0049	3.40E+01 c	0.0050	
91576	2-Methylnaphthalene	4.10E-02	1.60E+01	mg/kg	TP-18A08A	17/265	6.70E-03 - 3.90E+00	4.98E-01	2.40E+01 n	0.67	2.30E+02 n	0.07	
106445	4-Methylphenol	3.40E-01	3.40E-01	mg/kg	TP-18C72A	1/209	3.20E-01 - 5.50E+00	4.53E-01	6.30E+02 n	0.00054	3.10E+01 n	0.01	
179601231	m,p-Xylenes	5.20E-03	5.20E-03	mg/kg	AREA2-15-RE1	1/95	4.00E-03 - 1.00E-01	1.05E-02	NBA	--	1.20E+04 n	0.0000004	
91203	Naphthalene	3.10E-02	1.10E+01	mg/kg	TP-18C72A	20/281	6.70E-03 - 3.90E+00	4.72E-01	3.80E+00 c	2.9	6.00E+00 c	1.8	X
87865	Pentachlorophenol	1.90E+01	4.80E+01	mg/kg	SS-18C41A	1/209	7.00E-01 - 2.80E+01	2.42E+00	1.00E+00 c	48	3.00E+00 c	16	X
Petroleum	Petroleum Hydrocarbon	2.54E+01	2.54E+01	mg/kg	SS-18C125A	1/5	3.50E+00 - 2.50E+01	2.08E+01	NBA	--	NBA	---	
85018	Phenanthrene	2.50E-03	1.20E+02	mg/kg	TP-18C72A	117/280	6.80E-03 - 3.40E+00	9.28E-01	1.80E+02 n	0.67	NBA	---	
108952	Phenol	2.20E-02	2.50E-01	mg/kg	TP-18C72A	4/209	3.20E-01 - 5.50E+00	4.40E-01	1.90E+03 n	0.00013	1.80E+04 n	0.00001	
129000	Pyrene	5.10E-03	9.70E+01	mg/kg	TP-18C72A	132/280	6.80E-03 - 3.40E+00	1.02E+00	1.80E+02 n	0.54	1.70E+03 n	0.06	
100425	Styrene	1.00E-03	4.60E-03	mg/kg	SS-0104C	4/353	9.10E-04 - 6.90E+00	1.24E-01	6.00E+02 n	0.0000077	9.00E+01 n	0.00005	
127184	Tetrachloroethylene	1.40E-03	1.80E+00	mg/kg	SS-AOC2MIP05-07	12/357	8.00E-04 - 6.90E+00	7.34E-02	8.10E+00 n	0.22	2.00E+00 c	0.90	
108883	Toluene	5.00E-04	6.40E+00	mg/kg	TP-18A08A	27/352	9.10E-04 - 6.90E+00	1.37E-01	4.90E+02 n	0.013	6.30E+03 n	0.001	
71556	1,1,1-Trichloroethane	3.00E-03	1.20E-02	mg/kg	TP-18C60A	3/353	9.10E-04 - 6.90E+00	1.25E-01	8.10E+02 n	0.000015	2.90E+02 n	0.00004	
79016	Trichloroethylene	6.00E-04	6.10E+00	mg/kg	SS-AOC2MIP05-07	63/395	8.00E-04 - 6.90E+00	8.83E-02	4.10E-01 n	15	7.00E+00 c	0.87	X
75694	Trichlorofluoromethane	5.10E-03	6.00E-03	mg/kg	AREA5-9	2/82	9.10E-04 - 2.00E-01	8.56E-03	2.30E+03 n	0.000003	2.30E+04 n	0.0000003	
75014	Vinyl chloride	3.10E-03	4.80E-01	mg/kg	TP-18A08A	2/353	9.10E-04 - 1.40E+01	1.39E-01	5.90E-02 c	8.1	7.00E-01 c	0.69	X
1330207	Xylenes, Total	1.00E-03	6.40E+01	mg/kg	TP-18A08A	24/258	2.70E-03 - 8.40E-01	7.14E-01	5.80E+01 n	1.1	1.20E+04 n	0.005	X
7429905	Aluminum	1.31E+02	1.17E+04	mg/kg	SS-18E51Z	43/43	NA	4.18E+03	7.70E+03 n	1.5	7.80E+04 n	0.2	X
7440360	Antimony	3.10E-01	2.42E+02	mg/kg	SS-18G01B	143/334	4.50E-02 - 2.20E+00	2.63E+00	3.10E+00 n	78	3.10E+01 n	8	X
7440382	Arsenic	2.20E-01	4.88E+02	mg/kg	SS-18F21B	420/487	1.90E-01 - 1.60E+00	1.34E+01	6.80E-01 c	718	1.90E+01	26	X
7440393	Barium	5.30E-01	2.19E+02	mg/kg	SS-18A02A	157/170	5.00E-01 - 3.92E+00	1.74E+01	1.50E+03 n	0.15	1.60E+04 n	0.01	
7440417	Beryllium	1.00E-02	3.40E+00	mg/kg	SS-18E201A	124/332	1.00E-02 - 7.10E-01	2.43E-01	1.60E+01 n	0.21	1.60E+01 n	0.2	
7440439	Cadmium	5.00E-02	6.60E+00	mg/kg	SS-18F07B	194/403	2.40E-02 - 5.10E-01	5.17E-01	7.10E+00 n	0.93	7.80E+01 n	0.08	
7440702	Calcium	1.72E+01	2.44E+04	mg/kg	SS-18E51Z	32/40	1.61E+01 - 1.08E+02	1.01E+03	NUT	---	NUT	---	
7440473	Chromium	8.60E-01	6.85E+02	mg/kg	SS-18F07B	400/403	3.90E-01 - 2.70E+00	1.97E+01	3.00E-01 c	2283	NBA	---	X
7440484	Cobalt	1.10E-01	1.01E+01	mg/kg	SS-18E123Z	36/44	3.70E-01 - 8.40E-01	2.15E+00	2.30E+00 n	4.4	1.60E+03 n	0.006	X
7440508	Copper	1.00E+00	1.34E+03	mg/kg	SS-18F07B	302/328	5.00E-01 - 4.80E+00	3.49E+01	3.10E+02 n	4.3	3.10E+03 n	0.4	X
7439896	Iron	3.24E+02	3.05E+04	mg/kg	SS-18E123A	44/44	NA	1.18E+04	NUT	---	NUT	---	
7439921	Lead	1.40E-01	9.18E+03	mg/kg	SS-18F07B	489/516	2.40E-01 - 3.77E+01	1.28E+02	4.00E+02	23	4.00E+02	23	X
7439954	Magnesium	1.06E+01	3.79E+03	mg/kg	SS-18E51Z	36/40	8.00E+00 - 2.85E+01	3.75E+02	NUT	---	NUT	---	
7439965	Manganese	9.00E-01	4.14E+02	mg/kg	SS-18E51Z	41/44	9.00E-01 - 2.40E+00	6.10E+01	1.80E+02 n	2.3	1.10E+04 n	0.04	X
7439976	Mercury	2.00E-03	1.21E+01	mg/kg	SS-18E201A	190/398	1.00E-02 - 7.30E-02	9.45E-02	1.10E+00 n	11	2.30E+01 n	0.5	X
7440020	Nickel	1.90E-01	6.07E+01	mg/kg	SS-18G01B	232/307	1.90E-01 - 4.30E+00	4.25E+00	1.50E+02 n	0.40	1.60E+03 n	0.04	
7440097	Potassium	1.86E+01	1.27E+03	mg/kg	SS-18E51Z	25/40	8.75E+01 - 1.07E+02	3.73E+02	NUT	---	NUT	---	
7782492	Selenium	2.70E-01	6.30E+00	mg/kg	SS-0102A	133/383	2.00E-01 - 2.20E+00	7.29E-01	3.90E+01 n	0.16	3.90E+02 n	0.02	
7440224	Silver	6.20E-02	2.18E+01	mg/kg	PE-18C-175A	72/398	3.10E-02 - 8.30E-01	3.72E-01	3.90E+01 n	0.56	3.90E+02 n	0.06	
7440235	Sodium	6.30E+00	2.25E+02	mg/kg	SS-18E51Z	16/44	1.30E+01 - 8.64E+01	5.82E+01	NUT	---	NUT	---	
7440280	Thallium	4.50E-01	1.70E+00	mg/kg	SS-18A28B	17/330	1.30E-01 - 2.20E+00	5.75E-01	7.80E-02 n	22	5.00E+00 n	0.3	X
7440622	Vanadium	4.20E+00	1.01E+02	mg/kg	PE-18C187A	43/44	8.60E+00 - 8.60E+00	2.44E+01	3.90E+01 n	2.6	7.80E+01 n	1.3	X
7440666	Zinc	1.50E+00	2.22E+03	mg/kg	SS-18G02B	214/319	4.50E-01 - 1.44E+01	7.55E+01	2.30E+03 n	0.97	2.30E+04 n	0.10	

[a]Number of sampling locations at which analyte was detected compared with total number of sampling locations; duplicates at a location were averaged and considered one sample.

[b]Based on nondetected samples.

[c]Nondetects were included at the full detection limit.

Table 6-2
Summary of Analytes Detected in Aggregate Soil (0 to 10 ft bgs) - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency[a]	Limits of Quantitation[b]	Arithmetic Mean[c]	EPA Regional Screening Level[d]	Ratio of Maximum Concentration to EPA RSL	NJDEP Residential Soil Remediation Standard[e]	Ratio of Maximum Concentration to NJDEP RSR	COPC

[d]Risk-based residential soil concentrations obtained from the Regional Screening Level (RSL) Table (Nov, 2017).

Surrogate screening values used:

- Acenaphthene value used for acenaphthylene.
- Chlordane used for alpha- and gamma-chlordane.
- Endosulfan used for endosulfan II.
- Endrin used for endrin aldehyde.
- Pyrene used for phenanthrene.
- Xylenes used for m,p-xylene.

[e]NJDEP, 2012.

c = Cancer based, target risk equals 1E-06.
mg/kg = Milligra
NA = Not applicable.
NBA = No benchmark available.
n = Noncancer based, target hazard quotient equals 0.1 for RSLs.
NUT = Essential nutrient.

Table 6-3
Summary of Analytes Detected in the Sediment (0 to 2 ft bgs) - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency[a]	Limits of Quantitation[b]	Arithmetic Mean[c]	EPA Regional Screening Level[d]	Ratio of Maximum Concentration to EPA RSL	NJDEP Residential Soil Remediation Standard[e]	Ratio of Maximum Concentration to NJDEP RSR	COPC
83329	Acenaphthene	2.10E-01	1.40E+02	mg/kg	SD-1822B	10/22	7.10E-03 - 1.40E+00	1.28E+01	3.60E+02 n	0.39	3.40E+03 n	0.04	
208968	Acenaphthylene	4.60E-02	5.30E+00	mg/kg	SD-1822B	9/22	7.10E-03 - 3.40E+00	8.34E-01	3.60E+02 n	0.015	NBA	---	
67641	Acetone	2.10E-02	2.10E-02	mg/kg	SD-1803	1/20	1.20E-02 - 4.10E-02	1.62E-02	6.10E+03 n	0.0000034	7.00E+04 n	0.0000003	
309002	Aldrin	3.20E-01	6.90E-01	mg/kg	SD-1803	3/22	5.30E-04 - 6.60E-02	8.50E-02	3.90E-02 c	18	4.00E-02 c	17	X
120127	Anthracene	3.50E-02	2.70E+02	mg/kg	SD-1822B	13/22	7.10E-03 - 1.40E+00	2.25E+01	1.80E+03 n	0.15	1.70E+04 n	0.02	
56553	Benzo(a)anthracene	1.80E-03	4.20E+02	mg/kg	SD-1822B	18/22	3.90E-01 - 1.40E+00	3.61E+01	1.10E+00 c	382	6.00E-01 c	700	X
50328	Benzo(a)pyrene	1.70E-03	3.80E+02	mg/kg	SD-1822B	18/22	3.90E-01 - 1.40E+00	3.17E+01	1.10E-01 c	3455	2.00E-01 c	1900	X
205992	Benzo(b)fluoranthene	2.50E-03	5.20E+02	mg/kg	SD-1822B	18/22	3.90E-01 - 1.40E+00	4.13E+01	1.10E+00 c	473	6.00E-01 c	867	X
191242	Benzo(g,h,i)perylene	5.50E-02	2.40E+02	mg/kg	SD-1822B	16/22	7.10E-03 - 1.40E+00	2.00E+01	NBA	--	3.80E+05 c	0.00063	
207089	Benzo(k)fluoranthene	4.40E-02	2.30E+02	mg/kg	SD-1822B	17/22	7.10E-03 - 1.40E+00	2.03E+01	1.10E+01 c	21	6.00E+00 c	38	X
319868	delta-BHC	4.60E-03	4.60E-03	mg/kg	SD1812	1/23	5.30E-04 - 2.80E-01	5.76E-02	3.00E-01 c	0.015	NBA	---	
117817	Bis(2-ethylhexyl)phthalate	8.00E-02	2.20E+00	mg/kg	SD-1803	12/26	3.80E-01 - 4.70E+01	3.00E+00	3.90E+01 c	0.056	3.50E+01 c	0.063	
78933	2-Butanone	9.90E-01	9.90E-01	mg/kg	SD-1803	1/20	1.20E-02 - 4.10E-02	6.37E-02	2.70E+03 n	0.00037	3.10E+03 n	0.0003	
85687	Butylbenzylphthalate	8.50E+00	8.50E+00	mg/kg	SD-1815	1/26	3.80E-01 - 4.70E+01	3.40E+00	2.90E+02 c	0.029	1.20E+03 n	0.007	
86748	Carbazole	1.20E-01	2.60E+02	mg/kg	SD-1803	15/26	3.80E-01 - 1.40E+00	1.80E+01	NBA	--	2.40E+01 c	11	X
5566347	gamma-Chlordane	2.40E-01	2.40E-01	mg/kg	SD1812	1/23	5.30E-04 - 2.80E+00	5.84E-01	1.70E+00 c	0.14	2.00E-01 c	1.2	X
218019	Chrysene	2.20E-03	4.90E+02	mg/kg	SD-1822B	19/22	3.90E-01 - 1.40E+00	3.94E+01	1.10E+02 c	4.5	6.20E+01 c	7.9	X
72548	4,4-DDD	8.10E-04	8.60E-02	mg/kg	SD-1811	7/24	2.00E-03 - 5.60E-01	1.02E-01	1.90E-01 n	0.45	3.00E+00 c	0.029	
72559	4,4-DDE	1.50E-03	1.60E-01	mg/kg	SD-1803	6/22	1.00E-03 - 5.50E-01	7.55E-02	2.00E+00 c	0.080	2.00E+00 c	0.080	
50293	4,4-DDT	9.50E-04	2.20E-01	mg/kg	SD-1811	9/24	9.60E-03 - 5.60E-01	1.08E-01	1.90E+00 c	0.12	2.00E+00 c	0.11	
53703	Dibenz(a,h)anthracene	2.40E-02	6.20E+01	mg/kg	SD-1822B	13/22	7.10E-03 - 1.40E+00	5.53E+00	1.10E-01 c	564	2.00E-01 c	310	X
132649	Dibenzofuran	6.50E-02	7.20E+01	mg/kg	SD-1804	14/26	3.80E-01 - 1.40E+00	6.66E+00	7.30E+00 n	9.9	NBA	---	X
540590	1,2-Dichloroethene	2.00E-03	8.00E-03	mg/kg	SD-0101	2/20	6.00E-03 - 2.00E-02	7.30E-03	1.60E+01 n	0.00050	2.30E+02 n	0.00003	
60571	Dieldrin	2.90E-04	8.30E-03	mg/kg	SD1816	2/24	1.00E-03 - 5.60E-01	1.10E-01	3.40E-02 c	0.24	4.00E-02 c	0.21	
105679	2,4-Dimethylphenol	3.50E-01	3.50E-01	mg/kg	SD-1803	1/26	3.80E-01 - 4.70E+01	3.02E+00	1.30E+02 n	0.0027	1.20E+03 n	0.0003	
33213659	Endosulfan II	9.40E-04	1.80E-01	mg/kg	SD-1803	6/25	2.10E-03 - 5.50E-01	7.80E-02	4.70E+01 n	0.0038	4.70E+02 n	0.0004	
7421934	Endrin aldehyde	3.10E-03	6.80E-03	mg/kg	SD1816	1/23	2.10E-03 - 5.60E-01	1.15E-01	1.90E+00 n	0.0036	2.30E+01 n	0.0003	
53494705	Endrin ketone	5.30E-03	2.30E-01	mg/kg	SD-1803	4/24	5.10E-03 - 1.30E-01	6.91E-02	1.90E+00 n	0.12	2.30E+01 n	0.01	
206440	Fluoranthene	3.60E-03	1.30E+03	mg/kg	SD-1822B	20/22	4.00E-01 - 1.40E+00	1.05E+02	2.40E+02 n	5.4	2.30E+03 n	0.6	X
86737	Fluorene	1.90E-01	1.20E+02	mg/kg	SD-1822B	10/22	7.10E-03 - 1.40E+00	1.16E+01	2.40E+02 n	0.50	2.30E+03 n	0.05	
76448	Heptachlor	3.40E-03	3.50E-03	mg/kg	SD1812	2/24	5.30E-04 - 2.80E-01	5.53E-02	1.30E-01 c	0.027	1.00E-01 c	0.04	
1024573	Heptachlor epoxide	1.20E-03	3.60E+00	mg/kg	SD-1803	15/23	5.10E-04 - 3.90E-02	3.44E-01	7.00E-02 c	51	7.00E-02 c	51	X
193395	Indeno(1,2,3-c,d)pyrene	5.50E-02	2.60E+02	mg/kg	SD-1822B	16/22	7.10E-03 - 1.40E+00	2.00E+01	1.10E+00 c	236	6.00E-01 c	433	X
72435	Methoxychlor	3.50E-02	1.00E+00	mg/kg	SD1812	7/25	5.30E-03 - 6.60E-01	3.53E-01	3.20E+01 n	0.031	3.90E+02 n	0.003	
90120	1-Methylnaphthalene	4.10E-02	3.40E+01	mg/kg	SD-1822B	9/11	7.10E-03 - 4.30E-02	6.04E+00	1.80E+01 c	1.9	NBA	---	X
91576	2-Methylnaphthalene	4.80E-02	3.50E+01	mg/kg	SD-1822B	10/22	7.10E-03 - 1.40E+00	3.36E+00	2.40E+01 n	1.5	2.30E+02 n	0.2	X
95487	2-Methylphenol	2.40E-01	2.40E-01	mg/kg	SD-1803	1/26	3.80E-01 - 4.70E+01	3.02E+00	3.20E+02 n	0.00075	3.10E+02 n	0.0008	
106445	4-Methylphenol	8.90E-01	8.90E-01	mg/kg	SD-1803	1/26	3.80E-01 - 4.70E+01	3.91E+00	6.30E+02 n	0.0014	3.10E+01 n	0.03	
91203	Naphthalene	1.30E-01	8.40E+01	mg/kg	SD-1822B	10/22	7.10E-03 - 1.40E+00	7.45E+00	3.80E+00 c	22	6.00E+00 c	14	X
85018	Phenanthrene	4.60E-02	1.10E+03	mg/kg	SD-1822B	17/22	7.10E-03 - 1.40E+00	9.16E+01	1.80E+02 n	6.1	NBA	---	X
108952	Phenol	6.20E-01	6.20E-01	mg/kg	SD-1803	1/26	3.80E-01 - 4.70E+01	3.03E+00	1.90E+03 n	0.00033	1.80E+04 n	0.00003	
129000	Pyrene	3.20E-03	1.00E+03	mg/kg	SD-1822B	20/22	4.00E-01 - 1.40E+00	8.22E+01	1.80E+02 n	5.6	1.70E+03 n	0.6	X
108883	Toluene	6.00E-03	1.50E-02	mg/kg	SD-1803	2/20	6.00E-03 - 2.00E-02	7.75E-03	4.90E+02 n	0.000031	6.30E+03 n	0.000002	
71556	1,1,1-Trichloroethane	8.00E-03	8.00E-03	mg/kg	SD-1815	1/20	6.00E-03 - 2.00E-02	7.45E-03	8.10E+02 n	0.000010	2.90E+02 n	0.00003	
79016	Trichloroethylene	2.00E-03	1.50E-02	mg/kg	SD-0101	4/20	6.00E-03 - 2.00E-02	8.00E-03	4.10E-01 n	0.037	7.00E+00 c	0.0021	
7429905	Aluminum	4.13E+02	3.13E+03	mg/kg	SD1811	10/10	NA	1.44E+03	7.70E+03 n	0.41	7.80E+04 n	0.04	
7440360	Antimony	8.50E-02	3.10E+00	mg/kg	SD-1801	20/26	7.00E-02 - 2.00E+00	7.77E-01	3.10E+00 n	1.0	3.10E+01 n	0.1	X
7440382	Arsenic	2.50E-01	3.29E+01	mg/kg	SD-1810	23/26	1.40E+00 - 1.50E+00	3.58E+00	6.80E-01 c	48	1.90E+01	1.7	X

Table 6-3
Summary of Analytes Detected in the Sediment (0 to 2 ft bgs) - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	Analyte	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency[a]	Limits of Quantitation[b]	Arithmetic Mean[c]	EPA Regional Screening Level[d]	Ratio of Maximum Concentration to EPA RSL	NJDEP Residential Soil Remediation Standard[e]	Ratio of Maximum Concentration to NJDEP RSR	COPC
7440393	Barium	7.20E-01	4.01E+01	mg/kg	SD-1810	26/26	NA	1.02E+01	1.50E+03 n	0.027	1.60E+04 n	0.003	
7440417	Beryllium	3.00E-02	1.00E+00	mg/kg	SD-1807	16/26	7.00E-02 - 1.60E-01	2.66E-01	1.60E+01 n	0.063	1.60E+01 n	0.06	
7440439	Cadmium	2.10E-02	6.10E-01	mg/kg	SD-1803	22/26	1.00E-02 - 2.50E-01	1.77E-01	7.10E+00 n	0.086	7.80E+01 n	0.008	
7440702	Calcium	3.94E+01	1.70E+03	mg/kg	SD-1812	10/10	NA	5.11E+02	NUT	---	NUT	---	
7440473	Chromium	2.80E+00	2.58E+01	mg/kg	SD-1813	26/26	NA	9.79E+00	3.00E-01 c	86	NBA	---	X
7440484	Cobalt	3.00E-01	5.20E+00	mg/kg	SD1811	9/10	3.40E-01 - 3.40E-01	1.81E+00	2.30E+00 n	2.3	1.60E+03 n	0.003	X
7440508	Copper	1.90E+00	8.41E+01	mg/kg	SD-1803	26/26	NA	2.27E+01	3.10E+02 n	0.27	3.10E+03 n	0.03	
57125	Cyanide	2.00E-01	6.80E-01	mg/kg	SD-1806	4/10	1.70E-01 - 4.60E-01	3.45E-01	2.30E+00 n	0.3	1.60E+03 n	0.0004	
7439896	Iron	1.44E+03	1.57E+04	mg/kg	SD-1803	10/10	NA	5.83E+03	NUT	---	NUT	---	
7439921	Lead	2.30E+00	5.86E+02	mg/kg	SD-1801	26/26	NA	6.06E+01	4.00E+02	1.5	4.00E+02	1.5	X
7439954	Magnesium	2.77E+01	8.81E+02	mg/kg	SD-1812	10/10	NA	2.72E+02	NUT	---	NUT	---	
7439965	Manganese	1.60E+00	1.03E+02	mg/kg	SD1811	10/10	NA	3.52E+01	1.80E+02 n	0.57	1.10E+04 n	0.009	
7439976	Mercury	3.30E-02	9.40E-01	mg/kg	SD-1807	5/26	1.90E-02 - 1.80E-01	1.20E-01	1.10E+00 n	0.9	2.30E+01 n	0.04	
7440020	Nickel	3.90E-01	1.40E+01	mg/kg	SD-1803	17/26	9.50E-01 - 4.00E+00	3.55E+00	1.50E+02 n	0.093	1.60E+03 n	0.009	
7440097	Potassium	1.81E+01	2.24E+02	mg/kg	SD1811	8/10	4.65E+01 - 6.43E+01	1.13E+02	NUT	---	NUT	---	
7782492	Selenium	2.40E-01	8.60E-01	mg/kg	SD-1801	5/26	1.40E-01 - 2.80E+00	4.27E-01	3.90E+01 n	0.022	3.90E+02 n	0.002	
7440224	Silver	1.20E-01	1.90E+00	mg/kg	SD-1807	6/26	8.00E-02 - 1.00E+00	3.68E-01	3.90E+01 n	0.049	3.90E+02 n	0.005	
7440235	Sodium	3.10E+01	8.90E+01	mg/kg	SD-1803	7/10	1.39E+01 - 1.67E+01	4.44E+01	NUT	---	NUT	---	
7440622	Vanadium	8.40E+00	2.72E+01	mg/kg	SD-1803	10/10	NA	1.57E+01	3.90E+01 n	0.70	7.80E+01 n	0.3	
7440666	Zinc	3.30E+00	2.44E+02	mg/kg	SD-1803	25/26	1.70E+00 - 1.70E+00	4.95E+01	2.30E+03 n	0.11	2.30E+04 n	0.01	

[a]Number of sampling locations at which analyte was detected compared with total number of sampling locations; duplicates at a location were averaged and considered one sample.

[b]Based on nondetected samples.

[c]Nondetects were included at the full detection limit.

[d]Risk-based residential soil concentrations obtained from the Regional Screening Level (RSL) Table (Nov, 2017).

[e]NJDEP, 2012.

Surrogate screening values used:
- Acenaphthene value used for acenaphthylene.
- Chlordane used for gamma-chlordane.
- Endosulfan used for endosulfan II.
- Endrin used for endrin aldehyde and endrin ketone.
- Pyrene used for phenanthrene.

c = Cancer based, target risk equals 1E-06.
mg/kg = Milligrams per kilogram.
NA = Not applicable.
NBA = No benchmark available.
n = Noncancer based, target hazard quotient equals 0.1 for RSLs.
NUT = Essential nutrient.

Table 6-4
Summary of Exposure Point Concentrations for COPCs in Surface Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

COPC	Arithmetic Mean (mg/kg)	95% UCL (mg/kg)	Maximum Detected Concentration (mg/kg)	Exposure Point Concentration		
				Value (mg/kg)	Statistic	Rationale
Aroclor-1248	7.09E-02	NC	2.00E-01	7.00E-02	75th Percentile	See Section 6.3.2
Aroclor-1260	7.98E-02	NC	4.70E-01	8.10E-02	75th Percentile	See Section 6.3.2
Benzo(a)anthracene	4.06E-01	4.76E-01	2.70E+00	4.76E-01	95% KM (Chebyshev) UCL	ProUCL Recommendation
Benzo(a)pyrene	4.28E-01	5.16E-01	3.30E+00	5.16E-01	95% KM (Chebyshev) UCL	ProUCL Recommendation
Benzo(b)fluoranthene	4.85E-01	6.38E-01	4.90E+00	6.38E-01	95% KM (Chebyshev) UCL	ProUCL Recommendation
Dibenz(a,h)anthracene	3.49E-01	1.98E-01	9.30E-01	1.98E-01	95% KM (t) UCL	ProUCL Recommendation
Indeno(1,2,3-c,d)pyrene	3.78E-01	2.90E-01	2.50E+00	2.90E-01	95% KM (BCA) UCL	ProUCL Recommendation
Pentachlorophenol	2.28E+00	NC	4.80E+01	1.90E+00	75th Percentile	See Section 6.3.2
Trichloroethylene	8.32E-02	5.33E-02	1.50E+00	5.33E-02	95% KM (t) UCL	ProUCL Recommendation
Aluminum	3.93E+03	7.93E+03	1.17E+04	7.93E+03	95% Chebyshev (Mean, Sd) UCL	ProUCL Recommendation
Antimony	2.40E+00	4.30E+00	8.97E+01	4.30E+00	95% KM (Chebyshev) UCL	ProUCL Recommendation
Arsenic	1.80E+01	3.85E+01	4.88E+02	3.85E+01	97.5% KM (Chebyshev) UCL	ProUCL Recommendation
Chromium	2.54E+01	4.52E+01	6.85E+02	4.52E+01	95% KM (Chebyshev) UCL	ProUCL Recommendation
Cobalt	2.68E+00	7.30E+00	1.01E+01	7.30E+00	97.5% KM (Chebyshev) UCL	ProUCL Recommendation
Copper	4.31E+01	8.44E+01	1.34E+03	8.44E+01	95% KM (Chebyshev) UCL	ProUCL Recommendation
Lead	1.73E+02	4.12E+02	9.18E+03	4.12E+02	97.5% KM (Chebyshev) UCL	ProUCL Recommendation
Manganese	8.70E+01	3.80E+02	4.14E+02	3.80E+02	99% Chebyshev (Mean, Sd) UCL	ProUCL Recommendation
Mercury	1.33E-01	2.52E-01	1.21E+01	2.52E-01	95% KM (BCA) UCL	ProUCL Recommendation
Thallium	5.36E-01	2.60E-01	1.20E+00	2.60E-01	95% KM (t) UCL	ProUCL Recommendation

NC = Not calculated.

Table 6-5
Summary of Exposure Point Concentrations for COPCs in Aggregate Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

COPC	Arithmetic Mean (mg/kg)	95% UCL (mg/kg)	Maximum Detected Concentration (mg/kg)	Exposure Point Concentration		
				Value (mg/kg)	Statistic	Rationale
Aroclor-1248	8.50E-02	NC	2.00E-01	7.18E-02	75th Percentile	See Section 6.3.2
Aroclor-1254	9.41E-02	NC	1.20E-01	8.28E-02	75th Percentile	See Section 6.3.2
Aroclor-1260	9.74E-02	5.13E-02	9.70E-01	5.13E-02	95% KM (t) UCL	ProUCL Recommendation
Benzo(a)anthracene	6.94E-01	1.44E+00	5.80E+01	1.44E+00	95% KM (Chebyshev) UCL	ProUCL Recommendation
Benzo(a)pyrene	6.73E-01	1.27E+00	4.70E+01	1.27E+00	95% KM (Chebyshev) UCL	ProUCL Recommendation
Benzo(b)fluoranthene	6.24E-01	1.09E+00	3.80E+01	1.09E+00	95% KM (Chebyshev) UCL	ProUCL Recommendation
Benzo(k)fluoranthene	6.27E-01	7.57E-01	4.10E+01	7.57E-01	95% KM (BCA) UCL	ProUCL Recommendation
Chloroform	1.31E-01	NC	3.50E+00	6.20E-03	75th Percentile	See Section 6.3.2
4,4-DDT	3.92E-02	1.36E-01	3.80E+00	1.36E-01	95% KM (Chebyshev) UCL	ProUCL Recommendation
Dibenz(a,h)anthracene	4.26E-01	2.58E-01	1.00E+01	2.58E-01	95% KM (BCA) UCL	ProUCL Recommendation
Dibenzofuran	4.62E-01	2.39E-01	1.20E+01	2.39E-01	95% KM (BCA) UCL	ProUCL Recommendation
Dieldrin	1.12E-02	NC	4.10E-02	8.40E-03	75th Percentile	See Section 6.3.2
Ethylbenzene	1.58E-01	1.55E-01	1.00E+01	1.55E-01	95% KM (t) UCL	ProUCL Recommendation
Indeno(1,2,3-c,d)pyrene	5.20E-01	5.00E-01	2.60E+01	5.00E-01	95% KM (BCA) UCL	ProUCL Recommendation
Naphthalene	4.72E-01	4.01E-01	1.10E+01	4.01E-01	95% KM (Chebyshev) UCL	ProUCL Recommendation
Pentachlorophenol	2.42E+00	NC	4.80E+01	2.00E+00	75th Percentile	See Section 6.3.2
Trichloroethylene	8.83E-02	1.41E-01	6.10E+00	1.41E-01	97.5% KM (Chebyshev) UCL	ProUCL Recommendation
Vinyl chloride	1.39E-01	NC	4.80E-01	1.20E-02	75th Percentile	See Section 6.3.2
Xylenes, Total	7.14E-01	1.58E+00	6.40E+01	1.58E+00	95% KM Approximate Gamma UCL	ProUCL Recommendation
Aluminum	4.18E+03	6.79E+03	1.17E+04	6.79E+03	95% Chebyshev (Mean, Sd) UCL	ProUCL Recommendation
Antimony	2.63E+00	3.92E+00	2.42E+02	3.92E+00	95% KM (BCA) UCL	ProUCL Recommendation
Arsenic	1.34E+01	2.16E+01	4.88E+02	2.16E+01	95% KM (Chebyshev) UCL	ProUCL Recommendation
Chromium	1.97E+01	2.44E+01	6.85E+02	2.44E+01	95% KM (BCA) UCL	ProUCL Recommendation
Cobalt	2.15E+00	3.76E+00	1.01E+01	3.76E+00	95% KM (Chebyshev) UCL	ProUCL Recommendation
Copper	3.49E+01	6.29E+01	1.34E+03	6.29E+01	95% KM (Chebyshev) UCL	ProUCL Recommendation
Lead	1.28E+02	2.79E+02	9.18E+03	2.79E+02	97.5% KM (Chebyshev) UCL	ProUCL Recommendation
Manganese	6.10E+01	1.52E+02	4.14E+02	1.52E+02	97.5% KM (Chebyshev) UCL	ProUCL Recommendation
Mercury	9.45E-02	1.44E-01	1.21E+01	1.44E-01	95% KM (BCA) UCL	ProUCL Recommendation
Thallium	5.75E-01	1.87E-01	1.70E+00	1.87E-01	95% KM (t) UCL	ProUCL Recommendation
Vanadium	2.44E+01	3.62E+01	1.01E+02	3.62E+01	95% KM (Chebyshev) UCL	ProUCL Recommendation

NC = Not calculated.

Table 6-6
Summary of Exposure Point Concentrations for COPCs in Sediment - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

COPC	Arithmetic Mean (mg/kg)	95% UCL (mg/kg)	Maximum Detected Concentration (mg/kg)	Exposure Point Concentration		
				Value (mg/kg)	Statistic	Rationale
Aldrin	8.50E-02	NC	6.90E-01	5.43E-02	75th Percentile	See Section 6.3.2
Benzo(a)anthracene	3.61E+01	1.25E+02	4.20E+02	1.25E+02	95% KM (Chebyshev) UCL	ProUCL Recommendation
Benzo(a)pyrene	3.17E+01	1.11E+02	3.80E+02	1.11E+02	95% KM (Chebyshev) UCL	ProUCL Recommendation
Benzo(b)fluoranthene	4.13E+01	1.49E+02	5.20E+02	1.49E+02	95% KM (Chebyshev) UCL	ProUCL Recommendation
Benzo(k)fluoranthene	2.03E+01	6.83E+01	2.30E+02	6.83E+01	95% KM (Chebyshev) UCL	ProUCL Recommendation
Carbazole	1.80E+01	1.34E+02	2.60E+02	1.34E+02	99% KM (Chebyshev) UCL	ProUCL Recommendation
gamma-Chlordane	5.84E-01	NC	2.40E-01	2.40E-01	Maximum	See Section 6.3.2
Chrysene	3.94E+01	1.41E+02	4.90E+02	1.41E+02	95% KM (Chebyshev) UCL	ProUCL Recommendation
Dibenz(a,h)anthracene	5.53E+00	1.04E+01	6.20E+01	1.04E+01	95% KM (BCA) UCL	ProUCL Recommendation
Dibenzofuran	6.66E+00	4.48E+01	7.20E+01	4.48E+01	99% KM (Chebyshev) UCL	ProUCL Recommendation
Fluoranthene	1.05E+02	3.75E+02	1.30E+03	3.75E+02	95% KM (Chebyshev) UCL	ProUCL Recommendation
Heptachlor epoxide	3.44E-01	2.22E+00	3.60E+00	2.22E+00	99% KM (Chebyshev) UCL	ProUCL Recommendation
Indeno(1,2,3-c,d)pyrene	2.00E+01	7.30E+01	2.60E+02	7.30E+01	95% KM (Chebyshev) UCL	ProUCL Recommendation
1-Methylnaphthalene	6.04E+00	2.02E+01	3.40E+01	2.02E+01	95% KM (Chebyshev) UCL	ProUCL Recommendation
2-Methylnaphthalene	3.36E+00	6.32E+00	3.50E+01	6.32E+00	95% KM (t) UCL	ProUCL Recommendation
Naphthalene	7.45E+00	1.46E+01	8.40E+01	1.46E+01	95% KM (t) UCL	ProUCL Recommendation
Phenanthrene	9.16E+01	3.24E+02	1.10E+03	3.24E+02	95% KM (Chebyshev) UCL	ProUCL Recommendation
Pyrene	8.22E+01	2.90E+02	1.00E+03	2.90E+02	95% KM (Chebyshev) UCL	ProUCL Recommendation
Antimony	7.77E-01	8.67E-01	3.10E+00	8.67E-01	95% KM (BCA) UCL	ProUCL Recommendation
Arsenic	3.58E+00	1.13E+01	3.29E+01	1.13E+01	97.5% KM (Chebyshev) UCL	ProUCL Recommendation
Chromium	9.79E+00	1.24E+01	2.58E+01	1.24E+01	95% Adjusted Gamma UCL	ProUCL Recommendation
Cobalt	1.81E+00	2.84E+00	5.20E+00	2.84E+00	95% KM (t) UCL	ProUCL Recommendation
Lead	6.06E+01	1.02E+02	5.86E+02	1.02E+02	95% Adjusted Gamma UCL	ProUCL Recommendation

NC = Not calculated.

Table 6-7
Dermal Absorption Factors for Soil Exposure
Former Raritan Arsenal

COPC	Dermal Absorption Factor* (unitless)
Aldrin	NA
Aroclor-1248	0.14
Aroclor-1254	0.14
Aroclor-1260	0.14
Benzo(a)anthracene	0.13
Benzo(a)pyrene	0.13
Benzo(b)fluoranthene	0.13
Benzo(k)fluoranthene	0.13
Carbazole	0.13
gamma-Chlordane	0.04
Chloroform	NA
Chrysene	0.13
4,4-DDT	0.03
Dibenz(a,h)anthracene	0.13
Dibenzofuran	0.03
Dieldrin	0.1
Ethylbenzene	NA
Fluoranthene	0.13
Heptachlor epoxide	NA
Indeno(1,2,3-c,d)pyrene	0.13
1-Methylnaphthalene	0.13
2-Methylnaphthalene	0.13
Naphthalene	0.13
Pentachlorophenol	0.25
Phenanthrene	0.13
Pyrene	0.13
Trichloroethylene	NA
Vinyl chloride	NA
Xylenes, Total	NA
Aluminum	NA
Antimony	NA
Arsenic	0.03
Chromium	NA
Cobalt	NA
Copper	NA
Lead	NA
Manganese	NA
Mercury	NA
Thallium	NA
Vanadium	NA

* Dermal absorption factors obtained from the RSL Table (Nov, 2017).

NA = Not available

Table 6-8
Calculation of Particulate Emission Factor Based on Wind Erosion
U.S. EPA and GSA Property Area
Former Raritan Arsenal

$$PEF\ (m^3/kg) = Q/C \times \frac{3{,}600\ sec/hour}{0.036 \times (1 - V) \times (U_m/U_t)^3 \times F(x)}$$

Where:		Value
PEF =	Particulate emission factor (m^3/kg).	2.67E+09 (calculated)
Q/C_{wind} =	Inverse of the ratio of the geometric mean air concentration to the emission flux at the center of a square source (g/m^2-s per kg/m^3).	138.7 (NJDEP default value for 2 acres)
V =	Fraction of vegetative cover (unitless).	0.5 (NJDEP default value)
U_m =	Mean annual wind speed (m/sec).	4.56 (NJDEP default value)
U_t =	Equivalent threshold value of wind speed at 7m (m/sec).	11.32 (NJDEP default value)
F(x) =	Function dependent on U_m/U_t derived using Cowherd et al. (1985).	0.159 (NJDEP default value)

Table 6-9
Calculation of Particulate Emission Factor Based on Truck Traffic on Unpaved Roads
U.S. EPA and GSA Property Area
Former Raritan Arsenal

$$PEF\ (m^3/kg) = Q/C_{sr} \times \frac{1}{F_D} \times \left[\frac{T \times A_R}{\frac{2.6 \times (s/12)^{0.8} \times (W/3)^{0.4}}{(M_{dry}/0.2)^{0.3}} \times \frac{(365\ d/yr - p)}{365\ d/yr} \times 281.9\ g/km \times \sum VKT} \right]$$

Where:

$$Q/C_{sr}\ (g/m^2\text{-s per kg/m}^3) = A \times \exp\left[\frac{(\ln A_S - B)^2}{C}\right]$$

$$F_D = 0.1852 + \frac{5.3537}{t_c} + \frac{-9.6318}{t_c^2}$$

$$A_R\ (m^2) = (L_R \times W_R)$$

Where:		**RME**	**CTE**
PEF =	Particulate emission factor from truck traffic on unpaved roads (m^3/kg).	1.03E+06	9.71E+05
Q/C_{sr} =	Inverse of 1-h average air concentration along a straight road segment bisecting a 2-acre square site (g/m^2-s per kg/m^3).	18.4	
F_D =	Dispersion correction factor (unitless).	0.20	0.21
T =	Total time over which construction occurs (s).	1.73E+06[a]	8.64E+05[a]
t_c =	Total time over which construction occurs (hr).	480[a]	240[a]
A_R =	Surface area of contaminated road segment (m^2).	540	
s =	Road surface silt content (%).	11 (NJDEP default)	
W =	Mean vehicle weight (tons).	3.4 (NJDEP default)	
M_{dry} =	Road surface moisture content (%).	0.2 (NJDEP default)	
p =	Number of days with at least 0.01 inches of precipitation (days/yr).	121.3 (NJDEP default)	
VKT =	Sum of fleet vehicle kilometers traveled during the exposure duration (km).	178.2[b]	89.1[b]
A =	Constant (unitless). Default value (EPA, 2002a).	12.94	
A_s =	Areal extent of site soil contamination (acres).	2 (NJDEP default)	
B =	Constant (unitless). Default value (EPA, 2002a).	5.74	
C =	Constant (unitless). Default value (EPA, 2002a).	71.77	
L_R =	Length of road segment (m).	90[c]	
W_R =	Width of road segment (m). Default value (EPA, 2002a).	6.00	

[a] RME assumes exposure 60 days/year for 8 hours/day; CTE assumes 30 days/year for 8 hours per day.

[b] VKT = 33 vehicles x 0.09 km/day (see L_i) x 60 days/year for the RME. For the CTE, VKT = 33 vehicles x 0.09 km/day x 30 days/year.

[c] Calculated based on the area of the site (2 acres). Assumes site is roughly configured as a square with the unpaved road transecting the area evenly. Value is equal to the square root of the area where 2 acres equals 8,094 m^2.

Table 6-10
Calculation of Volatilization Factors
U.S. EPA and GSA Property Area
Former Raritan Arsenal

$$VF\ (m^3/kg) = Q/C_{vol}\ x \frac{\left(3.14\ x\ D_A\ x\ T\right)^{1/2}}{2\ x\ \rho b\ x\ D_A}\ x\ 0.0001\ m^2/cm^2$$

Where:

$$D_A\ (cm^2/sec) = \frac{\left[\left(\theta_a^{10/3}\ x\ D_i\ x\ H'\right) + \left(\theta_w^{10/3}\ x\ D_w\right)\right]/n^2}{\left(\rho b\ x\ K_d\right) + \theta_w + \left(\theta_a\ x\ H'\right)}$$

Where:		RME	CTE
VF =	Soil-to-air volatilization factor (m^3/kg).	See Table 6-11	See Table 6-11
Q/C_{vol} =	Inverse air concentration at center of source (g/m^2-s per kg/m^3).	138.7 (NJDEP default value for 2 acres)	
D_A =	Apparent diffusivity (cm^2/sec).	See Table 6-12	
T =	Exposure interval (sec). Estimated based on exposure duration.	Groundskeeper – 7.88E+08	Groundskeeper – 3.78E+08
		Construction/Utility Worker – 3.15E+07	Construction/Utility Worker – 3.15E+07
		Indoor Worker – 7.88E+08	Indoor Worker – 3.78E+08
		Residents – 9.45E+08	Residents – 4.73E+08
ρb =	Dry soil bulk density (g/cm^3).	1.5 (NJDEP default)	
θ_a =	Air-filled soil porosity (L_{air}/L_{soil}).	0.18 (NJDEP default)	
D_i =	Diffusivity in air (cm^2/sec).	See Table 6-12	
H' =	Dimensionless Henry's Law Constant (unitless).	See Table 6-12	
θ_w =	Water-filled soil porosity (L_{water}/L_{soil}).	0.23 (NJDEP default)	
D_w =	Diffusivity in water (cm^2/sec).	See Table 6-12	
n =	Total soil porosity(L_{pore}/L_{soil}).	0.41 (NJDEP default)	
K_d =	Soil-water partition coefficient (cm^3/g).	See Table 6-12	

Table 6-11
Volatilization Factors for Volatile Soil COPCs
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	COPC	RME			
		Groundskeeper VF (m^3/kg)	Construction/Utility Worker VF (m^3/kg)	Indoor Worker VF (m^3/kg)	Residents VF (m^3/kg)
67663	Chloroform	1.02E+05	2.04E+04	1.02E+05	1.12E+05
100414	Ethylbenzene	2.46E+05	4.92E+04	2.46E+05	2.70E+05
91203	Naphthalene	2.61E+06	5.23E+05	2.61E+06	2.86E+06
79016	Trichloroethylene	1.42E+05	2.84E+04	1.42E+05	1.56E+05
75014	Vinyl chloride	2.55E+04	5.10E+03	2.55E+04	2.79E+04
13300207	Xylenes	2.71E+05	5.43E+04	2.71E+05	2.97E+05

CAS Number	COPC	CTE			
		Groundskeeper VF (m^3/kg)	Construction/Utility Worker VF (m^3/kg)	Indoor Worker VF (m^3/kg)	Residents VF (m^3/kg)
67663	Chloroform	7.05E+04	2.04E+04	7.05E+04	7.89E+04
100414	Ethylbenzene	1.71E+05	4.92E+04	1.71E+05	1.91E+05
91203	Naphthalene	1.81E+06	5.23E+05	1.81E+06	2.03E+06
79016	Trichloroethylene	9.84E+04	2.84E+04	9.84E+04	1.10E+05
75014	Vinyl chloride	1.77E+04	5.10E+03	1.77E+04	1.98E+04
13300207	Xylenes	1.88E+05	5.43E+04	1.88E+05	2.10E+05

Table 6-12
Calculation of Apparent Diffusivity for Volatile Soil COPCs
U.S. EPA and GSA Property Area
Former Raritan Arsenal

CAS Number	COPC	D_i Diffusion Coefficient in Air [a] (cm^2/sec)	H' Dimensionless Henry's Law Constant [a] (unitless)	D_w Diffusion Coefficient in Water [a] (cm^2/sec)	K_d Soil-Water Partition Coefficient [a] (cm^3/g)	D_A Apparent Diffusivity (cm^2/sec)
67663	Chloroform	1.04E-01	1.50E-01	1.00E-05	3.98E+01	5.10E-06
100414	Ethylbenzene	7.50E-02	3.23E-01	7.80E-06	3.63E+02	8.72E-07
91203	Naphthalene	5.90E-02	1.98E-02	7.50E-06	2.00E+03	7.74E-09
79016	Trichloroethylene	7.90E-02	4.22E-01	9.10E-06	1.66E+02	2.62E-06
75014	Vinyl chloride	1.06E-01	1.11E+00	1.23E-06	1.86E+01	8.14E-05
13300207	Xylenes	7.69E-02	2.76E-01	8.44E-06	3.86E+02	7.18E-07

[a]NJDEP, 2008b.

TABLE 6-13
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE - SURFACE SOIL/SEDIMENT- GROUNDSKEEPER
Former Raritan Arsenal

Scenario Timeframe: Current/Future
Medium: Soils/Sediment
Exposure Medium: Surface Soils (0-2 ft bgs)/Sediment
Receptor Population: Groundskeeper
Receptor Age: Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation
Ingestion	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-4 and 6-6	Chronic daily intake (mg/kg-day) =
		IRS	Ingestion Rate of Soil	100	mg/day	EPA, 2014	EPC x IRS x RBA x CF x FI x EF x ED x 1/BW x 1/AT
		RBA	Relative bioavailability	0.6 - As 1.0 - other COPCs	unitless	EPA, 2012	
		FI	Fraction Ingested	1	unitless	Professional judgment	
		EF	Exposure Frequency-Soil EA	225	days/year	EPA, 2014	
			Exposure Frequency-Drainage Ditch EA	26	days/year	Professional judgment	
		ED	Exposure Duration	25	years	EPA, 2014	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		BW	Body Weight	80	kg	EPA, 2014	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	9,125	days	Calculated	
Dermal	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-4 and 6-6	Dermally Absorbed Dose (mg/kg-day) =
		SA	Exposed Skin Surface Area	3,527	cm^2/day	EPA, 2014	EPC x SA x AF x EF x ED x CF x ABS x 1/BW x 1/AT
		AF	Soil to Skin Adherence Factor	0.12	mg/cm^2	EPA, 2014	
		EF	Exposure Frequency-Soil EA	225	days/year	EPA, 2014	
			Exposure Frequency-Drainage Ditch EA	26	days/year	Professional judgment	
		ED	Exposure Duration	25	years	EPA, 2014	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		ABS	Dermal Absorption Factor	See Table 6-7	unitless	EPA, 2004	
		BW	Body Weight	80	kg	EPA, 2014	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	9,125	days	Calculated	
Inhalation	Particulate/Volatiles Released from Soil	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-4 and 6-6	Average Daily Concentration ($\mu g/m^3$) =
		CA	COPC Air Concentration	Calculated	$\mu g/m^3$	Calculated	CA x ET x EF x ED x CF2 x 1/AT
		ET	Exposure Time	8	hours/day	EPA, 2014	
		EF	Exposure Frequency-Soil EA	225	days/year	EPA, 2014	where:
		ED	Exposure Duration	25	years	EPA, 2014	CA (µg/m3) = EPC/PEF x CF3
		CF2	Conversion Factor 2	0.042	days/hour	-----	
		CF3	Conversion Factor 3	1000	µg/mg	-----	or
		PEF	Erosion	See Table 6-8	m^3/kg	EPA, 2002	
		VF	Volatilization Factor	See Table 6-11	m^3/kg	EPA, 2002	CA (µg/m3) = EPC/VF x CF3
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	9,125	days	Calculated	

TABLE 6-14
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE - SURFACE SOIL/SEDIMENT - GROUNDSKEEPER
Former Raritan Arsenal

Scenario Timeframe: Current/Future
Medium: Soils/Sediment
Exposure Medium: Surface Soils (0-2 ft bgs)/Sediment
Receptor Population: Groundskeeper
Receptor Age: Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation
Ingestion	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-4 and 6-6	Chronic daily intake (mg/kg-day) =
		IRS	Ingestion Rate of Soil	50	mg/day	EPA, 2014 (indoor worker rate)	EPC x IRS x RBA x CF x FI x EF x ED x 1/BW x 1/AT
		RBA	Relative bioavailability	0.6 - As 1.0 - other COPCs	unitless	EPA, 2012	
		FI	Fraction Ingested	0.5	unitless	Professional judgment	
		EF	Exposure Frequency-Soil EA	110	days/year	Approximately half of RME value	
			Exposure Frequency-Drainage Ditch EA	13	days/year	Half of RME value	
		ED	Exposure Duration	12	years	Approximately half of RME value	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		BW	Body Weight	80	kg	EPA, 2014	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	4,380	days	Calculated	
Dermal	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-4 and 6-6	Dermally Absorbed Dose (mg/kg-day) =
		SA	Exposed Skin Surface Area	3,527	cm^2/day	EPA, 2014	EPC x SA x AF x EF x ED x CF x ABS x 1/BW x 1/AT
		AF	Soil to Skin Adherence Factor	0.02	mg/cm^2	EPA, 2004	
		EF	Exposure Frequency-Soil EA	110	days/year	Approximately half of RME value	
			Exposure Frequency-Drainage Ditch EA	13	days/year	Half of RME value	
		ED	Exposure Duration	12	years	Approximately half of RME value	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		ABS	Dermal Absorption Factor	See Table 6-7	unitless	EPA, 2004	
		BW	Body Weight	80	kg	EPA, 2014	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	4,380	days	Calculated	
Inhalation	Particulate/Volatiles Released from Soil	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-4 and 6-6	Average Daily Concentration ($\mu g/m^3$) =
		CA	COPC Air Concentration	Calculated	$\mu g/m^3$	Calculated	CA x ET x EF x ED x CF2 x 1/AT
		ET	Exposure Time	4	hours/day	Half of work day	
		EF	Exposure Frequency-Soil EA	110	days/year	Approximately half of RME value	where:
		ED	Exposure Duration	12	years	Approximately half of RME value	CA (µg/m3) = EPC/PEF x CF3
		CF2	Conversion Factor 2	0.042	days/hour	-----	
		CF3	Conversion Factor 3	1000	µg/mg	-----	or
		PEF	Particulate Emissions Factor from Wind Erosion	See Table 6-8	m^3/kg	EPA, 2002	CA (µg/m3) = EPC/VF x CF3
		VF	Volatilization Factor	See Table 6-11	m^3/kg	EPA, 2002	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	4,380	days	Calculated	

TABLE 6-15
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE - AGGREGATE SOIL - CONSTRUCTION/UTILITY WORKER
Former Raritan Arsenal

Scenario Timeframe: Current/Future
Medium: Aggregate Soils
Exposure Medium: Aggregate Soils (0-10 ft bgs)
Receptor Population: Construction/Utility Worker
Receptor Age: Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation
Ingestion	Aggregate Soils	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Table 6-5	Chronic daily intake (mg/kg-day) =
		IRS	Ingestion Rate of Soil	330	mg/day	EPA, 2002	EPC x IRS x RBA x CF x FI x EF x ED x 1/BW x 1/AT
		RBA	Relative bioavailability	0.6 - As 1.0 - other COPCs	unitless	EPA, 2012	
		FI	Fraction Ingested	1	unitless	Professional judgment	
		EF	Exposure Frequency	60	days/year	Professional judgment (1)	
		ED	Exposure Duration	1	years	Professional judgment (2)	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		BW	Body Weight	80	kg	EPA, 2014	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	365	days	Calculated	
Dermal	Aggregate Soils	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Table 6-5	Dermally Absorbed Dose (mg/kg-day) =
		SA	Exposed Skin Surface Area	3,527	cm^2/day	EPA, 2014	EPC x SA x AF x EF x ED x CF x ABS x 1/BW x 1/AT
		AF	Soil to Skin Adherence Factor	0.3	mg/cm^2	EPA, 2004	
		EF	Exposure Frequency	60	days/year	Professional judgment (1)	
		ED	Exposure Duration	1	years	Professional judgment (2)	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		ABS	Dermal Absorption Factor	See Table 6-7	unitless	EPA, 2004	
		BW	Body Weight	80	kg	EPA, 2014	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	365	days	Calculated	
Inhalation	Particulate/Volatiles Released from Soil	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Table 6-5	Average Daily Concentration ($\mu g/m^3$) =
		CA	COPC Air Concentration	Calculated	$\mu g/m^3$	Calculated	CA x ET x EF x ED x CF2 x 1/AT
		ET	Exposure Time	8	hours/day	EPA, 2014	
		EF	Exposure Frequency	60	days/year	Professional judgment (1)	where:
		ED	Exposure Duration	1	years	Professional judgment (2)	CA (µg/m3) = EPC/PEF x CF3
		CF2	Conversion Factor 2	0.042	days/hour	-----	
		CF3	Conversion Factor 3	1000	µg/mg	-----	or
		PEF	Particulate Emission Factor from Truck Traffic on Unpaved Roads	See Table 6-9	m^3/kg	EPA, 2002	CA (µg/m3) = EPC/VF x CF3
		VF	Volatilization Factor	See Table 6-11	m^3/kg	EPA, 2002	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	365	days	Calculated	

(1) Assumes the construction/utility worker is exposed 5 days per week for a total of 12 weeks.
(2) Assumes the construction/utility worker is exposed for 1 year.

TABLE 6-16
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE - AGGREGATE SOIL - CONSTRUCTION/UTILITY WORKER
Former Raritan Arsenal

Scenario Timeframe: Current/Future
Medium: Aggregate Soils
Exposure Medium: Aggregate Soils (0-10 ft bgs)
Receptor Population: Construction/Utility Worker
Receptor Age: Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation
Ingestion	Aggregate Soils	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Table 6-5	Chronic daily intake (mg/kg-day) =
		IRS	Ingestion Rate of Soil	100	mg/day	EPA, 2014 (outdoor worker rate)	EPC x IRS x RBA x CF x FI x EF x ED x 1/BW x 1/AT
		RBA	Relative bioavailability	0.6 - As 1.0 - other COPCs	unitless	EPA, 2012	
		FI	Fraction Ingested	0.5	unitless	Professional judgment	
		EF	Exposure Frequency	30	days/year	Professional judgment (1)	
		ED	Exposure Duration	1	years	Professional judgment (2)	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		BW	Body Weight	80	kg	EPA, 2014	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	365	days	Calculated	
Dermal	Aggregate Soils	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Table 6-5	Dermally Absorbed Dose (mg/kg-day) =
		SA	Exposed Skin Surface Area	3,527	cm^2/day	EPA, 2014	EPC x SA x AF x EF x ED x CF x ABS x 1/BW x 1/AT
		AF	Soil to Skin Adherence Factor	0.1	mg/cm^2	EPA, 2004	
		EF	Exposure Frequency	30	days/year	Professional judgment (1)	
		ED	Exposure Duration	1	years	Professional judgment (2)	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		ABS	Dermal Absorption Factor	See Table 6-7	unitless	EPA, 2004	
		BW	Body Weight	80	kg	EPA, 2014	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	365	days	Calculated	
Inhalation	Particulate/Volatiles Released from Soil	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Table 6-5	Average Daily Concentration ($\mu g/m^3$) =
		CA	COPC Air Concentration	Calculated	$\mu g/m^3$	Calculated	CA x ET x EF x ED x CF2 x 1/AT
		ET	Exposure Time	4	hours/day	Half of work day	
		EF	Exposure Frequency	30	days/year	Professional judgment (1)	where:
		ED	Exposure Duration	1	years	Professional judgment (2)	CA (µg/m3) = EPC/PEF x CF3
		CF2	Conversion Factor 2	0.042	days/hour	-----	
		CF3	Conversion Factor 3	1000	µg/mg	-----	or
		PEF	Particulate Emission Factor from Truck Traffic on Unpaved Roads	See Table 6-9	m^3/kg	EPA, 2002	CA (µg/m3) = EPC/VF x CF3
		VF	Volatilization Factor	See Table 6-11	m^3/kg	EPA, 2002	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	365	days	Calculated	

(1) Assumes the construction/utility worker is exposed 5 days per week for a total of 6 weeks.
(2) Assumes the construction/utility worker is exposed for 1 year.

TABLE 6-17
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE - SURFACE SOIL - INDOOR WORKER
Former Raritan Arsenal

Scenario Timeframe: Current/Future
Medium: Soils
Exposure Medium: Surface Soils (0-2 ft bgs)
Receptor Population: Indoor Worker
Receptor Age: Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation
Ingestion	Surface Soils	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Table 6-4	Chronic daily intake (mg/kg-day) =
		IRS	Ingestion Rate of Soil	50	mg/day	EPA, 2014	EPC x IRS x RBA x CF x FI x EF x ED x 1/BW x 1/AT
		RBA	Relative bioavailability	0.6 - As 1.0 - other COPCs	unitless	EPA, 2012	
		FI	Fraction Ingested	1	unitless	Professional judgment	
		EF	Exposure Frequency	250	days/year	EPA, 2014	
		ED	Exposure Duration	25	years	EPA, 2014	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		BW	Body Weight	80	kg	EPA, 2014	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	9,125	days	Calculated	
Inhalation	Particulate/Volatiles Released from Soil	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Table 6-4	Average Daily Concentration (µg/m^3) =
		CA	COPC Air Concentration	Calculated	µg/m^3	Calculated	CA x ET x EF x ED x CF2 x 1/AT
		ET	Exposure Time	8	hours/day	EPA, 2014	
		EF	Exposure Frequency	250	days/year	EPA, 2014	where:
		ED	Exposure Duration	25	years	EPA, 2014	CA (µg/m3) = EPC/PEF x CF3
		CF2	Conversion Factor 2	0.042	days/hour	-----	
		CF3	Conversion Factor 3	1000	µg/mg	-----	or
		PEF	Particulate Emissions Factor from Wind Erosion	See Table 6-8	m^3/kg	EPA, 2002	CA (µg/m3) = EPC/VF x CF3
		VF	Volatilization Factor	See Table 6-11	m^3/kg	EPA, 2002	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	9,125	days	Calculated	

TABLE 6-18
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE - SURFACE SOIL - INDOOR WORKER
Former Raritan Arsenal

Scenario Timeframe: Current/Future
Medium: Soils
Exposure Medium: Surface Soils (0-2 ft bgs)
Receptor Population: Indoor Worker
Receptor Age: Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation
Ingestion	Surface Soils	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Table 6-4	Chronic daily intake (mg/kg-day) =
		IRS	Ingestion Rate of Soil	25	mg/day	Half of RME value	EPC x IRS x RBA x CF x FI x EF x ED x 1/BW x 1/AT
		RBA	Relative bioavailability	0.6 - As 1.0 - other COPCs	unitless	EPA, 2012	
		FI	Fraction Ingested	0.5	unitless	Professional judgment	
		EF	Exposure Frequency	125	days/year	Half of RME value	
		ED	Exposure Duration	12	years	Approximtely half of RME value	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		BW	Body Weight	80	kg	EPA, 2014	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	4,380	days	Calculated	
Inhalation	Particulate/Volatiles Released from Soil	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Table 6-4	Average Daily Concentration (µg/m^3) =
		CA	COPC Air Concentration	Calculated	µg/m^3	Calculated	CA x ET x EF x ED x CF2 x 1/AT
		ET	Exposure Time	4	hours/day	Half of work day	
		EF	Exposure Frequency	125	days/year	Half of RME value	where:
		ED	Exposure Duration	12	years	Approximtely half of RME value	CA (µg/m3) = EPC/PEF x CF3
		CF2	Conversion Factor 2	0.042	days/hour	-----	
		CF3	Conversion Factor 3	1000	µg/mg	-----	or
		PEF	Particulate Emissions Factor from Wind Erosion	See Table 6-8	m^3/kg	EPA, 2002	CA (µg/m3) = EPC/VF x CF3
		VF	Volatilization Factor	See Table 6-11	m^3/kg	EPA, 2002	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	4,380	days	Calculated	

TABLE 6-19
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE - AGGREGATE SOIL/SEDIMENT - RESIDENTS
Former Raritan Arsenal

Scenario Timeframe: Future
Medium: Soils/Sediment
Exposure Medium: Aggregate Soils (0-10 ft bgs)/ Sediment
Receptor Population: Residents
Receptor Age: Child/Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion (cancer effects)	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-5 and 6-6	Chronic daily intake (CDI)(mg/kg-day) =
		IFS_{adj}	Age-adjusted soil ingestion factor	105	mg-year/kg-day	Calculated	EPC x IFS_{adj} x RBA x CF x FI x EF x 1/AT
		RBA	Relative bioavailability	0.6 - As 1.0 - other COPCs	unitless	EPA, 2012	
		FI	Fraction Ingested	1	unitless	Professional judgment	Where
		EF	Exposure Frequency-Soil EA	350	days/year	EPA, 2014	IFS_{adj} = (IRS_c x ED_c x 1/BW_c) + (IRS_a x ED_a x 1/BW_a)
			Exposure Frequency-Drainage Ditch EA	56	days/year	Professional judgment	
		ED_c	Exposure Duration - child	6	years	EPA, 2014	
		ED_a	Exposure Duration - adult	20	years	EPA, 2014	
		IRS_c	Ingestion Rate of Soil - child	200	mg/day	EPA, 2014	
		IRS_a	Ingestion Rate of Soil - adult	100	mg/day	EPA, 2014	
		BW_c	Body Weight - child	15	kg	EPA, 2014	
		BW_a	Body Weight - adult	80	kg	EPA, 2014	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
Ingestion (child noncancer)	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-5 and 6-6	Chronic daily intake (CDI)(mg/kg-day) =
		IRS	Ingestion Rate of Soil	200	mg/day	EPA, 2014	EPC x IRS x RBA x CF x FI x EF x ED x 1/BW x 1/AT
		RBA	Relative bioavailability	0.6 - As 1.0 - other COPCs	unitless	EPA, 2012	
		FI	Fraction Ingested	1	unitless	Professional judgment	
		EF	Exposure Frequency-Soil EA	350	days/year	EPA, 2014	
			Exposure Frequency-Drainage Ditch EA	56	days/year	Professional judgment	
		ED	Exposure Duration	6	years	EPA, 2014	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		BW	Body Weight	15	kg	EPA, 2014	
		AT_{NC}	Averaging Time (Non-Cancer)	2,190	days	Calculated	
Ingestion (adult noncancer)	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-5 and 6-6	Chronic daily intake (CDI)(mg/kg-day) =
		IRS	Ingestion Rate of Soil	100	mg/day	EPA, 2014	EPC x IRS x RBA x CF x FI x EF x ED x 1/BW x 1/AT
		RBA	Relative bioavailability	0.6 - As 1.0 - other COPCs	unitless	EPA, 2012	
		FI	Fraction Ingested	1	unitless	Professional judgment	
		EF	Exposure Frequency-Soil EA	350	days/year	EPA, 2014	
			Exposure Frequency-Drainage Ditch EA	56	days/year	Professional judgment	
		ED	Exposure Duration	20	years	EPA, 2014	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		BW	Body Weight	80	kg	EPA, 2014	
		AT_{NC}	Averaging Time (Non-Cancer)	7,300	days	Calculated	

TABLE 6-19
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE - AGGREGATE SOIL/SEDIMENT - RESIDENTS
Former Raritan Arsenal

Scenario Timeframe: Future
Medium: Soils/Sediment
Exposure Medium: Aggregate Soils (0-10 ft bgs)/ Sediment
Receptor Population: Residents
Receptor Age: Child/Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cancer effects)	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-5 and 6-6	Dermally Absorbed Dose (DAD)(mg/kg-day) = EPC x CF x SFS_{adj} x ABS x EF x 1/AT
		SFS_{adj}	Age-adjusted soil contact factor	295	mg -year/kg-day	Calculated	
		ABS	Dermal Absorption Factor	See Table 6-7	unitless	EPA, 2004	Where
		EF	Exposure Frequency-Soil EA	350	days/year	EPA, 2014	$SFS_{adj} = (SA_c \times AF_c \times ED_c \times 1/BW_c) + (SA_a \times AF_a \times ED_a \times 1/BW_a)$
			Exposure Frequency-Drainage Ditch EA	56	days/year	Professional judgment	
		SA_c	Exposed Skin Surface Area - child	2,373	cm^2/day	EPA, 2014	
		SA_a	Exposed Skin Surface Area - adult	6,032	cm^2/day	EPA, 2014	
		AF_c	Soil to Skin Adherence Factor - child	0.2	mg/cm^2	EPA, 2014	
		AF_a	Soil to Skin Adherence Factor - adult	0.07	mg/cm^2	EPA, 2014	
		ED_c	Exposure Duration - child	6	years	EPA, 2014	
		ED_a	Exposure Duration - adult	20	years	EPA, 2014	
		BW_c	Body Weight - child	15	kg	EPA, 2014	
		BW_a	Body Weight - adult	80	kg	EPA, 2014	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
Dermal (child noncancer)	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-5 and 6-6	Dermally Absorbed Dose (DAD)(mg/kg-day) = EPC x CF x SA x AF x ABS x EF x ED x 1/BW x 1/AT
		SA	Exposed Skin Surface Area	2,373	cm^2/day	EPA, 2014	
		AF	Soil to Skin Adherence Factor	0.2	mg/cm^2	EPA, 2014	
		EF	Exposure Frequency-Soil EA	350	days/year	EPA, 2014	
			Exposure Frequency-Drainage Ditch EA	56	days/year	Professional judgment	
		ED	Exposure Duration	6	years	EPA, 2014	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		ABS	Dermal Absorption Factor	See Table 6-7	unitless	EPA, 2004	
		BW	Body Weight	15	kg	EPA, 2014	
		AT_{NC}	Averaging Time (Non-Cancer)	2,190	days	Calculated	
Dermal (adult noncancer)	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-5 and 6-6	Dermally Absorbed Dose (DAD)(mg/kg-day) = EPC x CF x SA x AF x ABS x EF x ED x 1/BW x 1/AT
		SA	Exposed Skin Surface Area	6,032	cm^2/day	EPA, 2014	
		AF	Soil to Skin Adherence Factor	0.07	mg/cm^2	EPA, 2014	
		EF	Exposure Frequency-Soil EA	350	days/year	EPA, 2014	
			Exposure Frequency-Drainage Ditch EA	56	days/year	Professional judgment	
		ED	Exposure Duration	20	years	EPA, 2014	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		ABS	Dermal Absorption Factor	See Table 6-7	unitless	EPA, 2004	
		BW	Body Weight	80	kg	EPA, 2014	
		AT_{NC}	Averaging Time (Non-Cancer)	7,300	days	Calculated	

TABLE 6-19
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE - AGGREGATE SOIL/SEDIMENT - RESIDENTS
Former Raritan Arsenal

Scenario Timeframe: Future
Medium: Soils/Sediment
Exposure Medium: Aggregate Soils (0-10 ft bgs)/ Sediment
Receptor Population: Residents
Receptor Age: Child/Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Particulate/Volatiles Released from Soil	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-5 and 6-6	Average Daily Concentration (µg/m^3) =
		CA	COPC Air Concentration	Calculated	µg/m^3	Calculated	CA x ET x EF x ED x CF2 x 1/AT
		ET	Exposure Time	24	hours/day	Residential exposure	where:
		EF	Exposure Frequency-Soil EA	350	days/year	EPA, 2014	CA (µg/m3) = EPC/PEF x CF3
		ED	Exposure Duration	26	years	EPA, 2014	or
		CF2	Conversion Factor 2	0.042	days/hour	-----	CA (µg/m3) = EPC/VF x CF3
		CF3	Conversion Factor 3	1000	µg/mg	-----	
		PEF	Particulate Emissions Factor from Wind Erosion	See Table 6-8	m^3/kg	EPA, 2002	
		VF	Volatilization Factor	See Table 6-11	m^3/kg	EPA, 2002	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	9,490	days	Calculated	

TABLE 6-20
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE - AGGREGATE SOIL/SEDIMENT - RESIDENTS
Former Raritan Arsenal

Scenario Timeframe: Future
Medium: Soils/Sediment
Exposure Medium: Aggregate Soils (0-10 ft bgs)/ Sediment
Receptor Population: Residents
Receptor Age: Child/Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion (cancer effects)	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-5 and 6-6	Chronic daily intake (CDI)(mg/kg-day) =
		IFS_{adj}	Age-adjusted soil ingestion factor	46	mg-year/kg-day	Calculated	EPC x IFS_{adj} x RBA x CF x FI x EF x 1/AT
		RBA	Relative bioavailability	0.6 - As 1.0 - other COPCs	unitless	EPA, 2012	
		FI	Fraction Ingested	0.5	unitless	Professional judgment	Where
		EF	Exposure Frequency-Soil EA	350	days/year	EPA, 2014	$IFS_{adj} = (IRS_c \times ED_c \times 1/BW_c) + (IRS_a \times ED_a \times 1/BW_a)$
			Exposure Frequency-Drainage Ditch EA	28	days/year	Half of RME value	
		ED_c	Exposure Duration - child	6	years	EPA, 2014	
		ED_a	Exposure Duration - adult	9	years	EPA, 1997	
		IRS_c	Ingestion Rate of Soil - child	100	mg/day	Half of RME value	
		IRS_a	Ingestion Rate of Soil - adult	50	mg/day	Half of RME value	
		BW_c	Body Weight - child	15	kg	EPA, 2014	
		BW_a	Body Weight - adult	80	kg	EPA, 2014	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
Ingestion (child noncancer)	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-5 and 6-6	Chronic daily intake (CDI)(mg/kg-day) =
		IRS	Ingestion Rate of Soil	100	mg/day	Half of RME value	EPC x IRS x RBA x CF x FI x EF x ED x 1/BW x 1/AT
		RBA	Relative bioavailability	0.6 - As 1.0 - other COPCs	unitless	EPA, 2012	
		FI	Fraction Ingested	0.5	unitless	Professional judgment	
		EF	Exposure Frequency-Soil EA	350	days/year	EPA, 2014	
			Exposure Frequency-Drainage Ditch EA	28	days/year	Half of RME value	
		ED	Exposure Duration	6	years	EPA, 2014	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		BW	Body Weight	15	kg	EPA, 2014	
		AT_{NC}	Averaging Time (Non-Cancer)	2,190	days	Calculated	
Ingestion (adult noncancer)	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-5 and 6-6	Chronic daily intake (CDI)(mg/kg-day) =
		IRS	Ingestion Rate of Soil	50	mg/day	Half of RME value	EPC x IRS x RBA x CF x FI x EF x ED x 1/BW x 1/AT
		RBA	Relative bioavailability	0.6 - As 1.0 - other COPCs	unitless	EPA, 2012	
		FI	Fraction Ingested	0.5	unitless	Professional judgment	
		EF	Exposure Frequency-Soil EA	350	days/year	EPA, 2014	
			Exposure Frequency-Drainage Ditch EA	28	days/year	Half of RME value	
		ED	Exposure Duration	9	years	EPA, 1997	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		BW	Body Weight	80	kg	EPA, 2014	
		AT_{NC}	Averaging Time (Non-Cancer)	3,285	days	Calculated	

TABLE 6-20
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE - AGGREGATE SOIL/SEDIMENT - RESIDENTS
Former Raritan Arsenal

Scenario Timeframe: Future
Medium: Soils/Sediment
Exposure Medium: Aggregate Soils (0-10 ft bgs)/ Sediment
Receptor Population: Residents
Receptor Age: Child/Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cancer effects)	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-5 and 6-6	Dermally Absorbed Dose (DAD)(mg/kg-day) = EPC x CF x SFS_{adj} x ABS x EF x 1/AT Where $SFS_{adj} = (SA_c \times AF_c \times ED_c \times 1/BW_c) + (SA_a \times AF_a \times ED_a \times 1/BW_a)$
		SFS_{adj}	Age-adjusted soil contact factor	45	mg -year/kg-day	Calculated	
		ABS	Dermal Absorption Factor	See Table 6-7	unitless	EPA, 2004	
		EF	Exposure Frequency-Soil EA	350	days/year	EPA, 2014	
			Exposure Frequency-Drainage Ditch EA	28	days/year	Half of RME value	
		SA_c	Exposed Skin Surface Area - child	2,373	cm^2/day	EPA, 2014	
		SA_a	Exposed Skin Surface Area - adult	6,032	cm^2/day	EPA, 2014	
		AF_c	Soil to Skin Adherence Factor - child	0.04	mg/cm^2	EPA, 2004	
		AF_a	Soil to Skin Adherence Factor - adult	0.01	mg/cm^2	EPA, 2004	
		ED_c	Exposure Duration - child	6	years	EPA, 2014	
		ED_a	Exposure Duration - adult	9	years	EPA, 1997	
		BW_c	Body Weight - child	15	kg	EPA, 2014	
		BW_a	Body Weight - adult	80	kg	EPA, 2014	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
Dermal (child noncancer)	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-5 and 6-6	Dermally Absorbed Dose (DAD)(mg/kg-day) = EPC x CF x SA x AF x ABS x EF x ED x 1/BW x 1/AT
		SA	Exposed Skin Surface Area	2,373	cm^2/day	EPA, 2014	
		AF	Soil to Skin Adherence Factor	0.04	mg/cm^2	EPA, 2004	
		EF	Exposure Frequency-Soil EA	350	days/year	EPA, 2014	
			Exposure Frequency-Drainage Ditch EA	28	days/year	Half of RME value	
		ED	Exposure Duration	6	years	EPA, 2014	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		ABS	Dermal Absorption Factor	See Table 6-7	unitless	EPA, 2004	
		BW	Body Weight	15	kg	EPA, 2014	
		AT_{NC}	Averaging Time (Non-Cancer)	2,190	days	Calculated	
Dermal (adult noncancer)	Surface Soils/ Sediment	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-5 and 6-6	Dermally Absorbed Dose (DAD)(mg/kg-day) = EPC x CF x SA x AF x ABS x EF x ED x 1/BW x 1/AT
		SA	Exposed Skin Surface Area	6,032	cm^2/day	EPA, 2014	
		AF	Soil to Skin Adherence Factor	0.01	mg/cm^2	EPA, 2004	
		EF	Exposure Frequency-Soil EA	350	days/year	EPA, 2014	
			Exposure Frequency-Drainage Ditch EA	28	days/year	Half of RME value	
		ED	Exposure Duration	9	years	EPA, 1997	
		CF	Conversion Factor	1.00E-06	kg/mg	-----	
		ABS	Dermal Absorption Factor	See Table 6-7	unitless	EPA, 2004	
		BW	Body Weight	80	kg	EPA, 2014	
		AT_{NC}	Averaging Time (Non-Cancer)	3,285	days	Calculated	

TABLE 6-20
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE - AGGREGATE SOIL/SEDIMENT - RESIDENTS
Former Raritan Arsenal

Scenario Timeframe: Future
Medium: Soils/Sediment
Exposure Medium: Aggregate Soils (0-10 ft bgs)/ Sediment
Receptor Population: Residents
Receptor Age: Child/Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Particulate/Volatiles Released from Soil	EPC	Exposure Point Concentration	COPC-specific	mg/kg	see Tables 6-5 and 6-6	Average Daily Concentration (µg/m^3) =
		CA	COPC Air Concentration	Calculated	µg/m^3	Calculated	CA x ET x EF x ED x CF2 x 1/AT
		ET	Exposure Time	24	hours/day	Residential exposure	where:
		EF	Exposure Frequency-Soil EA	350	days/year	EPA, 2014	CA (µg/m3) = EPC/PEF x CF3
		ED	Exposure Duration	9	years	EPA, 1997	or
		CF2	Conversion Factor 2	0.042	days/hour	-----	CA (µg/m3) = EPC/VF x CF3
		CF3	Conversion Factor 3	1000	µg/mg	-----	
		PEF	Particulate Emissions Factor from Wind Erosion	See Table 6-8	m^3/kg	EPA, 2002	
		VF	Volatilization Factor	See Table 6-11	m^3/kg	EPA, 2002	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	3,285	days	Calculated	

Table 6-21
Noncancer Toxicity Data - Oral and Dermal
U.S. EPA and GSA Property Area
Former Raritan Arsenal

COPC	Oral RfD Value	Oral RfD Units	GI_{abs} Oral Absorption Efficiency for Dermal (1)	Dermal RfD (1) Value	Dermal RfD (1) Units	Primary Target Organ(s)	Combined Uncertainty/ Modifying Factors	Source(s)	Date(s)
Aldrin	3.00E-05	(mg/kg-day)	1.0	3.00E-05	(mg/kg-day)	Liver	1,000	IRIS	3/31/1987
Aroclor-1248	NA	---	---	NA	---	---	---	---	---
Aroclor-1254	2.00E-05	(mg/kg-day)	1.0	2.00E-05	(mg/kg-day)	Eyes, Immune system, Dermal	300	IRIS	10/1/1994
Aroclor-1260	NA	---	---	NA	---	---	---	---	---
Benzo(a)anthracene	NA	---	---	NA	---	---	---	---	---
Benzo(a)pyrene	3.00E-04	(mg/kg-day)	1.0	3.00E-04	(mg/kg-day)	Developmental	300	IRIS	1/2017
Benzo(b)fluoranthene	NA	---	---	NA	---	---	---	---	---
Benzo(g,h,i)perylene	NA	---	---	NA	---	---	---	---	---
Benzo(k)fluoranthene	NA	---	---	NA	---	---	---	---	---
Carbazole	NA	---	---	NA	---	---	---	---	---
gamma-Chlordane	5.00E-04	(mg/kg-day)	1.0	5.00E-04	(mg/kg-day)	Liver	300	IRIS	2/7/1998
Chloroform	1.00E-02	(mg/kg-day)	1.0	1.00E-02	(mg/kg-day)	Liver	100	IRIS	10/19/2001
Chrysene	NA	---	---	NA	---	---	---	---	---
4,4-DDT	5.00E-04	(mg/kg-day)	1.0	5.00E-04	(mg/kg-day)	Liver	100	IRIS	3/31/1987
Dibenz(a,h)anthracene	NA	---	---	NA	---	---	---	---	---
Dibenzofuran	1.00E-03	(mg/kg-day)	1.0	1.00E-03	(mg/kg-day)	Body Weight	10,000	PPRTV Appendix	6/2007
Dieldrin	5.00E-05	(mg/kg-day)	1.0	5.00E-05	(mg/kg-day)	Liver	100	IRIS	9/7/1988
Ethylbenzene	1.00E-01	(mg/kg-day)	1.0	1.00E-01	(mg/kg-day)	Kidney, Liver	1,000	IRIS	1/31/1987
Fluoranthene	4.00E-02	(mg/kg-day)	1.0	4.00E-02	(mg/kg-day)	Kidney, Liver, Blood	3,000	IRIS	9/1/1990
Heptachlor epoxide	1.30E-05	(mg/kg-day)	1.0	1.30E-05	(mg/kg-day)	Liver	1,000	IRIS	9/30/1987
Indeno(1,2,3-c,d)pyrene	NA	---	---	NA	---	---	---	---	---
1-Methylnaphthalene	7.00E-02	(mg/kg-day)	1.0	7.00E-02	(mg/kg-day)	Respiratory system	1,000	ATSDR	8/2005
2-Methylnaphthalene	4.00E-03	(mg/kg-day)	1.0	4.00E-03	(mg/kg-day)	Respiratory system	1,000	IRIS	12/22/2003
Naphthalene	2.00E-02	(mg/kg-day)	1.0	2.00E-02	(mg/kg-day)	Body Weight	3,000	IRIS	9/17/1998
Pentachlorophenol	5.00E-03	(mg/kg-day)	1.0	5.00E-03	(mg/kg-day)	Liver	300	IRIS	9/30/2010
Phenanthrene	NA	---	---	NA	---	---	---	---	---
Pyrene	3.00E-02	(mg/kg-day)	1.0	3.00E-02	(mg/kg-day)	Kidney	3,000	IRIS	9/1/1990
Trichloroethylene	5.00E-04	(mg/kg-day)	1.0	5.00E-04	(mg/kg-day)	Ranges from immune effects to heart effects	Ranges from 10 to 1,000	IRIS	9/28/2011
Vinyl chloride	3.00E-03	(mg/kg-day)	1.0	3.00E-03	(mg/kg-day)	Liver	30	IRIS	8/7/2000
Xylenes, Total	2.00E-01	(mg/kg-day)	1.0	2.00E-01	(mg/kg-day)	Body weight, Mortality	1,000	IRIS	11/19/2015
Aluminum	1.00E+00	(mg/kg-day)	1.0	1.00E+00	(mg/kg-day)	Nervous system	100	PPRTV	10/23/2006
Antimony	4.00E-04	(mg/kg-day)	0.15	6.00E-05	(mg/kg-day)	Blood	1,000	IRIS	1/31/1987
Arsenic	3.00E-04	(mg/kg-day)	1.0	3.00E-04	(mg/kg-day)	Reproductive	3	IRIS	9/1/1991
Chromium (Hexavalent)	3.00E-03	(mg/kg-day)	0.025	7.50E-05	(mg/kg-day)	None observed	900	IRIS	9/3/1998
Cobalt	3.00E-04	(mg/kg-day)	1.0	3.00E-04	(mg/kg-day)	Thyroid	3,000	PPRTV	8/25/2008
Copper	4.00E-02	(mg/kg-day)	1.0	4.00E-02	(mg/kg-day)	Gastrointestinal tract	No information	HEAST	7/1997
Cyanide	6.00E-04	(mg/kg-day)	1.0	6.00E-04	(mg/kg-day)	Body Weight, Cardiovascular	3,000	IRIS	9/28/2010
Lead	NA	---	---	NA	---	---	---	---	---
Manganese	2.40E-02	(mg/kg-day)	0.04	9.60E-04	(mg/kg-day)	Nervous system	3	IRIS	11/1/1995
Mercury	3.00E-04	(mg/kg-day)	0.07	2.10E-05	(mg/kg-day)	Immune System	1,000	IRIS	5/1/1995
Thallium	1.00E-05	(mg/kg-day)	1.0	1.00E-05	(mg/kg-day)	Hair	3,000	PPRTV Appendix	10/25/2012
Vanadium	5.00E-03	(mg/kg-day)	0.026	1.30E-04	(mg/kg-day)	Hair	100	IRIS	6/30/1988

(1) Source: EPA, 2004.

Definitions: ATSDR=Agency for Toxic Substances and Disease Registry
HEAST=Health Effects Assessment Summry Tables
IRIS=Integrated Risk Information System
NA=Not available
PPRTV=Provisional Peer-Reviewed Toxicity Value
RfD=Reference dose

Table 6-22
Noncancer Toxicity Data - Inhalation
U.S. EPA and GSA Property Area
Former Raritan Arsenal

COPC	Inhalation RfC Value	Inhalation RfC Units	Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	Source(s)	Date(s)
Aldrin	NA	---	---	---	---	---
Aroclor-1248	NA	---	---	---	---	---
Aroclor-1254	NA	---	---	---	---	---
Aroclor-1260	NA	---	---	---	---	---
Benzo(a)anthracene	NA	---	---	---	---	---
Benzo(a)pyrene	2.00E-06	mg/m^3	Developmental	3,000	IRIS	1/2017
Benzo(b)fluoranthene	NA	---	---	---	---	---
Benzo(g,h,i)perylene	NA	---	---	---	---	---
Benzo(k)fluoranthene	NA	---	---	---	---	---
Carbazole	NA	---	---	---	---	---
gamma-Chlordane	7.00E-04	mg/m^3	Liver	1,000	IRIS	2/7/1998
Chloroform	9.80E-02	mg/m^3	Liver	100	ATSDR MRL	9/1997
Chrysene	NA	---	---	---	---	---
4,4-DDT	NA	---	---	---	---	---
Dibenz(a,h)anthracene	NA	---	---	---	---	---
Dibenzofuran	NA	---	---	---	---	---
Dieldrin	NA	---	---	---	---	---
Ethylbenzene	1.00E+00	mg/m^3	Developmental	300	IRIS	3/1/1991
Fluoranthene	NA	---	---	---	---	---
Heptachlor epoxide	NA	---	---	---	---	---
Indeno(1,2,3-c,d)pyrene	NA	---	---	---	---	---
1-Methylnaphthalene	NA	---	---	---	---	---
2-Methylnaphthalene	NA	---	---	---	---	---
Naphthalene	3.00E-03	mg/m^3	Respiratory System	3,000	IRIS	9/17/1998
Pentachlorophenol	NA	---	---	---	---	---
Phenanthrene	NA	---	---	---	---	---
Pyrene	NA	---	---	---	---	---
Trichloroethylene	2.00E-03	mg/m^3	Ranges from immune effects to heart effects	Ranges from 10 to 100	IRIS	9/28/2011
Vinyl chloride	1.00E-01	mg/m^3	Liver	30	IRIS	8/7/2000
Xylenes, Total	1.00E-01	mg/m^3	Nervous System	300	IRIS	2/2003
Aluminum	5.00E-03	mg/m^3	Nervous System	300	PPRTV	10/23/2006
Antimony	NA	mg/m^3	---	---	---	---
Arsenic	1.50E-05	mg/m^3	Developmental, Cardiovascular, Nervous System, Respiratory System, Skin	No information	CalEPA	12/2008
Chromium (Hexavalent)	1.00E-04	mg/m^3	Respiratory System	300	IRIS	9/3/1998
Cobalt	6.00E-06	mg/m^3	Respiratory System	300	PPRTV	8/25/2008
Copper	NA	---	---	---	---	---
Cyanide	8.00E-04	mg/m^3	Thyroid, Reproductive	3,000	IRIS	9/28/2010
Lead	NA	---	---	---	---	---
Manganese	5.00E-05	mg/m^3	Nervous System	1,000	IRIS	11/1/1995
Mercury	3.00E-04	mg/m^3	Nervous System	30	IRIS	6/1/1995
Thallium	NA	---	---	---	---	---
Vanadium	1.00E-04	mg/m^3	Respiratory System	30	ATSDR MRL	9/2012

Definitions: ATSDR=Agency for Toxic Substances and Disease Registry
IRIS=Integrated Risk Information System
MRL=Minimal risk level
RfC=Reference concentration
NA=Not available
CalEPA = California Environmental Protection Agency
PPRTV=Provisional Peer-Reviewed Toxicity Value

Table 6-23
Cancer Toxicity Data - Oral and Dermal
U.S. EPA and GSA Property Area
Former Raritan Arsenal

COPC	Oral CSF Value	Oral CSF Units	GI_{abs} Oral Absorption Efficiency for Dermal (1)	Dermal CSF (1) Value	Dermal CSF (1) Units	Weight of Evidence/ Cancer Guideline Description	Source(s)	Date(s)
Aldrin	1.70E+01	(mg/kg-day)-1	1.0	1.70E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	9/30/1987
Aroclor-1248	2.00E+00	$(mg/kg\text{-}day)^{-1}$	1.0	2.00E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/1/1996
Aroclor-1254	2.00E+00	$(mg/kg\text{-}day)^{-1}$	1.0	2.00E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/1/1996
Aroclor-1260	2.00E+00	$(mg/kg\text{-}day)^{-1}$	1.0	2.00E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/1/1996
Benzo(a)anthracene *	1.00E-01	$(mg/kg\text{-}day)^{-1}$	1.0	1.00E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	1/2017
Benzo(a)pyrene *	1.00E+00	$(mg/kg\text{-}day)^{-1}$	1.0	1.00E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	1/2017
Benzo(b)fluoranthene *	1.00E-01	$(mg/kg\text{-}day)^{-1}$	1.0	1.00E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	1/2017
Benzo(g,h,i)perylene	NA	---	---	NA	---	D	IRIS	12/1/1990
Benzo(k)fluoranthene *	1.00E-02	$(mg/kg\text{-}day)^{-1}$	1.0	1.00E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	1/2017
Carbazole	NA	---	---	NA	---	No information	---	---
gamma-Chlordane	3.50E-01	$(mg/kg\text{-}day)^{-1}$	1.0	3.50E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/7/1998
Chloroform	3.10E-02	$(mg/kg\text{-}day)^{-1}$	1.0	3.10E-02	$(mg/kg\text{-}day)^{-1}$	B2	CalEPA	2008
Chrysene *	1.00E-03	$(mg/kg\text{-}day)^{-1}$	1.0	1.00E-03	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	1/2017
4,4-DDT	3.40E-01	$(mg/kg\text{-}day)^{-1}$	1.0	3.40E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	8/22/1988
Dibenz(a,h)anthracene *	1.00E+00	$(mg/kg\text{-}day)^{-1}$	1.0	1.00E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	1/2017
Dibenzofuran	NA	---	---	NA	---	D	IRIS	11/19/2015
Dieldrin	1.60E+01	$(mg/kg\text{-}day)^{-1}$	1.0	1.60E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	9/7/1988
Ethylbenzene	1.10E-02	$(mg/kg\text{-}day)^{-1}$	1.0	1.10E-02	$(mg/kg\text{-}day)^{-1}$	D	CalEPA	2011
Fluoranthene	NA	---	---	NA	---	D	IRIS	12/1/1990
Heptachlor epoxide	9.10E+00	$(mg/kg\text{-}day)^{-1}$	1.0	9.10E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	9/30/1987
Indeno(1,2,3-c,d)pyrene *	1.00E-01	$(mg/kg\text{-}day)^{-1}$	1.0	1.00E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	1/2017
1-Methylnaphthalene	2.90E-02	$(mg/kg\text{-}day)^{-1}$	1.0	2.90E-02	$(mg/kg\text{-}day)^{-1}$	No information	PPRTV	1/10/2008
2-Methylnaphthalene	NA	---	---	NA	---	Inadequate data	IRIS	12/22/2003
Naphthalene	NA	---	---	NA	---	C	IRIS	9/17/1998
Pentachlorophenol	4.00E-01	$(mg/kg\text{-}day)^{-1}$	1.0	4.00E-01	$(mg/kg\text{-}day)^{-1}$	Likely	IRIS	9/30/2010
Phenanthrene	NA	---	---	NA	---	D	IRIS	12/1/1990
Pyrene	NA	---	---	NA	---	D	IRIS	9/1/1990
Trichloroethylene - Kidney *	9.30E-03	$(mg/kg\text{-}day)^{-1}$	1.0	9.30E-03	$(mg/kg\text{-}day)^{-1}$	Carcinogenic	IRIS	9/28/2011
Trichloroethylene - Liver+NHL	3.70E-02	$(mg/kg\text{-}day)^{-1}$	1.0	3.70E-02	$(mg/kg\text{-}day)^{-1}$	Carcinogenic	IRIS	9/28/2011
Vinyl chloride *	7.20E-01	$(mg/kg\text{-}day)^{-1}$	1.0	7.20E-01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	8/7/2000
Xylenes, Total	NA	---	---	NA	---	No information	---	---
Aluminum	NA	---	---	NA	---	No information	---	---
Antimony	NA	---	---	NA	---	No information	---	---
Arsenic	1.50E+00	$(mg/kg\text{-}day)^{-1}$	1.0	1.50E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	6/1/1995
Chromium (Hexavalent) *	5.00E-01	$(mg/kg\text{-}day)^{-1}$	0.025	2.00E+01	$(mg/kg\text{-}day)^{-1}$	Likely	NJDEP	4/2009
Cobalt	NA	---	---	NA	---	No information	---	---
Copper	NA	---	---	NA	---	D	IRIS	9/7/1988
Cyanide	NA	---	---	NA	---	D	IRIS	9/28/2010
Lead	NA	---	---	NA	---	B2	IRIS	9/26/1988
Manganese	NA	---	---	NA	---	D	IRIS	9/26/1988
Mercury	NA	---	---	NA	---	D	IRIS	5/1/1995
Thallium	NA	---	---	NA	---	Inadequate data	IRIS	9/30/2009
Vanadium	NA	---	---	NA	---	No information	IRIS	---

(1) Source: EPA, 2004.

* Carcinogenic via a mutagenic mode of action.

Definitions: A - Human carcinogen.

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

C - Possible human carcinogen.

D - Not classified as to human carcinogenicity.

CalEPA=California Environmental Protection Agency

NJDEP = New Jersey Department of Environmental Protection

IRIS=Integrated Risk Information System

NA=Not available

PPRTV=Provisional Peer-Reviewed Toxicity Value

Table 6-24
Cancer Toxicity Data - Inhalation
U.S. EPA and GSA Property Area
Former Raritan Arsenal

COPC	Unit Risk		Weight of Evidence/ Cancer Guideline	Source(s)	Date(s)
	Value	Units	Description		
Aldrin	4.90E-03	$(\mu g/m^3)^{-1}$	B2	IRIS	9/30/1987
Aroclor-1248	5.70E-04	$(\mu g/m^3)^{-1}$	B2	IRIS	10/1/1996
Aroclor-1254	5.70E-04	$(\mu g/m^3)^{-1}$	B2	IRIS	10/1/1996
Aroclor-1260	5.70E-04	$(\mu g/m^3)^{-1}$	B2	IRIS	10/1/1996
Benzo(a)anthracene *	6.00E-05	$(\mu g/m^3)^{-1}$	B2	IRIS	1/2017
Benzo(a)pyrene *	6.00E-04	$(\mu g/m^3)^{-1}$	A	IRIS	1/2017
Benzo(b)fluoranthene *	6.00E-05	$(\mu g/m^3)^{-1}$	B2	IRIS	1/2017
Benzo(g,h,i)perylene	NA	---	D	IRIS	12/1/1990
Benzo(k)fluoranthene *	6.00E-06	$(\mu g/m^3)^{-1}$	B2	IRIS	1/2017
Carbazole	NA	---	No information	---	---
gamma-Chlordane	1.00E-04	$(\mu g/m^3)^{-1}$	B2	IRIS	11/19/2015
Chloroform	2.30E-05	$(\mu g/m^3)^{-1}$	B2	IRIS	10/19/2001
Chrysene *	6.00E-07	$(\mu g/m^3)^{-1}$	B2	IRIS	1/2017
4,4-DDT	9.70E-05	$(\mu g/m^3)^{-1}$	B2	IRIS	8/22/1988
Dibenz(a,h)anthracene *	6.00E-04	$(\mu g/m^3)^{-1}$	B2	CalEPA	1/2017
Dibenzofuran	NA	---	D	IRIS	10/1/1990
Dieldrin	4.60E-03	$(\mu g/m^3)^{-1}$	B2	IRIS	9/7/1988
Ethylbenzene	2.50E-06	$(\mu g/m^3)^{-1}$	D	CalEPA	2011
Fluoranthene	NA	---	D	IRIS	12/1/1990
Heptachlor epoxide	2.60E-03	$(\mu g/m^3)^{-1}$	B2	IRIS	9/30/1987
Indeno(1,2,3-c,d)pyrene *	6.00E-05	$(\mu g/m^3)^{-1}$	B2	CalEPA	1/2017
1-Methylnaphthalene	NA	---	No information	---	---
2-Methylnaphthalene	NA	---	Inadequate data	IRIS	12/22/2003
Naphthalene	3.40E-05	$(\mu g/m^3)^{-1}$	C	CalEPA	2011
Pentachlorophenol	5.10E-06	$(\mu g/m^3)^{-1}$	B2	CalEPA	2009
Phenanthrene	NA	---	D	IRIS	12/1/1990
Pyrene	NA	---	D	IRIS	9/1/1990
Trichloroethylene - Kidney *	1.00E-06	$(\mu g/m^3)^{-1}$	Carcinogenic	IRIS	9/28/2011
Trichloroethylene - Liver+NHL	3.10E-06	$(\mu g/m^3)^{-1}$	Carcinogenic	IRIS	9/28/2011
Vinyl chloride *	4.40E-06	$(\mu g/m^3)^{-1}$	A	IRIS	8/7/2000
Xylenes, Total	NA	---	No information	---	---
Aluminum	NA	---	No information	---	---
Antimony	NA	---	No information	---	---
Arsenic	4.30E-03	$(\mu g/m^3)^{-1}$	A	IRIS	6/1/1995
Chromium (Hexavalent) *	8.40E-02	$(\mu g/m^3)^{-1}$	A	IRIS	9/3/1998
Cobalt	9.00E-03	$(\mu g/m^3)^{-1}$	No information	PPRTV	8/25/2008
Copper	NA	---	D	IRIS	9/7/1988
Cyanide	NA	---	D	IRIS	9/28/2010
Lead	NA	---	B2	IRIS	9/26/1988
Manganese	NA	---	D	IRIS	9/26/1988
Mercury	NA	---	D	IRIS	5/1/1995
Thallium	NA	---	Inadequate data	IRIS	9/30/2009
Vanadium	NA	---	No information	---	---

(1) Represents date source was searched.

* Carcinogenic via a mutagenic mode of action.

Definitions: A - Human carcinogen.

B1 - Probable human carcinogen - indicates limited evidence of carcinogenicity in humans.

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

C - Possible human carcinogen.

CalEPA=California Environmental Protection Agency

D - Not classified as to human carcinogenicity.

IRIS=Integrated Risk Information System.

NA=Not available.

PPRTV=Provisional Peer-Reviewed Toxicity Value

Table 6-25
Summary of RME Cancer Risks - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Receptor	Cancer Risk			Total
	Soil Ingestion	Dermal Contact with Soil	Inhalation of Particulate/VOCs	
Groundskeeper	2E-05	2E-06	1E-07	2E-05
Construction/Utility Worker	3E-07	5E-08	2E-06	2E-06
Indoor Worker	9E-06	---	1E-07	9E-06
Residents	1E-04	9E-06	8E-07	1E-04

Table 6-26
Summary of CTE Cancer Risks - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Receptor	Cancer Risk			Total
	Soil Ingestion	Dermal Contact with Soil	Inhalation of Particulate/VOCs	
Groundskeeper	1E-06	9E-08	1E-08	1E-06
Construction/Utility Worker	3E-08	8E-09	4E-07	5E-07
Indoor Worker	5E-07	---	1E-08	6E-07
Residents	3E-05	2E-06	4E-07	3E-05

Table 6-27
Summary of RME Hazard Indices - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Receptor	Hazard Index			Total
	Soil Ingestion	Dermal Contact with Soil	Inhalation of Particulate/VOCs	
Groundskeeper	0.1	0.01	0.001	0.2
Construction/Utility Worker	0.08	0.007	0.4	0.5
Indoor Worker	0.08	---	0.001	0.08
Child Resident	2	0.1	0.003	2
Adult Resident	0.1	0.02	0.003	0.2

Table 6-28
Summary of CTE Hazard Indices - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Receptor	Hazard Index			Total
	Soil Ingestion	Dermal Contact with Soil	Inhalation of Particulate/VOCs	
Groundskeeper	0.02	0.001	0.0003	0.02
Construction/Utility Worker	0.006	0.001	0.1	0.1
Indoor Worker	0.01	---	0.0003	0.01
Child Resident	0.4	0.02	0.003	0.4
Adult Resident	0.04	0.002	0.003	0.04

Table 6-29
Reasonable Maximum Exposure Doses and Cancer Risks for Hypothetical Age-Adjusted Residents Exposure to Aggregate Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		RME - Cancer									
		Age-Adjusted Exposure Doses						Age-Adjusted Cancer Risks			
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Dermal CSF $(mg/kg\text{-}day)^{-1}$	IUR $(\mu g/m^3)^{-1}$	Soil Ingestion	Dermal Contact	Inhalation	Total
Aroclor-1248	7.18E-02	1.03E-07	4.06E-08	9.65E-09	2.00E+00	2.00E+00	5.70E-04	2E-07	8E-08	5E-12	3E-07
Aroclor-1254	8.28E-02	1.19E-07	4.69E-08	1.11E-08	2.00E+00	2.00E+00	5.70E-04	2E-07	9E-08	6E-12	3E-07
Aroclor-1260	5.13E-02	7.38E-08	2.91E-08	6.90E-09	2.00E+00	2.00E+00	5.70E-04	1E-07	6E-08	4E-12	2E-07
Benzo(a)anthracene	1.44E+00	Mutagenic mode of action; See Table 6-35			1.00E-01	1.00E-01	6.00E-05	9E-07	3E-07	3E-11	1E-06
Benzo(a)pyrene	1.27E+00	Mutagenic mode of action; See Table 6-35			1.00E+00	1.00E+00	6.00E-04	8E-06	3E-06	3E-10	1E-05
Benzo(b)fluoranthene	1.09E+00	Mutagenic mode of action; See Table 6-35			1.00E-01	1.00E-01	6.00E-05	7E-07	2E-07	2E-11	9E-07
Benzo(k)fluoranthene	7.57E-01	Mutagenic mode of action; See Table 6-35			1.00E-02	1.00E-02	6.00E-06	5E-08	2E-08	2E-12	7E-08
Chloroform	6.20E-03	8.92E-09	NA	8.34E-10	3.10E-02	3.10E-02	2.30E-05	3E-10	NA	2E-14	3E-10
4,4-DDT	1.36E-01	1.96E-07	1.65E-08	1.83E-08	3.40E-01	3.40E-01	9.70E-05	7E-08	6E-09	2E-12	7E-08
Dibenz(a,h)anthracene	2.58E-01	Mutagenic mode of action; See Table 6-35			1.00E+00	1.00E+00	6.00E-04	2E-06	6E-07	6E-11	2E-06
Dibenzofuran	2.39E-01	3.44E-07	2.90E-08	3.21E-08	NA	NA	NA	NA	NA	NA	NA
Dieldrin	8.40E-03	1.21E-08	3.40E-09	1.13E-09	1.60E+01	1.60E+01	4.60E-03	2E-07	5E-08	5E-12	2E-07
Ethylbenzene	1.55E-01	2.23E-07	NA	2.08E-08	1.10E-02	1.10E-02	2.50E-06	2E-09	NA	5E-14	2E-09
Indeno(1,2,3-c,d)pyrene	5.00E-01	Mutagenic mode of action; See Table 6-35			1.00E-01	1.00E-01	6.00E-05	3E-07	1E-07	1E-11	4E-07
Naphthalene	4.01E-01	5.77E-07	2.11E-07	5.39E-08	NA	NA	3.40E-05	NA	NA	2E-12	2E-12
Pentachlorophenol	2.00E+00	2.88E-06	2.02E-06	2.69E-07	4.00E-01	4.00E-01	5.10E-06	1E-06	8E-07	1E-12	2E-06
Trichloroethylene	1.41E-01	Mutagenic mode of action; See Table 6-36			9.30E-03	9.30E-03	1.00E-06	2E-08	NA	2E-09	2E-08
Vinyl chloride	1.20E-02	1.73E-08	NA	1.61E-09	7.20E-01	7.20E-01	4.40E-06	1E-07	NA	2E-09	1E-07
Xylenes, Total	1.58E+00	2.27E-06	NA	2.12E-07	NA	NA	NA	NA	NA	NA	NA
Aluminum	6.79E+03	9.77E-03	NA	9.13E-04	NA	NA	NA	NA	NA	NA	NA
Antimony	3.92E+00	5.64E-06	NA	5.27E-07	NA	NA	NA	NA	NA	NA	NA
Arsenic	2.16E+01	1.87E-05	2.62E-06	2.91E-06	1.50E+00	1.50E+00	4.30E-03	3E-05	4E-06	1E-08	3E-05
Chromium	2.44E+01	Mutagenic mode of action; See Table 6-35			5.00E-01	2.00E+01	8.40E-02	8E-05	NA	8E-07	8E-05
Cobalt	3.76E+00	5.41E-06	NA	5.06E-07	NA	NA	9.00E-03	NA	NA	5E-09	5E-09
Copper	6.29E+01	9.04E-05	NA	8.45E-06	NA	NA	NA	NA	NA	NA	NA
Lead	2.79E+02	4.01E-04	NA	3.75E-05	NA	NA	NA	NA	NA	NA	NA
Manganese	1.52E+02	2.18E-04	NA	2.04E-05	NA	NA	NA	NA	NA	NA	NA
Mercury	1.44E-01	2.07E-07	NA	1.94E-08	NA	NA	NA	NA	NA	NA	NA
Thallium	1.87E-01	2.69E-07	NA	2.51E-08	NA	NA	NA	NA	NA	NA	NA
Vanadium	3.62E+01	5.20E-05	NA	4.86E-06	NA	NA	NA	NA	NA	NA	NA
							Total	1E-04	9E-06	8E-07	1E-04

Table 6-30
Central Tendency Exposure Doses and Cancer Risks for Age-Adjusted Residents Exposure to Aggregate Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		CTE - Cancer									
		Age-Adjusted Exposure Doses						Age-Adjusted Cancer Risks			
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Dermal CSF $(mg/kg\text{-}day)^{-1}$	IUR $(\mu g/m^3)^{-1}$	Soil Ingestion	Dermal Contact	Inhalation	Total
Aroclor-1248	7.18E-02	2.24E-08	6.16E-09	3.34E-09	2.00E+00	2.00E+00	5.70E-04	4E-08	1E-08	2E-12	6E-08
Aroclor-1254	8.28E-02	2.59E-08	7.10E-09	3.85E-09	2.00E+00	2.00E+00	5.70E-04	5E-08	1E-08	2E-12	7E-08
Aroclor-1260	5.13E-02	1.60E-08	4.40E-09	2.39E-09	2.00E+00	2.00E+00	5.70E-04	3E-08	9E-09	1E-12	4E-08
Benzo(a)anthracene	1.44E+00	Mutagenic mode of action; See Table 6-37			1.00E-01	1.00E-01	6.00E-05	2E-07	6E-08	2E-11	3E-07
Benzo(a)pyrene	1.27E+00	Mutagenic mode of action; See Table 6-37			1.00E+00	1.00E+00	6.00E-04	2E-06	5E-07	2E-10	2E-06
Benzo(b)fluoranthene	1.09E+00	Mutagenic mode of action; See Table 6-37			1.00E-01	1.00E-01	6.00E-05	2E-07	5E-08	1E-11	2E-07
Benzo(k)fluoranthene	7.57E-01	Mutagenic mode of action; See Table 6-37			1.00E-02	1.00E-02	6.00E-06	1E-08	3E-09	1E-12	1E-08
Chloroform	6.20E-03	1.94E-09	NA	2.89E-10	3.10E-02	3.10E-02	2.30E-05	6E-11	NA	7E-15	6E-11
4,4-DDT	1.36E-01	4.25E-08	2.50E-09	6.33E-09	3.40E-01	3.40E-01	9.70E-05	1E-08	9E-10	6E-13	2E-08
Dibenz(a,h)anthracene	2.58E-01	Mutagenic mode of action; See Table 6-37			1.00E+00	1.00E+00	6.00E-04	4E-07	1E-07	3E-11	5E-07
Dibenzofuran	2.39E-01	7.47E-08	4.40E-09	1.11E-08	NA	NA	NA	NA	NA	NA	NA
Dieldrin	8.40E-03	2.63E-09	5.15E-10	3.91E-10	1.60E+01	1.60E+01	4.60E-03	4E-08	8E-09	2E-12	5E-08
Ethylbenzene	1.55E-01	4.84E-08	NA	7.21E-09	1.10E-02	1.10E-02	2.50E-06	5E-10	NA	2E-14	5E-10
Indeno(1,2,3-c,d)pyrene	5.00E-01	Mutagenic mode of action; See Table 6-37			1.00E-01	1.00E-01	6.00E-05	7E-08	2E-08	6E-12	1E-07
Naphthalene	4.01E-01	1.25E-07	3.20E-08	1.87E-08	NA	NA	3.40E-05	NA	NA	6E-13	6E-13
Pentachlorophenol	2.00E+00	6.25E-07	3.07E-07	9.31E-08	4.00E-01	4.00E-01	5.10E-06	3E-07	1E-07	5E-13	4E-07
Trichloroethylene	1.41E-01	Mutagenic mode of action; See Table 6-38			9.30E-03	9.30E-03	1.00E-06	4E-09	NA	2E-09	5E-09
Vinyl chloride	1.20E-02	3.75E-09	NA	5.59E-10	7.20E-01	7.20E-01	4.40E-06	6E-08	NA	3E-09	6E-08
Xylenes, Total	1.58E+00	4.93E-07	NA	7.35E-08	NA	NA	NA	NA	NA	NA	NA
Aluminum	6.79E+03	2.12E-03	NA	3.16E-04	NA	NA	NA	NA	NA	NA	NA
Antimony	3.92E+00	1.22E-06	NA	1.82E-07	NA	NA	NA	NA	NA	NA	NA
Arsenic	2.16E+01	4.05E-06	3.98E-07	1.01E-06	1.50E+00	1.50E+00	4.30E-03	6E-06	6E-07	4E-09	7E-06
Chromium	2.44E+01	Mutagenic mode of action; See Table 6-37			5.00E-01	2.00E+01	8.40E-02	2E-05	NA	4E-07	2E-05
Cobalt	3.76E+00	1.18E-06	NA	1.75E-07	NA	NA	9.00E-03	NA	NA	2E-09	2E-09
Copper	6.29E+01	1.97E-05	NA	2.93E-06	NA	NA	NA	NA	NA	NA	NA
Lead	2.79E+02	8.72E-05	NA	1.30E-05	NA	NA	NA	NA	NA	NA	NA
Manganese	1.52E+02	4.75E-05	NA	7.07E-06	NA	NA	NA	NA	NA	NA	NA
Mercury	1.44E-01	4.50E-08	NA	6.70E-09	NA	NA	NA	NA	NA	NA	NA
Thallium	1.87E-01	5.84E-08	NA	8.70E-09	NA	NA	NA	NA	NA	NA	NA
Vanadium	3.62E+01	1.13E-05	NA	1.68E-06	NA	NA	NA	NA	NA	NA	NA
							Total	3E-05	2E-06	4E-07	3E-05

Table 6-31
Reasonable Maximum Exposure Doses and Hazard Quotients for Child Residents Exposure to Aggregate Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		RME - Noncancer										
		Child Exposure Doses							Child Hazard Quotients			
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Primary Target Organ	Soil Ingestion	Dermal Contact	Inhalation	Hazard Index
Aroclor-1248	7.18E-02	9.17E-07	3.05E-07	2.60E-08	NA	NA	NA	---	NA	NA	NA	NA
Aroclor-1254	8.28E-02	1.06E-06	3.51E-07	3.00E-08	2.00E-05	2.00E-05	NA	Eyes, Immune system, Dermal	0.05	0.02	NA	0.07
Aroclor-1260	5.13E-02	6.56E-07	2.18E-07	1.86E-08	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)anthracene	1.44E+00	1.84E-05	5.68E-06	5.22E-07	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)pyrene	1.27E+00	1.62E-05	5.00E-06	4.59E-07	3.00E-04	3.00E-04	2.00E-06	Developmental	0.05	0.02	0.00	0.07
Benzo(b)fluoranthene	1.09E+00	1.39E-05	4.30E-06	3.95E-07	NA	NA	NA	---	NA	NA	NA	NA
Benzo(k)fluoranthene	7.57E-01	9.68E-06	2.99E-06	2.74E-07	NA	NA	NA	---	NA	NA	NA	NA
Chloroform	6.20E-03	7.93E-08	NA	2.24E-09	1.00E-02	1.00E-02	9.80E-02	Liver	0.000008	NA	0.00000000002	0.000008
4,4-DDT	1.36E-01	1.74E-06	1.24E-07	4.92E-08	5.00E-04	5.00E-04	NA	Liver	0.003	0.0002	NA	0.004
Dibenz(a,h)anthracene	2.58E-01	3.30E-06	1.02E-06	9.34E-08	NA	NA	NA	---	NA	NA	NA	NA
Dibenzofuran	2.39E-01	3.06E-06	2.18E-07	8.65E-08	1.00E-03	1.00E-03	NA	Body Weight	0.00	0.00	NA	0.003
Dieldrin	8.40E-03	1.07E-07	2.55E-08	3.04E-09	5.00E-05	5.00E-05	NA	Liver	0.002	0.0005	NA	0.003
Ethylbenzene	1.55E-01	1.98E-06	NA	5.61E-08	1.00E-01	1.00E-01	1.00E+00	Kidney, Liver	0.00002	NA	0.00000000006	0.00002
Indeno(1,2,3-c,d)pyrene	5.00E-01	6.39E-06	1.97E-06	1.81E-07	NA	NA	NA	---	NA	NA	NA	NA
Naphthalene	4.01E-01	5.13E-06	1.58E-06	1.45E-07	2.00E-02	2.00E-02	3.00E-03	Body Weight	0.0003	0.00008	0.00000005	0.0003
Pentachlorophenol	2.00E+00	2.56E-05	1.52E-05	7.24E-07	5.00E-03	5.00E-03	NA	Liver	0.005	0.003	NA	0.008
Trichloroethylene	1.41E-01	1.80E-06	NA	5.10E-08	5.00E-04	5.00E-04	2.00E-03	Ranges from immune effects to heart effects	0.004	NA	0.00000003	0.004
Vinyl chloride	1.20E-02	1.53E-07	NA	4.34E-09	3.00E-03	3.00E-03	1.00E-01	Liver	0.00005	NA	0.00000000004	0.00005
Xylenes, Total	1.58E+00	2.02E-05	NA	5.72E-07	2.00E-01	2.00E-01	1.00E-01	Body weight, Mortality	0.0001	NA	0.000000006	0.0001
Aluminum	6.79E+03	8.68E-02	NA	2.46E-03	1.00E+00	1.00E+00	5.00E-03	Nervous system	0.09	NA	0.0005	0.09
Antimony	3.92E+00	5.01E-05	NA	1.42E-06	4.00E-04	6.00E-05	NA	Blood	0.1	NA	NA	0.1
Arsenic	2.16E+01	2.76E-04	1.97E-05	7.83E-06	3.00E-04	3.00E-04	1.50E-05	Reproductive	0.9	0.07	0.0005	0.99
Chromium	2.44E+01	3.12E-04	NA	8.85E-06	3.00E-03	7.50E-05	1.00E-04	None observed	0.1	NA	0.00009	0.1
Cobalt	3.76E+00	4.81E-05	NA	1.36E-06	3.00E-04	3.00E-04	6.00E-06	Thyroid	0.2	NA	0.0002	0.2
Copper	6.29E+01	8.04E-04	NA	2.28E-05	4.00E-02	4.00E-02	NA	Gastrointestinal tract	0.02	NA	NA	0.02
Lead	2.79E+02	3.57E-03	NA	1.01E-04	NA	NA	NA	---	NA	NA	NA	NA
Manganese	1.52E+02	1.94E-03	NA	5.50E-05	2.40E-02	9.60E-04	5.00E-05	Nervous system	0.08	NA	0.001	0.08
Mercury	1.44E-01	1.84E-06	NA	5.21E-08	3.00E-04	2.10E-05	3.00E-04	Immune System	0.006	NA	0.0000002	0.006
Thallium	1.87E-01	2.39E-06	NA	6.77E-08	1.00E-05	1.00E-05	NA	Hair	0.2	NA	NA	0.2
Vanadium	3.62E+01	4.62E-04	NA	1.31E-05	5.00E-03	1.30E-04	1.00E-04	Hair	0.09	NA	0.0001	0.09
								Total	2	0.1	0.003	2

Table 6-32
Central Tendency Exposure Doses and Hazard Quotients for Child Residents Exposure to Aggregate Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		CTE - Noncancer										
		Child Exposure Doses							Child Hazard Quotients			
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Primary Target Organ	Soil Ingestion	Dermal Contact	Inhalation	Hazard Index
Aroclor-1248	7.18E-02	2.29E-07	6.10E-08	2.60E-08	NA	NA	NA	---	NA	NA	NA	NA
Aroclor-1254	8.28E-02	2.64E-07	7.03E-08	3.00E-08	2.00E-05	2.00E-05	NA	Eyes, Immune system, Dermal	0.01	0.004	NA	0.02
Aroclor-1260	5.13E-02	1.64E-07	4.36E-08	1.86E-08	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)anthracene	1.44E+00	4.61E-06	1.14E-06	5.22E-07	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)pyrene	1.27E+00	4.05E-06	9.99E-07	4.59E-07	3.00E-04	3.00E-04	2.00E-06	Developmental	0.01	0.003	0.0002	0.02
Benzo(b)fluoranthene	1.09E+00	3.48E-06	8.60E-07	3.95E-07	NA	NA	NA	---	NA	NA	NA	NA
Benzo(k)fluoranthene	7.57E-01	2.42E-06	5.97E-07	2.74E-07	NA	NA	NA	---	NA	NA	NA	NA
Chloroform	6.20E-03	1.98E-08	NA	2.24E-09	1.00E-02	1.00E-02	9.80E-02	Liver	0.000002	NA	0.00000000002	0.000002
4,4-DDT	1.36E-01	4.35E-07	2.48E-08	4.92E-08	5.00E-04	5.00E-04	NA	Liver	0.0009	0.00005	NA	0.0009
Dibenz(a,h)anthracene	2.58E-01	8.25E-07	2.04E-07	9.34E-08	NA	NA	NA	---	NA	NA	NA	NA
Dibenzofuran	2.39E-01	7.64E-07	4.35E-08	8.65E-08	1.00E-03	1.00E-03	NA	Body Weight	0.0008	0.00004	NA	0.0008
Dieldrin	8.40E-03	2.68E-08	5.10E-09	3.04E-09	5.00E-05	5.00E-05	NA	Liver	0.0005	0.0001	NA	0.0006
Ethylbenzene	1.55E-01	4.95E-07	NA	5.61E-08	1.00E-01	1.00E-01	1.00E+00	Kidney, Liver	0.000005	NA	0.00000000006	0.000005
Indeno(1,2,3-c,d)pyrene	5.00E-01	1.60E-06	3.94E-07	1.81E-07	NA	NA	NA	---	NA	NA	NA	NA
Naphthalene	4.01E-01	1.28E-06	3.16E-07	1.45E-07	2.00E-02	2.00E-02	3.00E-03	Body Weight	0.00006	0.00002	0.00000005	0.0001
Pentachlorophenol	2.00E+00	6.39E-06	3.03E-06	7.24E-07	5.00E-03	5.00E-03	NA	Liver	0.001	0.0006	NA	0.002
Trichloroethylene	1.41E-01	4.51E-07	NA	5.10E-08	5.00E-04	5.00E-04	2.00E-03	Ranges from immune effects to heart effects	0.0009	NA	0.00000003	0.0009
Vinyl chloride	1.20E-02	3.84E-08	NA	4.34E-09	3.00E-03	3.00E-03	1.00E-01	Liver	0.00001	NA	0.00000000004	0.00001
Xylenes, Total	1.58E+00	5.05E-06	NA	5.72E-07	2.00E-01	2.00E-01	1.00E-01	Body weight, Mortality	0.00003	NA	0.000000006	0.00003
Aluminum	6.79E+03	2.17E-02	NA	2.46E-03	1.00E+00	1.00E+00	5.00E-03	Nervous system	0.02	NA	0.0005	0.02
Antimony	3.92E+00	1.25E-05	NA	1.42E-06	4.00E-04	6.00E-05	NA	Blood	0.03	NA	NA	0.03
Arsenic	2.16E+01	4.15E-05	3.94E-06	7.83E-06	3.00E-04	3.00E-04	1.50E-05	Reproductive	0.1	0.01	0.0005	0.2
Chromium	2.44E+01	7.81E-05	NA	8.85E-06	3.00E-03	7.50E-05	1.00E-04	None observed	0.03	NA	0.00009	0.03
Cobalt	3.76E+00	1.20E-05	NA	1.36E-06	3.00E-04	3.00E-04	6.00E-06	Thyroid	0.04	NA	0.0002	0.04
Copper	6.29E+01	2.01E-04	NA	2.28E-05	4.00E-02	4.00E-02	NA	Gastrointestinal tract	0.005	NA	NA	0.005
Lead	2.79E+02	8.92E-04	NA	1.01E-04	NA	NA	NA	---	NA	NA	NA	NA
Manganese	1.52E+02	4.86E-04	NA	5.50E-05	2.40E-02	9.60E-04	5.00E-05	Nervous system	0.02	NA	0.001	0.02
Mercury	1.44E-01	4.60E-07	NA	5.21E-08	3.00E-04	2.10E-05	3.00E-04	Immune System	0.002	NA	0.0000002	0.002
Thallium	1.87E-01	5.98E-07	NA	6.77E-08	1.00E-05	1.00E-05	NA	Hair	0.06	NA	NA	0.06
Vanadium	3.62E+01	1.16E-04	NA	1.31E-05	5.00E-03	1.30E-04	1.00E-04	Hair	0.02	NA	0.0001	0.02
								Total	0.4	0.02	0.003	0.4

Table 6-33
Reasonable Maximum Exposure Doses and Hazard Quotients for Adult Residents Exposure to Aggregate Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		RME - Noncancer										
		Adult Exposure Doses							Adult Hazard Quotients			
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Primary Target Organ	Soil Ingestion	Dermal Contact	Inhalation	Hazard Index
Aroclor-1248	7.18E-02	8.60E-08	5.08E-08	2.60E-08	NA	NA	NA	---	NA	NA	NA	NA
Aroclor-1254	8.28E-02	9.92E-08	5.86E-08	3.00E-08	2.00E-05	2.00E-05	NA	Eyes, Immune system, Dermal	0.005	0.003	NA	0.008
Aroclor-1260	5.13E-02	6.15E-08	3.63E-08	1.86E-08	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)anthracene	1.44E+00	1.73E-06	9.48E-07	5.22E-07	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)pyrene	1.27E+00	1.52E-06	8.34E-07	4.59E-07	3.00E-04	3.00E-04	2.00E-06	Developmental	0.005	0.003	0.0002	0.008
Benzo(b)fluoranthene	1.09E+00	1.31E-06	7.17E-07	3.95E-07	NA	NA	NA	---	NA	NA	NA	NA
Benzo(k)fluoranthene	7.57E-01	9.07E-07	4.98E-07	2.74E-07	NA	NA	NA	---	NA	NA	NA	NA
Chloroform	6.20E-03	7.43E-09	NA	2.24E-09	1.00E-02	1.00E-02	9.80E-02	Liver	0.0000007	NA	0.00000000002	0.0000007
4,4-DDT	1.36E-01	1.63E-07	2.06E-08	4.92E-08	5.00E-04	5.00E-04	NA	Liver	0.0003	0.00004	NA	0.0004
Dibenz(a,h)anthracene	2.58E-01	3.09E-07	1.70E-07	9.34E-08	NA	NA	NA	---	NA	NA	NA	NA
Dibenzofuran	2.39E-01	2.86E-07	3.63E-08	8.65E-08	1.00E-03	1.00E-03	NA	Body Weight	0.0003	0.00004	NA	0.0003
Dieldrin	8.40E-03	1.01E-08	4.25E-09	3.04E-09	5.00E-05	5.00E-05	NA	Liver	0.0002	0.00009	NA	0.0003
Ethylbenzene	1.55E-01	1.86E-07	NA	5.61E-08	1.00E-01	1.00E-01	1.00E+00	Kidney, Liver	0.000002	NA	0.00000000006	0.000002
Indeno(1,2,3-c,d)pyrene	5.00E-01	5.99E-07	3.29E-07	1.81E-07	NA	NA	NA	---	NA	NA	NA	NA
Naphthalene	4.01E-01	4.81E-07	2.64E-07	1.45E-07	2.00E-02	2.00E-02	3.00E-03	Body Weight	0.00002	0.00001	0.00000005	0.00004
Pentachlorophenol	2.00E+00	2.40E-06	2.53E-06	7.24E-07	5.00E-03	5.00E-03	NA	Liver	0.0005	0.0005	NA	0.001
Trichloroethylene	1.41E-01	1.69E-07	NA	5.10E-08	5.00E-04	5.00E-04	2.00E-03	Ranges from immune effects to heart effects	0.0003	NA	0.00000003	0.0003
Vinyl chloride	1.20E-02	1.44E-08	NA	4.34E-09	3.00E-03	3.00E-03	1.00E-01	Liver	0.000005	NA	0.00000000004	0.000005
Xylenes, Total	1.58E+00	1.89E-06	NA	5.72E-07	2.00E-01	2.00E-01	1.00E-01	Body weight, Mortality	0.000009	NA	0.000000006	0.000009
Aluminum	6.79E+03	8.14E-03	NA	2.46E-03	1.00E+00	1.00E+00	5.00E-03	Nervous system	0.008	NA	0.0005	0.009
Antimony	3.92E+00	4.70E-06	NA	1.42E-06	4.00E-04	6.00E-05	NA	Blood	0.01	NA	NA	0.01
Arsenic	2.16E+01	1.55E-05	3.28E-06	7.83E-06	3.00E-04	3.00E-04	1.50E-05	Reproductive	0.05	0.01	0.0005	0.06
Chromium	2.44E+01	2.93E-05	NA	8.85E-06	3.00E-03	7.50E-05	1.00E-04	None observed	0.01	NA	0.00009	0.01
Cobalt	3.76E+00	4.51E-06	NA	1.36E-06	3.00E-04	3.00E-04	6.00E-06	Thyroid	0.02	NA	0.0002	0.02
Copper	6.29E+01	7.54E-05	NA	2.28E-05	4.00E-02	4.00E-02	NA	Gastrointestinal tract	0.002	NA	NA	0.002
Lead	2.79E+02	3.34E-04	NA	1.01E-04	NA	NA	NA	---	NA	NA	NA	NA
Manganese	1.52E+02	1.82E-04	NA	5.50E-05	2.40E-02	9.60E-04	5.00E-05	Nervous system	0.008	NA	0.0011	0.009
Mercury	1.44E-01	1.73E-07	NA	5.21E-08	3.00E-04	2.10E-05	3.00E-04	Immune System	0.0006	NA	0.0000002	0.0006
Thallium	1.87E-01	2.24E-07	NA	6.77E-08	1.00E-05	1.00E-05	NA	Hair	0.02	NA	NA	0.02
Vanadium	3.62E+01	4.34E-05	NA	1.31E-05	5.00E-03	1.30E-04	1.00E-04	Hair	0.009	NA	0.0001	0.009
								Total	0.1	0.02	0.003	0.2

Table 6-34

Central Tendency Exposure Doses and Hazard Quotients for Adult Residents Exposure to Aggregate Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		CTE - Noncancer										
		Adult Exposure Doses							Adult Hazard Quotients			
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Primary Target Organ	Soil Ingestion	Dermal Contact	Inhalation	Hazard Index
Aroclor-1248	7.18E-02	2.15E-08	7.26E-09	2.60E-08	NA	NA	NA	---	NA	NA	NA	NA
Aroclor-1254	8.28E-02	2.48E-08	8.38E-09	3.00E-08	2.00E-05	2.00E-05	NA	Eyes, Immune system, Dermal	0.001	0.0004	NA	0.002
Aroclor-1260	5.13E-02	1.54E-08	5.19E-09	1.86E-08	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)anthracene	1.44E+00	4.32E-07	1.35E-07	5.22E-07	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)pyrene	1.27E+00	3.80E-07	1.19E-07	4.59E-07	3.00E-04	3.00E-04	2.00E-06	Developmental	0.001	0.0004	0.0002	0.002
Benzo(b)fluoranthene	1.09E+00	3.27E-07	1.02E-07	3.95E-07	NA	NA	NA	---	NA	NA	NA	NA
Benzo(k)fluoranthene	7.57E-01	2.27E-07	7.12E-08	2.74E-07	NA	NA	NA	---	NA	NA	NA	NA
Chloroform	6.20E-03	1.86E-09	NA	2.24E-09	1.00E-02	1.00E-02	9.80E-02	Liver	0.0000002	NA	0.00000000002	0.0000002
4,4-DDT	1.36E-01	4.08E-08	2.95E-09	4.92E-08	5.00E-04	5.00E-04	NA	Liver	0.00008	0.000006	NA	0.00009
Dibenz(a,h)anthracene	2.58E-01	7.73E-08	2.42E-08	9.34E-08	NA	NA	NA	---	NA	NA	NA	NA
Dibenzofuran	2.39E-01	7.16E-08	5.18E-09	8.65E-08	1.00E-03	1.00E-03	NA	Body Weight	0.00007	0.000005	NA	0.00008
Dieldrin	8.40E-03	2.52E-09	6.07E-10	3.04E-09	5.00E-05	5.00E-05	NA	Liver	0.00005	0.00001	NA	0.00006
Ethylbenzene	1.55E-01	4.64E-08	NA	5.61E-08	1.00E-01	1.00E-01	1.00E+00	Kidney, Liver	0.0000005	NA	0.00000000006	0.0000005
Indeno(1,2,3-c,d)pyrene	5.00E-01	1.50E-07	4.70E-08	1.81E-07	NA	NA	NA	---	NA	NA	NA	NA
Naphthalene	4.01E-01	1.20E-07	3.77E-08	1.45E-07	2.00E-02	2.00E-02	3.00E-03	Body Weight	0.000006	0.000002	0.00000005	0.000008
Pentachlorophenol	2.00E+00	5.99E-07	3.62E-07	7.24E-07	5.00E-03	5.00E-03	NA	Liver	0.0001	0.00007	NA	0.0002
Trichloroethylene	1.41E-01	4.23E-08	NA	5.10E-08	5.00E-04	5.00E-04	2.00E-03	Ranges from immune effects to heart effects	0.00008	NA	0.00000003	0.00008
Vinyl chloride	1.20E-02	3.60E-09	NA	4.34E-09	3.00E-03	3.00E-03	1.00E-01	Liver	0.000001	NA	0.00000000004	0.000001
Xylenes, Total	1.58E+00	4.73E-07	NA	5.72E-07	2.00E-01	2.00E-01	1.00E-01	Body weight, Mortality	0.000002	NA	0.000000006	0.000002
Aluminum	6.79E+03	2.04E-03	NA	2.46E-03	1.00E+00	1.00E+00	5.00E-03	Nervous system	0.002	NA	0.0005	0.003
Antimony	3.92E+00	1.17E-06	NA	1.42E-06	4.00E-04	6.00E-05	NA	Blood	0.003	NA	NA	0.003
Arsenic	2.16E+01	3.89E-06	4.69E-07	7.83E-06	3.00E-04	3.00E-04	1.50E-05	Reproductive	0.01	0.002	0.0005	0.02
Chromium	2.44E+01	7.32E-06	NA	8.85E-06	3.00E-03	7.50E-05	1.00E-04	None observed	0.002	NA	0.00009	0.003
Cobalt	3.76E+00	1.13E-06	NA	1.36E-06	3.00E-04	3.00E-04	6.00E-06	Thyroid	0.004	NA	0.0002	0.004
Copper	6.29E+01	1.88E-05	NA	2.28E-05	4.00E-02	4.00E-02	NA	Gastrointestinal tract	0.0005	NA	NA	0.0005
Lead	2.79E+02	8.36E-05	NA	1.01E-04	NA	NA	NA	---	NA	NA	NA	NA
Manganese	1.52E+02	4.55E-05	NA	5.50E-05	2.40E-02	9.60E-04	5.00E-05	Nervous system	0.002	NA	0.001	0.003
Mercury	1.44E-01	4.32E-08	NA	5.21E-08	3.00E-04	2.10E-05	3.00E-04	Immune System	0.0001	NA	0.0000002	0.0001
Thallium	1.87E-01	5.60E-08	NA	6.77E-08	1.00E-05	1.00E-05	NA	Hair	0.006	NA	NA	0.006
Vanadium	3.62E+01	1.08E-05	NA	1.31E-05	5.00E-03	1.30E-04	1.00E-04	Hair	0.002	NA	0.0001	0.002
								Total	0.04	0.002	0.003	0.04

Table 6-35
Calculation of Reasonable Maximum Exposure Cancer Risks - Mutagenic Mode of Action - Future Residential Exposure to Aggregate Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Incidental Soil Ingestion Risk

Where:

$$Risk = EPC \times \sum_i \frac{IRS \times FI \times CF \times EF \times ED}{BW \times AT} \times CSFo \times ADAF$$

Exposure Parameters (by age interval, i)					
Parameter	**Units**	**0-<2**	**2-<6**	**6-<16**	**16-<26**
EPC	mg/kg	See Table 6-5			
IRS	mg/day	200	200	100	100
FI	unitless	1	1	1	1
CF	kg/mg	1E-06	1E-06	1E-06	1E-06
EF	days/year	350	350	350	350
ED	years	2	4	10	10
BW	kg	15	15	80	80
AT	days	25550	25550	25550	25550
CSFo	$(mg/kg\text{-}day)^{-1}$	See Table 6-23			
ADAF	unitless	10	3	3	1

	Incidential Soil Ingestion Risks					
COPC	**EPC**	**CSFo**	**0-<2**	**2-<6**	**6-<16**	**16-<30**
Benzo(a)anthracene	1.44E+00	1.0E-01	5E-07	3E-07	7E-08	2E-08
Benzo(a)pyrene	1.27E+00	1.0E+00	5E-06	3E-06	7E-07	2E-07
Benzo(b)fluoranthene	1.09E+00	1.0E-01	4E-07	2E-07	6E-08	2E-08
Benzo(k)fluoranthene	7.57E-01	1.0E-02	3E-08	2E-08	4E-09	1E-09
Dibenz(a,h)anthracene	2.58E-01	1.0E+00	9E-07	6E-07	1E-07	4E-08
Indeno(1,2,3-cd)pyrene	5.00E-01	1.0E-01	2E-07	1E-07	3E-08	9E-09
Chromium Total	2.44E+01	5.0E-01	4E-05	3E-05	6E-06	2E-06

Dermal Contact Risk

Where:

$$Risk = EPC \times \sum_i \frac{SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT} \times CSFd \times ADAF$$

Exposure Parameters (by age interval, i)					
Parameter	**Units**	**0-<2**	**2-<6**	**6-<16**	**16-<26**
EPC	mg/kg	See Table 6-5			
SA	cm^2/day	2373	2373	6032	6032
AF	mg/cm^2	0.2	0.2	0.07	0.07
ABS	unitless	See Table 6-7			
EF	days/year	350	350	350	350
ED	years	2	4	10	10
CF	kg/mg	1E-06	1E-06	1E-06	1E-06
BW	kg	15	15	80	80
AT	days	25550	25550	25550	25550
CSFd	$(mg/kg\text{-}day)^{-1}$	See Table 6-23			
ADAF	unitless	10	3	3	1

	Dermal Contact Risks						
COPC	**EPC**	**CSFd**	**ABS**	**0-<2**	**2-<6**	**6-<16**	**16-<30**
Benzo(a)anthracene	1.44E+00	1.0E-01	0.13	2E-07	1E-07	4E-08	1E-08
Benzo(a)pyrene	1.27E+00	1.0E+00	0.13	1E-06	9E-07	4E-07	1E-07
Benzo(b)fluoranthene	1.09E+00	1.0E-01	0.13	1E-07	7E-08	3E-08	1E-08
Benzo(k)fluoranthene	7.57E-01	1.0E-02	0.13	9E-09	5E-09	2E-09	7E-10
Dibenz(a,h)anthracene	2.58E-01	1.0E+00	0.13	3E-07	2E-07	7E-08	2E-08
Indeno(1,2,3-cd)pyrene	5.00E-01	1.0E-01	0.13	6E-08	3E-08	1E-08	5E-09
Chromium Total	2.44E+01	2.0E+01	NA	NA	NA	NA	NA

Inhalation of Particulate Risk

Where:

$$Risk = EPC \times 1/PEF \sum_i \frac{ET \times EF \times ED \times CF}{AT} \times IUR \times ADAF$$

Exposure Parameters (by age interval, i)					
Parameter	**Units**	**0-<2**	**2-<6**	**6-<16**	**16-<26**
EPC	mg/kg	See Table 6-5			
PEF	m^3/kg	2.67E+09	2.67E+09	2.67E+09	2.67E+09
ET	hours/day	24	24	24	24
EF	days/year	350	350	350	350
ED	years	2	4	10	10
CF	µg/mg	1000	1000	1000	1000
AT	hours	613200	613200	613200	613200
IUR	$(\mu g/m^3)^{-1}$	See Table 6-24			
ADAF	unitless	10	3	3	1

	Inhalation of Particulate Risks					
COPC	**EPC**	**IUR**	**0-<2**	**2-<6**	**6-<16**	**16-<30**
Benzo(a)anthracene	1.44E+00	6.0E-05	9E-12	5E-12	1E-11	4E-12
Benzo(a)pyrene	1.27E+00	6.0E-04	8E-11	5E-11	1E-10	4E-11
Benzo(b)fluoranthene	1.09E+00	6.0E-05	7E-12	4E-12	1E-11	3E-12
Benzo(k)fluoranthene	7.57E-01	6.0E-06	5E-13	3E-13	7E-13	2E-13
Dibenz(a,h)anthracene	2.58E-01	6.0E-04	2E-11	1E-11	2E-11	8E-12
Indeno(1,2,3-cd)pyrene	5.00E-01	6.0E-05	3E-12	2E-12	5E-12	2E-12
Chromium Total	2.44E+01	8.4E-02	2E-07	1E-07	3E-07	1E-07

	Total Cancer Risks			
COPC	**Soil Ingestion**	**Dermal Contact**	**Inhalation**	**Total**
Benzo(a)anthracene	9E-07	3E-07	3E-11	**1E-06**
Benzo(a)pyrene	8E-06	3E-06	3E-10	**1E-05**
Benzo(b)fluoranthene	7E-07	2E-07	2E-11	**9E-07**
Benzo(k)fluoranthene	5E-08	2E-08	2E-12	**7E-08**
Dibenz(a,h)anthracene	2E-06	6E-07	6E-11	**2E-06**
Indeno(1,2,3-cd)pyrene	3E-07	1E-07	1E-11	**4E-07**
Chromium Total	8E-05	NA	8E-07	**8E-05**

Table 6-36
Calculation of Reasonable Maximum Exposure Cancer Risks from Trichloroethylene - Mutagenic Mode of Action - Future Residential Exposure to Aggregate Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Incidental Soil Ingestion Risk

Where:

$$Risk = EPC \times \sum_{i} \left(\left(\frac{IRS \times FI \times EF \times ED \times CF}{BW \times AT} \right) \times CSF_{kidney} \times ADAF \right) + \left(\left(\frac{IRS \times FI \times EF \times ED \times CF}{BW \times AT} \right) \times CSF_{Liver + NHL} \right)$$

Exposure Parameters (by age interval, i)					
Parameter	**Units**	**0-<2**	**2-<6**	**6-<16**	**16-<26**
EPC	mg/kg	See Table 6-5			
IRS	mg/day	200	200	100	100
FI	unitless	1	1	1	1
CF	kg/mg	1E-06	1E-06	1E-06	1E-06
EF	days/year	350	350	350	350
ED	years	2	4	10	10
BW	kg	15	15	80	80
AT	days	25550	25550	25550	25550
CSF_{kidney}	$(mg/kg\text{-}day)^{-1}$	9.3E-03			
ADAF	unitless	10	3	3	1
$CSF_{liver+NHL}$	$(mg/kg\text{-}day)^{-1}$	3.7E-02			

	Incidential Soil Ingestion Risks				
COPC	**EPC**	**0-<2**	**2-<6**	**6-<16**	**16-<30**
Trichloroethylene	1.41E-01	7E-09	7E-09	2E-09	1E-09

Inhalation of Volatiles Risk

Where:

$$Risk = EPC \times 1/VF \times \sum_{i} \left(\left(\frac{ET \times EF \times ED \times CF}{AT} \right) \times IUR_{kidney} \times ADAF \right) + \left(\left(\frac{ET \times EF \times ED \times CF}{AT} \right) \times IUR_{liver + NHL} \right)$$

Exposure Parameters (by age interval, i)					
Parameter	**Units**	**0-<2**	**2-<6**	**6-<16**	**16-<26**
EPC	mg/kg	See Table 6-5			
VF	m^3/kg	1.56E+05	1.56E+05	1.56E+05	1.56E+05
ET	hours/day	24	24	24	24
EF	days/year	350	350	350	350
ED	years	2	4	10	10
CF	µg/mg	1000	1000	1000	1000
AT	hours	613200	613200	613200	613200
IUR_{kidney}	$(\mu g/m^3)^{-1}$	1.0E-06			
ADAF	unitless	10	3	3	1
$IUR_{liver+NHL}$	$(\mu g/m^3)^{-1}$	3.1E-06			

	Inhalation of Volatiles Risks				
COPC	**EPC**	**0-<2**	**2-<6**	**6-<16**	**16-<30**
Trichloroethylene	1.41E-01	3E-10	3E-10	8E-10	5E-10

	Total Cancer Risks		
COPC	**Soil Ingestion**	**Inhalation**	**Total**
Trichloroethylene	2E-08	2E-09	2E-08

Table 6-37
Calculation of Central Tendency Exposure Cancer Risks - Mutagenic Mode of Action - Future Residential Exposure to Aggregate Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Incidental Soil Ingestion Risk

Where:

$$Risk = EPC \times \sum_i \frac{IRS \times FI \times CF \times EF \times ED}{BW \times AT} \times CSFo \times ADAF$$

Exposure Parameters (by age interval, i)				
Parameter	**Units**	**0-<2**	**2-<6**	**20-<29**
EPC	mg/kg	See Table 6-5		
IRS	mg/day	100	100	50
FI	unitless	0.5	0.5	0.5
CF	kg/mg	1E-06	1E-06	1E-06
EF	days/year	350	350	350
ED	years	2	4	9
BW	kg	15	15	80
AT	days	25550	25550	25550
CSFo	$(mg/kg\text{-}day)^{-1}$	See Table 6-23		
ADAF	unitless	10	3	1

Dermal Contact Risk

Where:

$$Risk = EPC \times \sum_i \frac{SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT} \times CSFd \times ADAF$$

Exposure Parameters (by age interval, i)				
Parameter	**Units**	**0-<2**	**2-<6**	**20-<29**
EPC	mg/kg	See Table 6-5		
SA	cm^2	2690	2690	6032
AF	mg/cm^2	0.04	0.04	0.01
ABS	unitless	See Table 6-7		
EF	days/year	350	350	350
ED	years	2	4	9
CF	kg/mg	1E-06	1E-06	1E-06
BW	kg	15	15	70
AT	days	25550	25550	25550
CSFd	$(mg/kg\text{-}day)^{-1}$	See Table 6-23		
ADAF	unitless	10	3	1

Inhalation of Particulate Risk

Where:

$$Risk = EPC \times 1/PEF \sum_i \frac{ET \times EF \times ED \times CF}{AT} \times IUR \times ADAF$$

Exposure Parameters (by age interval, i)				
Parameter	**Units**	**0-<2**	**2-<6**	**20-<29**
EPC	mg/kg	See Table 6-5		
PEF	m^3/kg	2.67E+09	2.67E+09	2.67E+09
ET	hours/day	24	24	24
EF	days/year	350	350	350
ED	years	2	4	9
CF	µg/mg	1000	1000	1000
AT	hours	613200	613200	613200
IUR	$(\mu g/m^3)^{-1}$	See Table 6-24		
ADAF	unitless	10	3	1

	Incidential Soil Ingestion Risks				
COPC	**EPC**	**CSFo**	**0-<2**	**2-<6**	**20-<29**
Benzo(a)anthracene	1.44E+00	1.0E-01	1E-07	8E-08	6E-09
Benzo(a)pyrene	1.27E+00	1.0E+00	1E-06	7E-07	5E-08
Benzo(b)fluoranthene	1.09E+00	1.0E-01	1E-07	6E-08	4E-09
Benzo(k)fluoranthene	7.57E-01	1.0E-02	7E-09	4E-09	3E-10
Dibenz(a,h)anthracene	2.58E-01	1.0E+00	2E-07	1E-07	1E-08
Indeno(1,2,3-cd)pyrene	5.00E-01	1.0E-01	5E-08	3E-08	2E-09
Chromium Total	2.44E+01	5.0E-01	1E-05	7E-06	5E-07

	Dermal Contact Risks					
COPC	**EPC**	**CSFd**	**ABS**	**0-<2**	**2-<6**	**20-<29**
Benzo(a)anthracene	1.44E+00	1.0E-01	0.13	4E-08	2E-08	2E-09
Benzo(a)pyrene	1.27E+00	1.0E+00	0.13	3E-07	2E-07	2E-08
Benzo(b)fluoranthene	1.09E+00	1.0E-01	0.13	3E-08	2E-08	2E-09
Benzo(k)fluoranthene	7.57E-01	1.0E-02	0.13	2E-09	1E-09	1E-10
Dibenz(a,h)anthracene	2.58E-01	1.0E+00	0.13	7E-08	4E-08	4E-09
Indeno(1,2,3-cd)pyrene	5.00E-01	1.0E-01	0.13	1E-08	8E-09	7E-10
Chromium Total	2.44E+01	5.0E-01	NA	NA	NA	NA

	Inhalation of Particulate Risks				
COPC	**EPC**	**URFi**	**0-<2**	**6-<13**	**20-<29**
Benzo(a)anthracene	1.44E+00	6.0E-05	9E-12	5E-12	4E-12
Benzo(a)pyrene	1.27E+00	6.0E-04	8E-11	5E-11	4E-11
Benzo(b)fluoranthene	1.09E+00	6.0E-05	7E-12	4E-12	3E-12
Benzo(k)fluoranthene	7.57E-01	6.0E-06	5E-13	3E-13	2E-13
Dibenz(a,h)anthracene	2.58E-01	6.0E-04	2E-11	1E-11	7E-12
Indeno(1,2,3-cd)pyrene	5.00E-01	6.0E-05	3E-12	2E-12	1E-12
Chromium Total	2.44E+01	8.4E-02	2E-07	1E-07	9E-08

	Total Cancer Risks			
COPC	**Soil Ingestion**	**Dermal Contact**	**Inhalation**	**Total**
Benzo(a)anthracene	2E-07	6E-08	2E-11	**3E-07**
Benzo(a)pyrene	2E-06	5E-07	2E-10	**2E-06**
Benzo(b)fluoranthene	2E-07	5E-08	1E-11	**2E-07**
Benzo(k)fluoranthene	1E-08	3E-09	1E-12	**1E-08**
Dibenz(a,h)anthracene	4E-07	1E-07	3E-11	**5E-07**
Indeno(1,2,3-cd)pyrene	7E-08	2E-08	6E-12	**1E-07**
Chromium Total	2E-05	NA	4E-07	**2E-05**

Table 6-38
Calculation of Central Tendency Exposure Cancer Risks from Trichloroethylene - Mutagenic Mode of Action - Future Residential Exposure to Aggregate Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Incidental Soil Ingestion Risk

Where:

$$Risk = EPC \times \sum_i \left(\left(\frac{IRS \times FI \times EF \times ED \times CF}{BW \times AT} \right) \times CSF_{kidney} \times ADAF \right) + \left(\left(\frac{IRS \times FI \times EF \times ED \times CF}{BW \times AT} \right) \times CSF_{liver + NHL} \right)$$

Exposure Parameters (by age interval, i)				
Parameter	**Units**	**0-<2**	**2-<6**	**20-<29**
EPC	mg/kg	See Table 6-5		
IRS	mg/day	100	100	50
FI	unitless	0.5	0.5	0.5
CF	kg/mg	1E-06	1E-06	1E-06
EF	days/year	350	350	350
ED	years	2	4	9
BW	kg	15	15	80
AT	days	25550	25550	25550
CSF_{kidney}	$(mg/kg\text{-}day)^{-1}$	9.3E-03		
ADAF	unitless	10	3	1
$CSFI_{liver+NHL}$	$(mg/kg\text{-}day)^{-1}$	3.7E-02		

	Incidential Soil Ingestion Risks			
COPC	**EPC**	**0-<2**	**2-<6**	**20-<29**
Trichloroethylene	1.41E-01	2E-09	2E-09	3E-10

Inhalation of Volatiles Risk

Where:

$$Risk = EPC \times 1/VF \times \sum_i \left(\left(\frac{ET \times EF \times ED \times CF}{AT} \right) \times IUR_{kidney} \times ADAF \right) + \left(\left(\frac{ET \times EF \times ED \times CF}{AT} \right) \times IUR_{liver + NHL} \right)$$

Exposure Parameters (by age interval, i)				
Parameter	**Units**	**0-<2**	**2-<6**	**20-<29**
EPC	mg/kg	See Table 6-5		
VF	m^3/kg	1.10E+05	1.10E+05	1.10E+05
ET	hours/day	24	24	24
EF	days/year	350	350	350
ED	years	2	4	9
CF	µg/mg	1000	1000	1000
AT	hours	613200	613200	613200
IUR_{kidney}	$(\mu g/m^3)^{-1}$	1.0E-06		
ADAF	unitless	10	3	1
$IUR_{liver+NHL}$	$(\mu g/m^3)^{-1}$	3.1E-06		

	Inhalation of Volatiles Risks			
COPC	**EPC**	**0-<2**	**2-<6**	**20-<29**
Trichloroethylene	1.41E-01	5E-10	4E-10	6E-10

	Total Cancer Risks		
COPC	**Soil Ingestion**	**Inhalation**	**Total**
Trichloroethylene	4E-09	2E-09	5E-09

Table 6-39
Reasonable Maximum Exposure Doses and Cancer Risks for Groundskeeper Exposure to Surface Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		RME - Cancer									
		Exposure Doses						Cancer Risks			
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Dermal CSF $(mg/kg\text{-}day)^{-1}$	IUR $(\mu g/m^3)^{-1}$	Soil Ingestion	Dermal Contact	Inhalation	Total
Aroclor-1248	7.00E-02	1.93E-08	1.14E-08	1.94E-09	2.00E+00	2.00E+00	5.70E-04	4E-08	2E-08	1E-12	6E-08
Aroclor-1260	8.10E-02	2.23E-08	1.32E-08	2.24E-09	2.00E+00	2.00E+00	5.70E-04	4E-08	3E-08	1E-12	7E-08
Benzo(a)anthracene	4.76E-01	1.31E-07	7.21E-08	1.32E-08	1.00E-01	1.00E-01	6.00E-05	1E-08	7E-09	8E-13	2E-08
Benzo(a)pyrene	5.16E-01	1.42E-07	7.81E-08	1.43E-08	1.00E+00	1.00E+00	6.00E-04	1E-07	8E-08	9E-12	2E-07
Benzo(b)fluoranthene	6.38E-01	1.76E-07	9.66E-08	1.77E-08	1.00E-01	1.00E-01	6.00E-05	2E-08	1E-08	1E-12	3E-08
Dibenz(a,h)anthracene	1.98E-01	5.45E-08	3.00E-08	5.49E-09	1.00E+00	1.00E+00	6.00E-04	5E-08	3E-08	3E-12	8E-08
Indeno(1,2,3-c,d)pyrene	2.90E-01	7.98E-08	4.39E-08	8.03E-09	1.00E-01	1.00E-01	6.00E-05	8E-09	4E-09	5E-13	1E-08
Pentachlorophenol	1.90E+00	5.23E-07	5.53E-07	5.26E-08	4.00E-01	4.00E-01	5.10E-06	2E-07	2E-07	3E-13	4E-07
Trichloroethylene	5.33E-02	1.47E-08	NA	1.48E-09	9.30E-03	9.30E-03	1.00E-06	1E-10	NA	1E-15	1E-10
Aluminum	7.93E+03	2.18E-03	NA	2.20E-04	NA	NA	NA	NA	NA	NA	NA
Antimony	4.30E+00	1.18E-06	NA	1.19E-07	NA	NA	NA	NA	NA	NA	NA
Arsenic	3.85E+01	6.36E-06	1.35E-06	1.07E-06	1.50E+00	1.50E+00	4.30E-03	1E-05	2E-06	5E-09	1E-05
Chromium	4.52E+01	1.24E-05	NA	1.25E-06	5.00E-01	2.00E+01	8.40E-02	6E-06	NA	1E-07	6E-06
Cobalt	7.30E+00	2.01E-06	NA	2.02E-07	NA	NA	9.00E-03	NA	NA	2E-09	2E-09
Copper	8.44E+01	2.32E-05	NA	2.34E-06	NA	NA	NA	NA	NA	NA	NA
Lead	4.12E+02	1.13E-04	NA	1.14E-05	NA	NA	NA	NA	NA	NA	NA
Manganese	3.80E+02	1.05E-04	NA	1.05E-05	NA	NA	NA	NA	NA	NA	NA
Mercury	2.52E-01	6.93E-08	NA	6.98E-09	NA	NA	NA	NA	NA	NA	NA
Thallium	2.60E-01	7.16E-08	NA	7.20E-09	NA	NA	NA	NA	NA	NA	NA
							Total	2E-05	2E-06	1E-07	2E-05

Table 6-40
Central Tendency Exposure Doses and Cancer Risks for Groundskeeper Exposure to Surface Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		CTE - Cancer									
		Exposure Doses						Cancer Risks			
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Dermal CSF $(mg/kg\text{-}day)^{-1}$	IUR $(\mu g/m^3)^{-1}$	Soil Ingestion	Dermal Contact	Inhalation	Total
Aroclor-1248	7.00E-02	1.13E-09	4.46E-10	2.28E-10	2.00E+00	2.00E+00	5.70E-04	2E-09	9E-10	1E-13	3E-09
Aroclor-1260	8.10E-02	1.31E-09	5.17E-10	2.63E-10	2.00E+00	2.00E+00	5.70E-04	3E-09	1E-09	2E-13	4E-09
Benzo(a)anthracene	4.76E-01	7.68E-09	2.82E-09	1.55E-09	1.00E-01	1.00E-01	6.00E-05	8E-10	3E-10	9E-14	1E-09
Benzo(a)pyrene	5.16E-01	8.33E-09	3.06E-09	1.68E-09	1.00E+00	1.00E+00	6.00E-04	8E-09	3E-09	1E-12	1E-08
Benzo(b)fluoranthene	6.38E-01	1.03E-08	3.78E-09	2.07E-09	1.00E-01	1.00E-01	6.00E-05	1E-09	4E-10	1E-13	1E-09
Dibenz(a,h)anthracene	1.98E-01	3.20E-09	1.17E-09	6.44E-10	1.00E+00	1.00E+00	6.00E-04	3E-09	1E-09	4E-13	4E-09
Indeno(1,2,3-c,d)pyrene	2.90E-01	4.68E-09	1.72E-09	9.43E-10	1.00E-01	1.00E-01	6.00E-05	5E-10	2E-10	6E-14	6E-10
Pentachlorophenol	1.90E+00	3.07E-08	2.16E-08	6.18E-09	4.00E-01	4.00E-01	5.10E-06	1E-08	9E-09	3E-14	2E-08
Trichloroethylene	5.33E-02	8.61E-10	NA	1.73E-10	9.30E-03	9.30E-03	1.00E-06	8E-12	NA	2E-16	8E-12
Aluminum	7.93E+03	1.28E-04	NA	2.58E-05	NA	NA	NA	NA	NA	NA	NA
Antimony	4.30E+00	6.94E-08	NA	1.40E-08	NA	NA	NA	NA	NA	NA	NA
Arsenic	3.85E+01	3.73E-07	5.26E-08	1.25E-07	1.50E+00	1.50E+00	4.30E-03	6E-07	8E-08	5E-10	6E-07
Chromium	4.52E+01	7.30E-07	NA	1.47E-07	5.00E-01	2.00E+01	8.40E-02	4E-07	NA	1E-08	4E-07
Cobalt	7.30E+00	1.18E-07	NA	2.37E-08	NA	NA	9.00E-03	NA	NA	2E-10	2E-10
Copper	8.44E+01	1.36E-06	NA	2.74E-07	NA	NA	NA	NA	NA	NA	NA
Lead	4.12E+02	6.64E-06	NA	1.34E-06	NA	NA	NA	NA	NA	NA	NA
Manganese	3.80E+02	6.13E-06	NA	1.23E-06	NA	NA	NA	NA	NA	NA	NA
Mercury	2.52E-01	4.07E-09	NA	8.19E-10	NA	NA	NA	NA	NA	NA	NA
Thallium	2.60E-01	4.20E-09	NA	8.45E-10	NA	NA	NA	NA	NA	NA	NA
							Total	1E-06	9E-08	1E-08	1E-06

Table 6-41
Reasonable Maximum Exposure Doses and Hazard Quotients for Groundskeeper Exposure to Surface Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		RME - Noncancer										
		Exposure Doses							Hazard Quotients			
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Primary Target Organ	Soil Ingestion	Dermal Contact	Inhalation	Hazard Index
Aroclor-1248	7.00E-02	5.39E-08	3.20E-08	5.43E-09	NA	NA	NA	---	NA	NA	NA	NA
Aroclor-1260	8.10E-02	6.24E-08	3.70E-08	6.28E-09	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)anthracene	4.76E-01	3.67E-07	2.02E-07	3.69E-08	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)pyrene	5.16E-01	3.98E-07	2.19E-07	4.00E-08	3.00E-04	3.00E-04	2.00E-06	Developmental	0.001	0.0007	0.00002	0.002
Benzo(b)fluoranthene	6.38E-01	4.92E-07	2.70E-07	4.95E-08	NA	NA	NA	---	NA	NA	NA	NA
Dibenz(a,h)anthracene	1.98E-01	1.53E-07	8.39E-08	1.54E-08	NA	NA	NA	---	NA	NA	NA	NA
Indeno(1,2,3-c,d)pyrene	2.90E-01	2.23E-07	1.23E-07	2.25E-08	NA	NA	NA	---	NA	NA	NA	NA
Pentachlorophenol	1.90E+00	1.46E-06	1.55E-06	1.47E-07	5.00E-03	5.00E-03	NA	Liver	0.0003	0.0003	NA	0.0006
Trichloroethylene	5.33E-02	4.11E-08	NA	4.13E-09	5.00E-04	5.00E-04	2.00E-03	Ranges from immune effects to heart effects	0.00008	NA	0.000000002	0.00008
Aluminum	7.93E+03	6.11E-03	NA	6.15E-04	1.00E+00	1.00E+00	5.00E-03	system	0.006	NA	0.0001	0.006
Antimony	4.30E+00	3.31E-06	NA	3.34E-07	4.00E-04	6.00E-05	NA	Blood	0.008	NA	NA	0.008
Arsenic	3.85E+01	1.78E-05	3.77E-06	2.99E-06	3.00E-04	3.00E-04	1.50E-05	Reproductive	0.06	0.01	0.0002	0.07
Chromium	4.52E+01	3.48E-05	NA	3.51E-06	3.00E-03	7.50E-05	1.00E-04	None observed	0.01	NA	0.00004	0.01
Cobalt	7.30E+00	5.62E-06	NA	5.66E-07	3.00E-04	3.00E-04	6.00E-06	Thyroid	0.02	NA	0.00009	0.02
Copper	8.44E+01	6.50E-05	NA	6.55E-06	4.00E-02	4.00E-02	NA	Gastrointestinal tract	0.002	NA	NA	0.002
Lead	4.12E+02	3.17E-04	NA	3.19E-05	NA	NA	NA	---	NA	NA	NA	NA
Manganese	3.80E+02	2.93E-04	NA	2.95E-05	2.40E-02	9.60E-04	5.00E-05	system	0.01	NA	0.0006	0.01
Mercury	2.52E-01	1.94E-07	NA	1.95E-08	3.00E-04	2.10E-05	3.00E-04	Immune System	0.0006	NA	0.00000007	0.0006
Thallium	2.60E-01	2.00E-07	NA	2.02E-08	1.00E-05	1.00E-05	NA	Hair	0.02	NA	NA	0.02
								Total	0.1	0.01	0.001	0.2

Table 6-42
Central Tendency Exposure Doses and Hazard Quotients for Groundskeeper Exposure to Surface Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		CTE - Noncancer										
		Exposure Doses							Hazard Quotients			
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Primary Target Organ	Soil Ingestion	Dermal Contact	Inhalation	Hazard Index
Aroclor-1248	7.00E-02	6.59E-09	2.60E-09	1.33E-09	NA	NA	NA	---	NA	NA	NA	NA
Aroclor-1260	8.10E-02	7.63E-09	3.01E-09	1.54E-09	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)anthracene	4.76E-01	4.48E-08	1.64E-08	9.03E-09	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)pyrene	5.16E-01	4.86E-08	1.78E-08	9.78E-09	3.00E-04	3.00E-04	2.00E-06	Developmental	0.0002	0.00006	0.000005	0.0002
Benzo(b)fluoranthene	6.38E-01	6.01E-08	2.20E-08	1.21E-08	NA	NA	NA	---	NA	NA	NA	NA
Dibenz(a,h)anthracene	1.98E-01	1.86E-08	6.84E-09	3.75E-09	NA	NA	NA	---	NA	NA	NA	NA
Indeno(1,2,3-c,d)pyrene	2.90E-01	2.73E-08	1.00E-08	5.50E-09	NA	NA	NA	---	NA	NA	NA	NA
Pentachlorophenol	1.90E+00	1.79E-07	1.26E-07	3.60E-08	5.00E-03	5.00E-03	NA	Liver	0.00004	0.00003	NA	0.00006
Trichloroethylene	5.33E-02	5.02E-09	NA	1.01E-09	5.00E-04	5.00E-04	2.00E-03	Ranges from immune effects to heart effects	0.00001	NA	0.0000000005	0.00001
Aluminum	7.93E+03	7.47E-04	NA	1.50E-04	1.00E+00	1.00E+00	5.00E-03	Nervous system	0.0007	NA	0.00003	0.0008
Antimony	4.30E+00	4.05E-07	NA	8.16E-08	4.00E-04	6.00E-05	NA	Blood	0.001	NA	NA	0.001
Arsenic	3.85E+01	2.18E-06	3.07E-07	7.30E-07	3.00E-04	3.00E-04	1.50E-05	Reproductive	0.007	0.001	0.00005	0.008
Chromium	4.52E+01	4.26E-06	NA	8.57E-07	3.00E-03	7.50E-05	1.00E-04	None observed	0.001	NA	0.000009	0.001
Cobalt	7.30E+00	6.87E-07	NA	1.38E-07	3.00E-04	3.00E-04	6.00E-06	Thyroid	0.002	NA	0.00002	0.002
Copper	8.44E+01	7.95E-06	NA	1.60E-06	4.00E-02	4.00E-02	NA	Gastrointestinal tract	0.0002	NA	NA	0.0002
Lead	4.12E+02	3.88E-05	NA	7.80E-06	NA	NA	NA	---	NA	NA	NA	NA
Manganese	3.80E+02	3.58E-05	NA	7.20E-06	2.40E-02	9.60E-04	5.00E-05	Nervous system	0.001	NA	0.0001	0.002
Mercury	2.52E-01	2.37E-08	NA	4.78E-09	3.00E-04	2.10E-05	3.00E-04	Immune System	0.00008	NA	0.00000002	0.00008
Thallium	2.60E-01	2.45E-08	NA	4.93E-09	1.00E-05	1.00E-05	NA	Hair	0.002	NA	NA	0.002
								Total	0.02	0.001	0.0003	0.02

Table 6-43
Reasonable Maximum Exposure Doses and Cancer Risks for Construction/Utility Worker Exposure to Aggregate Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		RME - Cancer									
		Exposure Doses						Cancer Risks			
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Dermal CSF $(mg/kg\text{-}day)^{-1}$	IUR $(\mu g/m^3)^{-1}$	Soil Ingestion	Dermal Contact	Inhalation	Total
Aroclor-1248	7.18E-02	6.95E-10	3.12E-10	5.50E-08	2.00E+00	2.00E+00	5.70E-04	1E-09	6E-10	3E-11	2E-09
Aroclor-1254	8.28E-02	8.02E-10	3.60E-10	6.34E-08	2.00E+00	2.00E+00	5.70E-04	2E-09	7E-10	4E-11	2E-09
Aroclor-1260	5.13E-02	4.97E-10	2.23E-10	3.93E-08	2.00E+00	2.00E+00	5.70E-04	1E-09	4E-10	2E-11	1E-09
Benzo(a)anthracene	1.44E+00	1.40E-08	5.82E-09	1.10E-06	1.00E-01	1.00E-01	6.00E-05	1E-09	6E-10	7E-11	2E-09
Benzo(a)pyrene	1.27E+00	1.23E-08	5.12E-09	9.71E-07	1.00E+00	1.00E+00	6.00E-04	1E-08	5E-09	6E-10	2E-08
Benzo(b)fluoranthene	1.09E+00	1.06E-08	4.40E-09	8.35E-07	1.00E-01	1.00E-01	6.00E-05	1E-09	4E-10	5E-11	2E-09
Benzo(k)fluoranthene	7.57E-01	7.33E-09	3.06E-09	5.80E-07	1.00E-02	1.00E-02	6.00E-06	7E-11	3E-11	3E-12	1E-10
Chloroform	6.20E-03	6.01E-11	NA	4.75E-09	3.10E-02	3.10E-02	2.30E-05	2E-12	NA	1E-13	2E-12
4,4-DDT	1.36E-01	1.32E-09	1.27E-10	1.04E-07	3.40E-01	3.40E-01	9.70E-05	4E-10	4E-11	1E-11	5E-10
Dibenz(a,h)anthracene	2.58E-01	2.50E-09	1.04E-09	1.98E-07	1.00E+00	1.00E+00	6.00E-04	2E-09	1E-09	1E-10	4E-09
Dibenzofuran	2.39E-01	2.32E-09	2.23E-10	1.83E-07	NA	NA	NA	NA	NA	NA	NA
Dieldrin	8.40E-03	8.14E-11	2.61E-11	6.43E-09	1.60E+01	1.60E+01	4.60E-03	1E-09	4E-10	3E-11	2E-09
Ethylbenzene	1.55E-01	1.50E-09	NA	1.19E-07	1.10E-02	1.10E-02	2.50E-06	2E-11	NA	3E-13	2E-11
Indeno(1,2,3-c,d)pyrene	5.00E-01	4.84E-09	2.02E-09	3.83E-07	1.00E-01	1.00E-01	6.00E-05	5E-10	2E-10	2E-11	7E-10
Naphthalene	4.01E-01	3.88E-09	1.62E-09	3.07E-07	NA	NA	3.40E-05	NA	NA	1E-11	1E-11
Pentachlorophenol	2.00E+00	1.94E-08	1.55E-08	1.53E-06	4.00E-01	4.00E-01	5.10E-06	8E-09	6E-09	8E-12	1E-08
Trichloroethylene	1.41E-01	1.37E-09	NA	1.08E-07	9.30E-03	9.30E-03	1.00E-06	1E-11	NA	1E-13	1E-11
Vinyl chloride	1.20E-02	1.16E-10	NA	9.19E-09	7.20E-01	7.20E-01	4.40E-06	8E-11	NA	4E-14	8E-11
Xylenes, Total	1.58E+00	1.53E-08	NA	1.21E-06	NA	NA	NA	NA	NA	NA	NA
Aluminum	6.79E+03	6.58E-05	NA	5.20E-03	NA	NA	NA	NA	NA	NA	NA
Antimony	3.92E+00	3.80E-08	NA	3.00E-06	NA	NA	NA	NA	NA	NA	NA
Arsenic	2.16E+01	1.26E-07	2.01E-08	1.66E-05	1.50E+00	1.50E+00	4.30E-03	2E-07	3E-08	7E-08	3E-07
Chromium	2.44E+01	2.37E-07	NA	1.87E-05	5.00E-01	2.00E+01	8.40E-02	1E-07	NA	2E-06	2E-06
Cobalt	3.76E+00	3.64E-08	NA	2.88E-06	NA	NA	9.00E-03	NA	NA	3E-08	3E-08
Copper	6.29E+01	6.09E-07	NA	4.82E-05	NA	NA	NA	NA	NA	NA	NA
Lead	2.79E+02	2.70E-06	NA	2.14E-04	NA	NA	NA	NA	NA	NA	NA
Manganese	1.52E+02	1.47E-06	NA	1.16E-04	NA	NA	NA	NA	NA	NA	NA
Mercury	1.44E-01	1.39E-09	NA	1.10E-07	NA	NA	NA	NA	NA	NA	NA
Thallium	1.87E-01	1.81E-09	NA	1.43E-07	NA	NA	NA	NA	NA	NA	NA
Vanadium	3.62E+01	3.50E-07	NA	2.77E-05	NA	NA	NA	NA	NA	NA	NA
							Total	3E-07	5E-08	2E-06	2E-06

Table 6-44
Central Tendency Exposure Doses and Cancer Risks for Construction/Utility Worker Exposure to Aggregate Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		CTE - Cancer									
		Exposure Doses						Cancer Risks			
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Dermal CSF $(mg/kg\text{-}day)^{-1}$	IUR $(\mu g/m^3)^{-1}$	Soil Ingestion	Dermal Contact	Inhalation	Total
Aroclor-1248	7.18E-02	5.27E-11	5.20E-11	1.46E-08	2.00E+00	2.00E+00	5.70E-04	1E-10	1E-10	8E-12	2E-10
Aroclor-1254	8.28E-02	6.07E-11	6.00E-11	1.68E-08	2.00E+00	2.00E+00	5.70E-04	1E-10	1E-10	1E-11	3E-10
Aroclor-1260	5.13E-02	3.76E-11	3.72E-11	1.04E-08	2.00E+00	2.00E+00	5.70E-04	8E-11	7E-11	6E-12	2E-10
Benzo(a)anthracene	1.44E+00	1.06E-09	9.70E-10	2.93E-07	1.00E-01	1.00E-01	6.00E-05	1E-10	1E-10	2E-11	2E-10
Benzo(a)pyrene	1.27E+00	9.30E-10	8.53E-10	2.57E-07	1.00E+00	1.00E+00	6.00E-04	9E-10	9E-10	2E-10	2E-09
Benzo(b)fluoranthene	1.09E+00	8.00E-10	7.34E-10	2.21E-07	1.00E-01	1.00E-01	6.00E-05	8E-11	7E-11	1E-11	2E-10
Benzo(k)fluoranthene	7.57E-01	5.56E-10	5.09E-10	1.54E-07	1.00E-02	1.00E-02	6.00E-06	6E-12	5E-12	9E-13	1E-11
Chloroform	6.20E-03	4.55E-12	NA	1.26E-09	3.10E-02	3.10E-02	2.30E-05	1E-13	NA	3E-14	2E-13
4,4-DDT	1.36E-01	9.98E-11	2.11E-11	2.76E-08	3.40E-01	3.40E-01	9.70E-05	3E-11	7E-12	3E-12	4E-11
Dibenz(a,h)anthracene	2.58E-01	1.89E-10	1.74E-10	5.24E-08	1.00E+00	1.00E+00	6.00E-04	2E-10	2E-10	3E-11	4E-10
Dibenzofuran	2.39E-01	1.75E-10	3.71E-11	4.86E-08	NA	NA	NA	NA	NA	NA	NA
Dieldrin	8.40E-03	6.16E-12	4.35E-12	1.71E-09	1.60E+01	1.60E+01	4.60E-03	1E-10	7E-11	8E-12	2E-10
Ethylbenzene	1.55E-01	1.14E-10	NA	3.15E-08	1.10E-02	1.10E-02	2.50E-06	1E-12	NA	8E-14	1E-12
Indeno(1,2,3-c,d)pyrene	5.00E-01	3.67E-10	3.36E-10	1.02E-07	1.00E-01	1.00E-01	6.00E-05	4E-11	3E-11	6E-12	8E-11
Naphthalene	4.01E-01	2.94E-10	2.70E-10	8.15E-08	NA	NA	3.40E-05	NA	NA	3E-12	3E-12
Pentachlorophenol	2.00E+00	1.47E-09	2.59E-09	4.06E-07	4.00E-01	4.00E-01	5.10E-06	6E-10	1E-09	2E-12	2E-09
Trichloroethylene	1.41E-01	1.03E-10	NA	2.86E-08	9.30E-03	9.30E-03	1.00E-06	1E-12	NA	3E-14	1E-12
Vinyl chloride	1.20E-02	8.81E-12	NA	2.44E-09	7.20E-01	7.20E-01	4.40E-06	6E-12	NA	1E-14	6E-12
Xylenes, Total	1.58E+00	1.16E-09	NA	3.21E-07	NA	NA	NA	NA	NA	NA	NA
Aluminum	6.79E+03	4.98E-06	NA	1.38E-03	NA	NA	NA	NA	NA	NA	NA
Antimony	3.92E+00	2.88E-09	NA	7.96E-07	NA	NA	NA	NA	NA	NA	NA
Arsenic	2.16E+01	9.52E-09	3.36E-09	4.39E-06	1.50E+00	1.50E+00	4.30E-03	1E-08	5E-09	2E-08	4E-08
Chromium	2.44E+01	1.79E-08	NA	4.97E-06	5.00E-01	2.00E+01	8.40E-02	9E-09	NA	4E-07	4E-07
Cobalt	3.76E+00	2.76E-09	NA	7.64E-07	NA	NA	9.00E-03	NA	NA	7E-09	7E-09
Copper	6.29E+01	4.61E-08	NA	1.28E-05	NA	NA	NA	NA	NA	NA	NA
Lead	2.79E+02	2.05E-07	NA	5.67E-05	NA	NA	NA	NA	NA	NA	NA
Manganese	1.52E+02	1.11E-07	NA	3.09E-05	NA	NA	NA	NA	NA	NA	NA
Mercury	1.44E-01	1.06E-10	NA	2.93E-08	NA	NA	NA	NA	NA	NA	NA
Thallium	1.87E-01	1.37E-10	NA	3.80E-08	NA	NA	NA	NA	NA	NA	NA
Vanadium	3.62E+01	2.65E-08	NA	7.35E-06	NA	NA	NA	NA	NA	NA	NA
							Total	3E-08	8E-09	4E-07	5E-07

Table 6-45
Reasonable Maximum Exposure Doses and Hazard Quotients for Construction/Utility Worker Exposure to Aggregate Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		RME - Noncancer										
		Exposure Doses							Hazard Quotients			
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Primary Target Organ	Soil Ingestion	Dermal Contact	Inhalation	Hazard Index
Aroclor-1248	7.18E-02	4.87E-08	2.18E-08	3.85E-06	NA	NA	NA	---	NA	NA	NA	NA
Aroclor-1254	8.28E-02	5.61E-08	2.52E-08	4.44E-06	2.00E-05	2.00E-05	NA	Eyes, Immune system, Dermal	0.003	0.001	NA	0.004
Aroclor-1260	5.13E-02	3.48E-08	1.56E-08	2.75E-06	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)anthracene	1.44E+00	9.77E-07	4.07E-07	7.73E-05	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)pyrene	1.27E+00	8.59E-07	3.58E-07	6.79E-05	3.00E-04	3.00E-04	2.00E-06	Developmental	0.003	0.001	0.03	0.04
Benzo(b)fluoranthene	1.09E+00	7.39E-07	3.08E-07	5.85E-05	NA	NA	NA	---	NA	NA	NA	NA
Benzo(k)fluoranthene	7.57E-01	5.13E-07	2.14E-07	4.06E-05	NA	NA	NA	---	NA	NA	NA	NA
Chloroform	6.20E-03	4.20E-09	NA	3.32E-07	1.00E-02	1.00E-02	9.80E-02	Liver	0.0000004	NA	0.000000003	0.0000004
4,4-DDT	1.36E-01	9.22E-08	8.87E-09	7.29E-06	5.00E-04	5.00E-04	NA	Liver	0.0002	0.00002	NA	0.0002
Dibenz(a,h)anthracene	2.58E-01	1.75E-07	7.29E-08	1.38E-05	NA	NA	NA	---	NA	NA	NA	NA
Dibenzofuran	2.39E-01	1.62E-07	1.56E-08	1.28E-05	1.00E-03	1.00E-03	NA	Body Weight	0.0002	0.00002	NA	0.0002
Dieldrin	8.40E-03	5.70E-09	1.83E-09	4.50E-07	5.00E-05	5.00E-05	NA	Liver	0.0001	0.00004	NA	0.0002
Ethylbenzene	1.55E-01	1.05E-07	NA	8.31E-06	1.00E-01	1.00E-01	1.00E+00	Kidney, Liver	0.000001	NA	0.000000008	0.000001
Indeno(1,2,3-c,d)pyrene	5.00E-01	3.39E-07	1.41E-07	2.68E-05	NA	NA	NA	---	NA	NA	NA	NA
Naphthalene	4.01E-01	2.72E-07	1.13E-07	2.15E-05	2.00E-02	2.00E-02	3.00E-03	Body Weight	0.00001	0.000006	0.000007	0.00003
Pentachlorophenol	2.00E+00	1.36E-06	1.09E-06	1.07E-04	5.00E-03	5.00E-03	NA	Liver	0.0003	0.0002	NA	0.0005
Trichloroethylene	1.41E-01	9.56E-08	NA	7.56E-06	5.00E-04	5.00E-04	2.00E-03	Ranges from immune effects to heart effects	0.0002	NA	0.000004	0.0002
Vinyl chloride	1.20E-02	8.14E-09	NA	6.43E-07	3.00E-03	3.00E-03	1.00E-01	Liver	0.000003	NA	0.000000006	0.000003
Xylenes, Total	1.58E+00	1.07E-06	NA	8.47E-05	2.00E-01	2.00E-01	1.00E-01	Body weight, Mortality	0.000005	NA	0.000001	0.000006
Aluminum	6.79E+03	4.61E-03	NA	3.64E-01	1.00E+00	1.00E+00	5.00E-03	Nervous system	0.005	NA	0.07	0.08
Antimony	3.92E+00	2.66E-06	NA	2.10E-04	4.00E-04	6.00E-05	NA	Blood	0.007	NA	NA	0.007
Arsenic	2.16E+01	8.80E-06	1.41E-06	1.16E-03	3.00E-04	3.00E-04	1.50E-05	Reproductive	0.03	0.005	0.08	0.1
Chromium	2.44E+01	1.66E-05	NA	1.31E-03	3.00E-03	7.50E-05	1.00E-04	None observed	0.006	NA	0.01	0.02
Cobalt	3.76E+00	2.55E-06	NA	2.02E-04	3.00E-04	3.00E-04	6.00E-06	Thyroid	0.009	NA	0.03	0.04
Copper	6.29E+01	4.26E-05	NA	3.37E-03	4.00E-02	4.00E-02	NA	Gastrointestinal tract	0.001	NA	NA	0.001
Lead	2.79E+02	1.89E-04	NA	1.50E-02	NA	NA	NA	---	NA	NA	NA	NA
Manganese	1.52E+02	1.03E-04	NA	8.15E-03	2.40E-02	9.60E-04	5.00E-05	Nervous system	0.004	NA	0.2	0.2
Mercury	1.44E-01	9.76E-08	NA	7.72E-06	3.00E-04	2.10E-05	3.00E-04	Immune System	0.0003	NA	0.00003	0.0004
Thallium	1.87E-01	1.27E-07	NA	1.00E-05	1.00E-05	1.00E-05	NA	Hair	0.01	NA	NA	0.01
Vanadium	3.62E+01	2.45E-05	NA	1.94E-03	5.00E-03	1.30E-04	1.00E-04	Hair	0.005	NA	0.02	0.02
								Total	0.08	0.007	0.4	0.5

Table 6-46
Central Tendency Exposure Doses and Hazard Quotients for Construction/Utility Worker Exposure to Aggregate Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		CTE - Noncancer									
		Exposure Doses						Hazard Quotients			
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Inhalation (µg/m^3)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Primary Target Organ	Soil Ingestion	Dermal Contact	Inhalation	Hazard Index
Aroclor-1248	7.18E-02	3.69E-09	3.64E-09	1.02E-06	NA	NA	NA	---	NA	NA	NA	NA
Aroclor-1254	8.28E-02	4.25E-09	4.20E-09	1.18E-06	2.00E-05	2.00E-05	NA	Eyes, Immune system, Dermal	0.0002	0.0002	NA	0.0004
Aroclor-1260	5.13E-02	2.64E-09	2.60E-09	7.30E-07	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)anthracene	1.44E+00	7.40E-08	6.79E-08	2.05E-05	NA	NA	NA	---	NA	NA	NA	NA
Benzo(a)pyrene	1.27E+00	6.51E-08	5.97E-08	1.80E-05	3.00E-04	3.00E-04	2.00E-06	Developmental	0.0002	0.0002	0.009	0.009
Benzo(b)fluoranthene	1.09E+00	5.60E-08	5.13E-08	1.55E-05	NA	NA	NA	---	NA	NA	NA	NA
Benzo(k)fluoranthene	7.57E-01	3.89E-08	3.57E-08	1.08E-05	NA	NA	NA	---	NA	NA	NA	NA
Chloroform	6.20E-03	3.18E-10	NA	8.82E-08	1.00E-02	1.00E-02	9.80E-02	Liver	0.00000003	NA	0.0000000009	0.00000003
4,4-DDT	1.36E-01	6.99E-09	1.48E-09	1.93E-06	5.00E-04	5.00E-04	NA	Liver	0.00001	0.000003	NA	0.00002
Dibenz(a,h)anthracene	2.58E-01	1.33E-08	1.22E-08	3.67E-06	NA	NA	NA	---	NA	NA	NA	NA
Dibenzofuran	2.39E-01	1.23E-08	2.60E-09	3.40E-06	1.00E-03	1.00E-03	NA	Body Weight	0.00001	0.000003	NA	0.00001
Dieldrin	8.40E-03	4.32E-10	3.04E-10	1.19E-07	5.00E-05	5.00E-05	NA	Liver	0.000009	0.000006	NA	0.00001
Ethylbenzene	1.55E-01	7.96E-09	NA	2.20E-06	1.00E-01	1.00E-01	1.00E+00	Kidney, Liver	0.00000008	NA	0.000000002	0.00000008
Indeno(1,2,3-c,d)pyrene	5.00E-01	2.57E-08	2.36E-08	7.11E-06	NA	NA	NA	---	NA	NA	NA	NA
Naphthalene	4.01E-01	2.06E-08	1.89E-08	5.70E-06	2.00E-02	2.00E-02	3.00E-03	Body Weight	0.000001	0.0000009	0.000002	0.000004
Pentachlorophenol	2.00E+00	1.03E-07	1.81E-07	2.84E-05	5.00E-03	5.00E-03	NA	Liver	0.00002	0.00004	NA	0.00006
Trichloroethylene	1.41E-01	7.24E-09	NA	2.01E-06	5.00E-04	5.00E-04	2.00E-03	Ranges from immune effects to heart effects	0.00001	NA	0.000001	0.00002
Vinyl chloride	1.20E-02	6.16E-10	NA	1.71E-07	3.00E-03	3.00E-03	1.00E-01	Liver	0.0000002	NA	0.000000002	0.0000002
Xylenes, Total	1.58E+00	8.11E-08	NA	2.25E-05	2.00E-01	2.00E-01	1.00E-01	Body weight, Mortality	0.0000004	NA	0.0000002	0.0000006
Aluminum	6.79E+03	3.49E-04	NA	9.66E-02	1.00E+00	1.00E+00	5.00E-03	Nervous system	0.0003	NA	0.02	0.02
Antimony	3.92E+00	2.01E-07	NA	5.57E-05	4.00E-04	6.00E-05	NA	Blood	0.0005	NA	NA	0.0005
Arsenic	2.16E+01	6.66E-07	2.35E-07	3.07E-04	3.00E-04	3.00E-04	1.50E-05	Reproductive	0.002	0.0008	0.02	0.02
Chromium	2.44E+01	1.26E-06	NA	3.48E-04	3.00E-03	7.50E-05	1.00E-04	None observed	0.0004	NA	0.003	0.004
Cobalt	3.76E+00	1.93E-07	NA	5.35E-05	3.00E-04	3.00E-04	6.00E-06	Thyroid	0.0006	NA	0.009	0.01
Copper	6.29E+01	3.23E-06	NA	8.94E-04	4.00E-02	4.00E-02	NA	Gastrointestinal tract	0.00008	NA	NA	0.00008
Lead	2.79E+02	1.43E-05	NA	3.97E-03	NA	NA	NA	---	NA	NA	NA	NA
Manganese	1.52E+02	7.80E-06	NA	2.16E-03	2.40E-02	9.60E-04	5.00E-05	Nervous system	0.0003	NA	0.04	0.04
Mercury	1.44E-01	7.40E-09	NA	2.05E-06	3.00E-04	2.10E-05	3.00E-04	Immune System	0.00002	NA	0.000007	0.00003
Thallium	1.87E-01	9.61E-09	NA	2.66E-06	1.00E-05	1.00E-05	NA	Hair	0.001	NA	NA	0.001
Vanadium	3.62E+01	1.86E-06	NA	5.14E-04	5.00E-03	1.30E-04	1.00E-04	Hair	0.0004	NA	0.005	0.006
								Total	0.006	0.001	0.11	0.1

Table 6-47
Reasonable Maximum Exposure Doses and Cancer Risks for Indoor Worker Exposure to Surface Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		RME - Cancer						
		Exposure Doses				Cancer Risks		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral CSF $(mg/kg\text{-}day)^{-1}$	IUR $(\mu g/m^3)^{-1}$	Soil Ingestion	Inhalation	Total
Aroclor-1248	7.00E-02	1.07E-08	2.15E-09	2.00E+00	5.70E-04	2E-08	1E-12	2E-08
Aroclor-1260	8.10E-02	1.24E-08	2.49E-09	2.00E+00	5.70E-04	2E-08	1E-12	2E-08
Benzo(a)anthracene	4.76E-01	7.28E-08	1.47E-08	1.00E-01	6.00E-05	7E-09	9E-13	7E-09
Benzo(a)pyrene	5.16E-01	7.89E-08	1.59E-08	1.00E+00	6.00E-04	8E-08	1E-11	8E-08
Benzo(b)fluoranthene	6.38E-01	9.75E-08	1.96E-08	1.00E-01	6.00E-05	1E-08	1E-12	1E-08
Dibenz(a,h)anthracene	1.98E-01	3.03E-08	6.10E-09	1.00E+00	6.00E-04	3E-08	4E-12	3E-08
Indeno(1,2,3-c,d)pyrene	2.90E-01	4.43E-08	8.93E-09	1.00E-01	6.00E-05	4E-09	5E-13	4E-09
Pentachlorophenol	1.90E+00	2.90E-07	5.85E-08	4.00E-01	5.10E-06	1E-07	3E-13	1E-07
Trichloroethylene	5.33E-02	8.15E-09	1.64E-09	9.30E-03	1.00E-06	8E-11	2E-15	8E-11
Aluminum	7.93E+03	1.21E-03	2.44E-04	NA	NA	NA	NA	NA
Antimony	4.30E+00	6.58E-07	1.32E-07	NA	NA	NA	NA	NA
Arsenic	3.85E+01	3.53E-06	1.19E-06	1.50E+00	4.30E-03	5E-06	5E-09	5E-06
Chromium	4.52E+01	6.91E-06	1.39E-06	5.00E-01	8.40E-02	3E-06	1E-07	4E-06
Cobalt	7.30E+00	1.12E-06	2.25E-07	NA	9.00E-03	NA	2E-09	2E-09
Copper	8.44E+01	1.29E-05	2.60E-06	NA	NA	NA	NA	NA
Lead	4.12E+02	6.29E-05	1.27E-05	NA	NA	NA	NA	NA
Manganese	3.80E+02	5.81E-05	1.17E-05	NA	NA	NA	NA	NA
Mercury	2.52E-01	3.85E-08	7.76E-09	NA	NA	NA	NA	NA
Thallium	2.60E-01	3.98E-08	8.00E-09	NA	NA	NA	NA	NA
					Total	9E-06	1E-07	9E-06

Table 6-48
Central Tendency Exposure Doses and Cancer Risks for Indoor Worker Exposure to Surface Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		CTE - Cancer						
		Exposure Doses				Cancer Risks		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral CSF $(mg/kg\text{-}day)^{-1}$	IUR $(\mu g/m^3)^{-1}$	Soil Ingestion	Inhalation	Total
Aroclor-1248	7.00E-02	6.42E-10	2.59E-10	2.00E+00	5.70E-04	1E-09	1E-13	1E-09
Aroclor-1260	8.10E-02	7.43E-10	2.99E-10	2.00E+00	5.70E-04	1E-09	2E-13	1E-09
Benzo(a)anthracene	4.76E-01	4.37E-09	1.76E-09	1.00E-01	6.00E-05	4E-10	1E-13	4E-10
Benzo(a)pyrene	5.16E-01	4.73E-09	1.91E-09	1.00E+00	6.00E-04	5E-09	1E-12	5E-09
Benzo(b)fluoranthene	6.38E-01	5.85E-09	2.36E-09	1.00E-01	6.00E-05	6E-10	1E-13	6E-10
Dibenz(a,h)anthracene	1.98E-01	1.82E-09	7.31E-10	1.00E+00	6.00E-04	2E-09	4E-13	2E-09
Indeno(1,2,3-c,d)pyrene	2.90E-01	2.66E-09	1.07E-09	1.00E-01	6.00E-05	3E-10	6E-14	3E-10
Pentachlorophenol	1.90E+00	1.74E-08	7.02E-09	4.00E-01	5.10E-06	7E-09	4E-14	7E-09
Trichloroethylene	5.33E-02	4.89E-10	1.97E-10	9.30E-03	1.00E-06	5E-12	2E-16	5E-12
Aluminum	7.93E+03	7.28E-05	2.93E-05	NA	NA	NA	NA	NA
Antimony	4.30E+00	3.95E-08	1.59E-08	NA	NA	NA	NA	NA
Arsenic	3.85E+01	2.12E-07	1.42E-07	1.50E+00	4.30E-03	3E-07	6E-10	3E-07
Chromium	4.52E+01	4.15E-07	1.67E-07	5.00E-01	8.40E-02	2E-07	1E-08	2E-07
Cobalt	7.30E+00	6.70E-08	2.70E-08	NA	9.00E-03	NA	2E-10	2E-10
Copper	8.44E+01	7.74E-07	3.12E-07	NA	NA	NA	NA	NA
Lead	4.12E+02	3.77E-06	1.52E-06	NA	NA	NA	NA	NA
Manganese	3.80E+02	3.48E-06	1.40E-06	NA	NA	NA	NA	NA
Mercury	2.52E-01	2.31E-09	9.31E-10	NA	NA	NA	NA	NA
Thallium	2.60E-01	2.39E-09	9.60E-10	NA	NA	NA	NA	NA
					Total	5E-07	1E-08	6E-07

Table 6-49
Reasonable Maximum Exposure Doses and Hazard Quotients for Indoor Worker Exposure to Surface Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		RME - Noncancer							
		Exposure Doses					Hazard Quotients		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Primary Target Organ	Soil Ingestion	Inhalation	Hazard Index
Aroclor-1248	7.00E-02	3.00E-08	6.03E-09	NA	NA	---	NA	NA	NA
Aroclor-1260	8.10E-02	3.47E-08	6.98E-09	NA	NA	---	NA	NA	NA
Benzo(a)anthracene	4.76E-01	2.04E-07	4.10E-08	NA	NA	---	NA	NA	NA
Benzo(a)pyrene	5.16E-01	2.21E-07	4.45E-08	3.00E-04	2.00E-06	Developmental	0.0007	0.00002	0.0008
Benzo(b)fluoranthene	6.38E-01	2.73E-07	5.50E-08	NA	NA	---	NA	NA	NA
Dibenz(a,h)anthracene	1.98E-01	8.48E-08	1.71E-08	NA	NA	---	NA	NA	NA
Indeno(1,2,3-c,d)pyrene	2.90E-01	1.24E-07	2.50E-08	NA	NA	---	NA	NA	NA
Pentachlorophenol	1.90E+00	8.13E-07	1.64E-07	5.00E-03	NA	Liver	0.0002	NA	0.0002
Trichloroethylene	5.33E-02	2.28E-08	4.59E-09	5.00E-04	2.00E-03	Ranges from immune effects to heart effects	0.00005	0.000000002	0.00005
Aluminum	7.93E+03	3.40E-03	6.84E-04	1.00E+00	5.00E-03	system	0.003	0.0001	0.004
Antimony	4.30E+00	1.84E-06	3.71E-07	4.00E-04	NA	Blood	0.005	NA	0.005
Arsenic	3.85E+01	9.89E-06	3.32E-06	3.00E-04	1.50E-05	Reproductive	0.03	0.0002	0.03
Chromium	4.52E+01	1.94E-05	3.90E-06	3.00E-03	1.00E-04	None observed	0.006	0.00004	0.006
Cobalt	7.30E+00	3.12E-06	6.29E-07	3.00E-04	6.00E-06	Thyroid	0.01	0.0001	0.01
Copper	8.44E+01	3.61E-05	7.28E-06	4.00E-02	NA	Gastrointestinal tract	0.0009	NA	0.0009
Lead	4.12E+02	1.76E-04	3.55E-05	NA	NA	---	NA	NA	NA
Manganese	3.80E+02	1.63E-04	3.27E-05	2.40E-02	5.00E-05	system	0.007	0.0007	0.007
Mercury	2.52E-01	1.08E-07	2.17E-08	3.00E-04	3.00E-04	Immune System	0.0004	0.00000007	0.0004
Thallium	2.60E-01	1.11E-07	2.24E-08	1.00E-05	NA	Hair	0.01	NA	0.01
						Total	0.08	0.001	0.08

Table 6-50
Central Tendency Exposure Doses and Hazard Quotients for Indoor Worker Exposure to Surface Soil - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		CTE - Noncancer							
		Exposure Doses					Hazard Quotients		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Inhalation ($\mu g/m^3$)	Oral RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Primary Target Organ	Soil Ingestion	Inhalation	Hazard Index
Aroclor-1248	7.00E-02	3.75E-09	1.51E-09	NA	NA	---	NA	NA	NA
Aroclor-1260	8.10E-02	4.33E-09	1.75E-09	NA	NA	---	NA	NA	NA
Benzo(a)anthracene	4.76E-01	2.55E-08	1.03E-08	NA	NA	---	NA	NA	NA
Benzo(a)pyrene	5.16E-01	2.76E-08	1.11E-08	3.00E-04	2.00E-06	Developmental	0.00009	0.000006	0.0001
Benzo(b)fluoranthene	6.38E-01	3.41E-08	1.37E-08	NA	NA	---	NA	NA	NA
Dibenz(a,h)anthracene	1.98E-01	1.06E-08	4.27E-09	NA	NA	---	NA	NA	NA
Indeno(1,2,3-c,d)pyrene	2.90E-01	1.55E-08	6.25E-09	NA	NA	---	NA	NA	NA
Pentachlorophenol	1.90E+00	1.02E-07	4.09E-08	5.00E-03	NA	Liver	0.00002	NA	0.00002
Trichloroethylene	5.33E-02	2.85E-09	1.15E-09	5.00E-04	2.00E-03	Ranges from immune effects to heart effects	0.000006	0.0000000006	0.000006
Aluminum	7.93E+03	4.24E-04	1.71E-04	1.00E+00	5.00E-03	system	0.0004	0.00003	0.0005
Antimony	4.30E+00	2.30E-07	9.27E-08	4.00E-04	NA	Blood	0.0006	NA	0.0006
Arsenic	3.85E+01	1.24E-06	8.30E-07	3.00E-04	1.50E-05	Reproductive	0.004	0.00006	0.004
Chromium	4.52E+01	2.42E-06	9.74E-07	3.00E-03	1.00E-04	None observed	0.0008	0.00001	0.0008
Cobalt	7.30E+00	3.91E-07	1.57E-07	3.00E-04	6.00E-06	Thyroid	0.001	0.00003	0.001
Copper	8.44E+01	4.52E-06	1.82E-06	4.00E-02	NA	Gastrointestinal tract	0.0001	NA	0.0001
Lead	4.12E+02	2.20E-05	8.87E-06	NA	NA	---	NA	NA	NA
Manganese	3.80E+02	2.03E-05	8.18E-06	2.40E-02	5.00E-05	system	0.0008	0.0002	0.001
Mercury	2.52E-01	1.35E-08	5.43E-09	3.00E-04	3.00E-04	Immune System	0.00004	0.00000002	0.00004
Thallium	2.60E-01	1.39E-08	5.60E-09	1.00E-05	NA	Hair	0.001	NA	0.001
						Total	0.01	0.0003	0.01

Table 6-51
Summary of RME Cancer Risks - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Receptor	Cancer Risk		
	Soil Ingestion	Dermal Contact with Soil	Total
Groundskeeper	6E-06	3E-06	9E-06
Child Resident	2E-04	5E-05	2E-04
Adult Resident	6E-06	3E-06	9E-06

Table 6-52
Summary of CTE Cancer Risks - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Receptor	Cancer Risk		
	Soil Ingestion	Dermal Contact with Soil	Total
Groundskeeper	4E-07	1E-07	5E-07
Child Resident	3E-06	1E-07	3E-06
Adult Resident	4E-06	2E-07	4E-06

Table 6-53
Summary of RME Hazard Indices - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Receptor	Hazard Index		Total
	Soil Ingestion	Dermal Contact with Soil	
Groundskeeper	0.1	0.02	0.1
Child Resident	1	0.3	2
Adult Resident	0.1	0.04	0.2

Table 6-54
Summary of CTE Hazard Indices - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Receptor	Hazard Index		Total
	Soil Ingestion	Dermal Contact with Soil	
Groundskeeper	0.01	0.002	0.01
Child Resident	0.2	0.03	0.2
Adult Resident	0.02	0.003	0.02

Table 6-55
Reasonable Maximum Exposure Doses and Cancer Risks for Child Resident Exposure to Soil/Sediment - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		RME - Cancer						
		Child Exposure Doses				Child Cancer Risks		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Dermal CSF $(mg/kg\text{-}day)^{-1}$	Soil Ingestion	Dermal Contact	Total
Aldrin	5.43E-02	9.51E-09	NA	1.70E+01	1.70E+01	2E-07	NA	2E-07
Benzo(a)anthracene	1.25E+02	Mutagenic mode of action; See Table 6-63		1.00E-01	1.00E-01	1E-05	4E-06	2E-05
Benzo(a)pyrene	1.11E+02	Mutagenic mode of action; See Table 6-63		1.00E+00	1.00E+00	1E-04	3E-05	1E-04
Benzo(b)fluoranthene	1.49E+02	Mutagenic mode of action; See Table 6-63		1.00E-01	1.00E-01	1E-05	4E-06	2E-05
Benzo(k)fluoranthene	6.83E+01	Mutagenic mode of action; See Table 6-63		1.00E-02	1.00E-02	6E-07	2E-07	8E-07
Carbazole	1.34E+02	2.34E-05	7.22E-06	NA	NA	NA	NA	NA
gamma-Chlordane	2.40E-01	4.21E-08	3.99E-09	3.50E-01	3.50E-01	1E-08	1E-09	2E-08
Chrysene	1.41E+02	Mutagenic mode of action; See Table 6-63		1.00E-03	1.00E-03	1E-07	4E-08	2E-07
Dibenz(a,h)anthracene	1.04E+01	Mutagenic mode of action; See Table 6-63		1.00E+00	1.00E+00	1E-05	3E-06	1E-05
Dibenzofuran	4.48E+01	7.85E-06	5.59E-07	NA	NA	NA	NA	NA
Fluoranthene	3.75E+02	6.57E-05	2.03E-05	NA	NA	NA	NA	NA
Heptachlor epoxide	2.22E+00	3.89E-07	NA	9.10E+00	9.10E+00	4E-06	NA	4E-06
Indeno(1,2,3-c,d)pyrene	7.30E+01	Mutagenic mode of action; See Table 6-63		1.00E-01	1.00E-01	7E-06	2E-06	9E-06
1-Methylnaphthalene	2.02E+01	3.53E-06	1.09E-06	2.90E-02	2.90E-02	1E-07	3E-08	1E-07
2-Methylnaphthalene	6.32E+00	1.11E-06	3.42E-07	NA	NA	NA	NA	NA
Naphthalene	1.46E+01	2.55E-06	7.88E-07	NA	NA	NA	NA	NA
Phenanthrene	3.24E+02	5.67E-05	1.75E-05	NA	NA	NA	NA	NA
Pyrene	2.90E+02	5.09E-05	1.57E-05	NA	NA	NA	NA	NA
Antimony	8.67E-01	1.52E-07	NA	NA	NA	NA	NA	NA
Arsenic	1.13E+01	1.19E-06	1.41E-07	1.50E+00	1.50E+00	2E-06	2E-07	2E-06
Chromium	1.24E+01	Mutagenic mode of action; See Table 6-63		5.00E-01	2.00E+01	6E-06	NA	6E-06
Cobalt	2.84E+00	4.97E-07	NA	NA	NA	NA	NA	NA
Lead	1.02E+02	1.79E-05	NA	NA	NA	NA	NA	NA
						2E-04	5E-05	2E-04

Table 6-56
Central Tendency Exposure Doses and Cancer Risks for Child Resident Exposure to Soil/Sediment - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		CTE - Cancer						
		Child Exposure Doses				Child Cancer Risks		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Dermal CSF $(mg/kg\text{-}day)^{-1}$	Soil Ingestion	Dermal Contact	Total
Aldrin	5.43E-02	1.19E-09	NA	1.70E+01	1.70E+01	2E-08	NA	2E-08
Benzo(a)anthracene	1.25E+02	Mutagenic mode of action; See Table 6-64		1.00E-01	1.00E-01	2E-08	5E-09	2E-08
Benzo(a)pyrene	1.11E+02	Mutagenic mode of action; See Table 6-64		1.00E+00	1.00E+00	1E-07	4E-08	2E-07
Benzo(b)fluoranthene	1.49E+02	Mutagenic mode of action; See Table 6-64		1.00E-01	1.00E-01	1E-08	4E-09	2E-08
Benzo(k)fluoranthene	6.83E+01	Mutagenic mode of action; See Table 6-64		1.00E-02	1.00E-02	9E-10	2E-10	1E-09
Carbazole	1.34E+02	2.93E-06	7.22E-07	NA	NA	NA	NA	NA
gamma-Chlordane	2.40E-01	5.26E-09	3.99E-10	3.50E-01	3.50E-01	2E-09	1E-10	2E-09
Chrysene	1.41E+02	Mutagenic mode of action; See Table 6-64		1.00E-03	1.00E-03	NA	NA	NA
Dibenz(a,h)anthracene	1.04E+01	2.29E-07	5.64E-08	1.00E+00	1.00E+00	2E-07	6E-08	3E-07
Dibenzofuran	4.48E+01	9.81E-07	5.59E-08	NA	NA	NA	NA	NA
Fluoranthene	3.75E+02	8.21E-06	2.03E-06	NA	NA	NA	NA	NA
Heptachlor epoxide	2.22E+00	4.86E-08	NA	9.10E+00	9.10E+00	4E-07	NA	4E-07
Indeno(1,2,3-c,d)pyrene	7.30E+01	Mutagenic mode of action; See Table 6-64		1.00E-01	1.00E-01	6E-09	2E-09	7E-09
1-Methylnaphthalene	2.02E+01	4.42E-07	1.09E-07	2.90E-02	2.90E-02	1E-08	3E-09	2E-08
2-Methylnaphthalene	6.32E+00	1.39E-07	3.42E-08	NA	NA	NA	NA	NA
Naphthalene	1.46E+01	3.19E-07	7.88E-08	NA	NA	NA	NA	NA
Phenanthrene	3.24E+02	7.09E-06	1.75E-06	NA	NA	NA	NA	NA
Pyrene	2.90E+02	6.36E-06	1.57E-06	NA	NA	NA	NA	NA
Antimony	8.67E-01	1.90E-08	NA	NA	NA	NA	NA	NA
Arsenic	1.13E+01	1.49E-07	1.41E-08	1.50E+00	1.50E+00	2E-07	2E-08	2E-07
Chromium	1.24E+01	Mutagenic mode of action; See Table 6-64		5.00E-01	2.00E+01	1E-06	NA	1E-06
Cobalt	2.84E+00	6.22E-08	NA	NA	NA	NA	NA	NA
Lead	1.02E+02	2.24E-06	NA	NA	NA	NA	NA	NA
						3E-06	1E-07	3E-06

Table 6-57
Reasonable Maximum Exposure Doses and Cancer Risks for Adult Resident Exposure to Soil/Sediment - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		RME - Cancer						
		Adult Exposure Doses				Adult Cancer Risks		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Dermal CSF $(mg/kg\text{-}day)^{-1}$	Soil Ingestion	Dermal Contact	Total
Aldrin	5.43E-02	2.97E-09	NA	1.70E+01	1.70E+01	5E-08	NA	5E-08
Benzo(a)anthracene	1.25E+02	Mutagenic mode of action; See Table 6-65		1.00E-01	1.00E-01	3E-07	2E-07	5E-07
Benzo(a)pyrene	1.11E+02	Mutagenic mode of action; See Table 6-65		1.00E+00	1.00E+00	3E-06	2E-06	5E-06
Benzo(b)fluoranthene	1.49E+02	Mutagenic mode of action; See Table 6-65		1.00E-01	1.00E-01	4E-07	2E-07	6E-07
Benzo(k)fluoranthene	6.83E+01	Mutagenic mode of action; See Table 6-65		1.00E-02	1.00E-02	2E-08	1E-08	3E-08
Carbazole	1.34E+02	7.32E-06	4.02E-06	NA	NA	NA	NA	NA
gamma-Chlordane	2.40E-01	1.32E-08	2.22E-09	3.50E-01	3.50E-01	5E-09	8E-10	5E-09
Chrysene	1.41E+02	Mutagenic mode of action; See Table 6-65		1.00E-03	1.00E-03	4E-09	2E-09	6E-09
Dibenz(a,h)anthracene	1.04E+01	5.72E-07	3.14E-07	1.00E+00	1.00E+00	6E-07	3E-07	9E-07
Dibenzofuran	4.48E+01	2.45E-06	3.11E-07	NA	NA	NA	NA	NA
Fluoranthene	3.75E+02	2.05E-05	1.13E-05	NA	NA	NA	NA	NA
Heptachlor epoxide	2.22E+00	1.21E-07	NA	9.10E+00	9.10E+00	1E-06	NA	1E-06
Indeno(1,2,3-c,d)pyrene	7.30E+01	Mutagenic mode of action; See Table 6-65		1.00E-01	1.00E-01	2E-07	1E-07	3E-07
1-Methylnaphthalene	2.02E+01	1.10E-06	6.06E-07	2.90E-02	2.90E-02	3E-08	2E-08	5E-08
2-Methylnaphthalene	6.32E+00	3.46E-07	1.90E-07	NA	NA	NA	NA	NA
Naphthalene	1.46E+01	7.98E-07	4.38E-07	NA	NA	NA	NA	NA
Phenanthrene	3.24E+02	1.77E-05	9.73E-06	NA	NA	NA	NA	NA
Pyrene	2.90E+02	1.59E-05	8.73E-06	NA	NA	NA	NA	NA
Antimony	8.67E-01	4.75E-08	NA	NA	NA	NA	NA	NA
Arsenic	1.13E+01	3.72E-07	7.86E-08	1.50E+00	1.50E+00	6E-07	1E-07	7E-07
Chromium	1.24E+01	Mutagenic mode of action; See Table 6-65		5.00E-01	2.00E+01	2E-07	NA	2E-07
Cobalt	2.84E+00	1.55E-07	NA	NA	NA	NA	NA	NA
Lead	1.02E+02	5.59E-06	NA	NA	NA	NA	NA	NA
						6E-06	3E-06	9E-06

Table 6-58
Central Tendency Exposure Doses and Cancer Risks for Adult Resident Exposure to Soil/Sediment - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		CTE - Cancer						
		Adult Exposure Doses				Adult Cancer Risks		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Dermal CSF $(mg/kg\text{-}day)^{-1}$	Soil Ingestion	Dermal Contact	Total
Aldrin	5.43E-02	1.19E-09	NA	1.70E+01	1.70E+01	2E-08	NA	2E-08
Benzo(a)anthracene	1.25E+02	2.73E-06	1.20E-07	1.00E-01	1.00E-01	3E-07	1E-08	3E-07
Benzo(a)pyrene	1.11E+02	2.43E-06	1.07E-07	1.00E+00	1.00E+00	2E-06	1E-07	3E-06
Benzo(b)fluoranthene	1.49E+02	3.26E-06	1.44E-07	1.00E-01	1.00E-01	3E-07	1E-08	3E-07
Benzo(k)fluoranthene	6.83E+01	1.50E-06	6.60E-08	1.00E-02	1.00E-02	1E-08	7E-10	2E-08
Carbazole	1.34E+02	2.93E-06	1.29E-07	NA	NA	NA	NA	NA
gamma-Chlordane	2.40E-01	5.26E-09	7.14E-11	3.50E-01	3.50E-01	2E-09	2E-11	2E-09
Chrysene	1.41E+02	3.08E-06	1.36E-07	1.00E-03	1.00E-03	3E-09	1E-10	3E-09
Dibenz(a,h)anthracene	1.04E+01	2.29E-07	1.01E-08	1.00E+00	1.00E+00	2E-07	1E-08	2E-07
Dibenzofuran	4.48E+01	9.81E-07	9.98E-09	NA	NA	NA	NA	NA
Fluoranthene	3.75E+02	8.21E-06	3.62E-07	NA	NA	NA	NA	NA
Heptachlor epoxide	2.22E+00	4.86E-08	NA	9.10E+00	9.10E+00	4E-07	NA	4E-07
Indeno(1,2,3-c,d)pyrene	7.30E+01	1.60E-06	7.06E-08	1.00E-01	1.00E-01	2E-07	7E-09	2E-07
1-Methylnaphthalene	2.02E+01	4.42E-07	1.95E-08	2.90E-02	2.90E-02	1E-08	6E-10	1E-08
2-Methylnaphthalene	6.32E+00	1.39E-07	6.11E-09	NA	NA	NA	NA	NA
Naphthalene	1.46E+01	3.19E-07	1.41E-08	NA	NA	NA	NA	NA
Phenanthrene	3.24E+02	7.09E-06	3.13E-07	NA	NA	NA	NA	NA
Pyrene	2.90E+02	6.36E-06	2.81E-07	NA	NA	NA	NA	NA
Antimony	8.67E-01	1.90E-08	NA	NA	NA	NA	NA	NA
Arsenic	1.13E+01	1.49E-07	2.53E-09	1.50E+00	1.50E+00	2E-07	4E-09	2E-07
Chromium	1.24E+01	2.72E-07	NA	5.00E-01	2.00E+01	1E-07	NA	1E-07
Cobalt	2.84E+00	6.22E-08	NA	NA	NA	NA	NA	NA
Lead	1.02E+02	2.24E-06	NA	NA	NA	NA	NA	NA
						4E-06	2E-07	4E-06

Table 6-59
Reasonable Maximum Exposure Doses and Hazard Quotients for Child Resident Exposure to Soil/Sediment - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		RME - Noncancer							
		Child Exposure Doses					Child Hazard Quotients		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Primary Target Organ	Soil Ingestion	Dermal Contact	Hazard Index
Aldrin	5.43E-02	1.11E-07	NA	3.00E-05	3.00E-05	Liver	0.004	NA	0.004
Benzo(a)anthracene	1.25E+02	2.55E-04	7.86E-05	NA	NA	---	NA	NA	NA
Benzo(a)pyrene	1.11E+02	2.27E-04	6.99E-05	3.00E-04	3.00E-04	Developmental	0.8	0.2	1.0
Benzo(b)fluoranthene	1.49E+02	3.04E-04	9.38E-05	NA	NA	---	NA	NA	NA
Benzo(k)fluoranthene	6.83E+01	1.40E-04	4.31E-05	NA	NA	---	NA	NA	NA
Carbazole	1.34E+02	2.73E-04	8.42E-05	NA	NA	---	NA	NA	NA
gamma-Chlordane	2.40E-01	4.91E-07	4.66E-08	5.00E-04	5.00E-04	Liver	0.001	0.00009	0.001
Chrysene	1.41E+02	2.87E-04	8.87E-05	NA	NA	---	NA	NA	NA
Dibenz(a,h)anthracene	1.04E+01	2.13E-05	6.58E-06	NA	NA	---	NA	NA	NA
Dibenzofuran	4.48E+01	9.15E-05	6.52E-06	1.00E-03	1.00E-03	Body Weight	0.09	0.01	0.1
Fluoranthene	3.75E+02	7.66E-04	2.36E-04	4.00E-02	4.00E-02	Kidney, Liver, Blood	0.02	0.006	0.03
Heptachlor epoxide	2.22E+00	4.54E-06	NA	1.30E-05	1.30E-05	Liver	0.3	NA	0.3
Indeno(1,2,3-c,d)pyrene	7.30E+01	1.49E-04	4.61E-05	NA	NA	---	NA	NA	NA
1-Methylnaphthalene	2.02E+01	4.12E-05	1.27E-05	7.00E-02	7.00E-02	Respiratory system	0.0006	0.0002	0.0008
2-Methylnaphthalene	6.32E+00	1.29E-05	3.99E-06	4.00E-03	4.00E-03	Respiratory system	0.003	0.001	0.004
Naphthalene	1.46E+01	2.98E-05	9.19E-06	2.00E-02	2.00E-02	Body Weight	0.001	0.0005	0.002
Phenanthrene	3.24E+02	6.62E-04	2.04E-04	NA	NA	---	NA	NA	NA
Pyrene	2.90E+02	5.94E-04	1.83E-04	3.00E-02	3.00E-02	Kidney	0.02	0.006	0.03
Antimony	8.67E-01	1.77E-06	NA	4.00E-04	6.00E-05	Blood	0.004	NA	0.004
Arsenic	1.13E+01	1.39E-05	1.65E-06	3.00E-04	3.00E-04	Reproductive	0.05	0.005	0.05
Chromium	1.24E+01	2.54E-05	NA	3.00E-03	7.50E-05	None observed	0.008	NA	0.008
Cobalt	2.84E+00	5.80E-06	NA	3.00E-04	3.00E-04	Thyroid	0.02	NA	0.02
Lead	1.02E+02	2.09E-04	NA	NA	NA	---	NA	NA	NA
						Total	1	0.3	2

Table 6-60
Central Tendency Exposure Doses and Hazard Quotients for Child Resident Exposure to Soil/Sediment - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		CTE - Noncancer							
		Child Exposure Doses					Child Hazard Quotients		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Primary Target Organ	Soil Ingestion	Dermal Contact	Hazard Index
Aldrin	5.43E-02	1.39E-08	NA	3.00E-05	3.00E-05	Liver	0.0005	NA	0.0005
Benzo(a)anthracene	1.25E+02	3.18E-05	7.86E-06	NA	NA	---	NA	NA	NA
Benzo(a)pyrene	1.11E+02	2.83E-05	6.99E-06	3.00E-04	3.00E-04	Developmental	0.09	0.02	0.12
Benzo(b)fluoranthene	1.49E+02	3.80E-05	9.38E-06	NA	NA	---	NA	NA	NA
Benzo(k)fluoranthene	6.83E+01	1.75E-05	4.31E-06	NA	NA	---	NA	NA	NA
Carbazole	1.34E+02	3.41E-05	8.42E-06	NA	NA	---	NA	NA	NA
gamma-Chlordane	2.40E-01	6.14E-08	4.66E-09	5.00E-04	5.00E-04	Liver	0.0001	0.000009	0.0001
Chrysene	1.41E+02	3.59E-05	8.87E-06	NA	NA	---	NA	NA	NA
Dibenz(a,h)anthracene	1.04E+01	2.67E-06	6.58E-07	NA	NA	---	NA	NA	NA
Dibenzofuran	4.48E+01	1.14E-05	6.52E-07	1.00E-03	1.00E-03	Body Weight	0.01	0.00	0.01
Fluoranthene	3.75E+02	9.58E-05	2.36E-05	4.00E-02	4.00E-02	Kidney, Liver, Blood	0.002	0.0006	0.003
Heptachlor epoxide	2.22E+00	5.67E-07	NA	1.30E-05	1.30E-05	Liver	0.04	NA	0.04
Indeno(1,2,3-c,d)pyrene	7.30E+01	1.87E-05	4.61E-06	NA	NA	---	NA	NA	NA
1-Methylnaphthalene	2.02E+01	5.16E-06	1.27E-06	7.00E-02	7.00E-02	Respiratory system	0.00007	0.00002	0.00009
2-Methylnaphthalene	6.32E+00	1.62E-06	3.99E-07	4.00E-03	4.00E-03	Respiratory system	0.0004	0.0001	0.0005
Naphthalene	1.46E+01	3.73E-06	9.19E-07	2.00E-02	2.00E-02	Body Weight	0.0002	0.00005	0.0002
Phenanthrene	3.24E+02	8.27E-05	2.04E-05	NA	NA	---	NA	NA	NA
Pyrene	2.90E+02	7.43E-05	1.83E-05	3.00E-02	3.00E-02	Kidney	0.002	0.0006	0.003
Antimony	8.67E-01	2.22E-07	NA	4.00E-04	6.00E-05	Blood	0.0006	NA	0.0006
Arsenic	1.13E+01	1.74E-06	1.65E-07	3.00E-04	3.00E-04	Reproductive	0.006	0.0005	0.006
Chromium	1.24E+01	3.17E-06	NA	3.00E-03	7.50E-05	None observed	0.001	NA	0.001
Cobalt	2.84E+00	7.25E-07	NA	3.00E-04	3.00E-04	Thyroid	0.002	NA	0.002
Lead	1.02E+02	2.61E-05	NA	NA	NA	---	NA	NA	NA
						Total	0.2	0.03	0.2

Table 6-61
Reasonable Maximum Exposure Doses and Hazard Quotients for Adult Resident Exposure to Soil/Sediment - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		RME - Noncancer							
		Adult Exposure Doses					Adult Hazard Quotients		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Primary Target Organ	Soil Ingestion	Dermal Contact	Hazard Index
Aldrin	5.43E-02	1.04E-08	NA	3.00E-05	3.00E-05	Liver	0.0003	NA	0.0003
Benzo(a)anthracene	1.25E+02	2.39E-05	1.31E-05	NA	NA	---	NA	NA	NA
Benzo(a)pyrene	1.11E+02	2.12E-05	1.17E-05	3.00E-04	3.00E-04	Developmental	0.07	0.04	0.1
Benzo(b)fluoranthene	1.49E+02	2.85E-05	1.56E-05	NA	NA	---	NA	NA	NA
Benzo(k)fluoranthene	6.83E+01	1.31E-05	7.19E-06	NA	NA	---	NA	NA	NA
Carbazole	1.34E+02	2.56E-05	1.41E-05	NA	NA	---	NA	NA	NA
gamma-Chlordane	2.40E-01	4.60E-08	7.77E-09	5.00E-04	5.00E-04	Liver	0.00009	0.00002	0.0001
Chrysene	1.41E+02	2.69E-05	1.48E-05	NA	NA	---	NA	NA	NA
Dibenz(a,h)anthracene	1.04E+01	2.00E-06	1.10E-06	NA	NA	---	NA	NA	NA
Dibenzofuran	4.48E+01	8.58E-06	1.09E-06	1.00E-03	1.00E-03	Body Weight	0.01	0.00	0.01
Fluoranthene	3.75E+02	7.18E-05	3.94E-05	4.00E-02	4.00E-02	Kidney, Liver, Blood	0.002	0.001	0.003
Heptachlor epoxide	2.22E+00	4.25E-07	NA	1.30E-05	1.30E-05	Liver	0.03	NA	0.03
Indeno(1,2,3-c,d)pyrene	7.30E+01	1.40E-05	7.68E-06	NA	NA	---	NA	NA	NA
1-Methylnaphthalene	2.02E+01	3.87E-06	2.12E-06	7.00E-02	7.00E-02	Respiratory system	0.00006	0.00003	0.00009
2-Methylnaphthalene	6.32E+00	1.21E-06	6.66E-07	4.00E-03	4.00E-03	Respiratory system	0.0003	0.0002	0.0005
Naphthalene	1.46E+01	2.79E-06	1.53E-06	2.00E-02	2.00E-02	Body Weight	0.0001	0.00008	0.0002
Phenanthrene	3.24E+02	6.20E-05	3.41E-05	NA	NA	---	NA	NA	NA
Pyrene	2.90E+02	5.57E-05	3.06E-05	3.00E-02	3.00E-02	Kidney	0.002	0.001	0.003
Antimony	8.67E-01	1.66E-07	NA	4.00E-04	6.00E-05	Blood	0.0004	NA	0.0004
Arsenic	1.13E+01	1.30E-06	2.75E-07	3.00E-04	3.00E-04	Reproductive	0.004	0.0009	0.005
Chromium	1.24E+01	2.38E-06	NA	3.00E-03	7.50E-05	None observed	0.0008	NA	0.0008
Cobalt	2.84E+00	5.44E-07	NA	3.00E-04	3.00E-04	Thyroid	0.002	NA	0.002
Lead	1.02E+02	1.96E-05	NA	NA	NA	---	NA	NA	NA
						Total	0.1	0.04	0.2

Table 6-62
Central Tendency Exposure Doses and Hazard Quotients for Adult Resident Exposure to Soil/Sediment - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		CTE - Noncancer							
		Adult Exposure Doses					Adult Hazard Quotients		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Primary Target Organ	Soil Ingestion	Dermal Contact	Hazard Index
Aldrin	5.43E-02	1.30E-09	NA	3.00E-05	3.00E-05	Liver	0.00004	NA	0.00004
Benzo(a)anthracene	1.25E+02	2.98E-06	9.36E-07	NA	NA	---	NA	NA	NA
Benzo(a)pyrene	1.11E+02	2.66E-06	8.33E-07	3.00E-04	3.00E-04	Developmental	0.01	0.003	0.01
Benzo(b)fluoranthene	1.49E+02	3.56E-06	1.12E-06	NA	NA	---	NA	NA	NA
Benzo(k)fluoranthene	6.83E+01	1.64E-06	5.14E-07	NA	NA	---	NA	NA	NA
Carbazole	1.34E+02	3.20E-06	1.00E-06	NA	NA	---	NA	NA	NA
gamma-Chlordane	2.40E-01	5.75E-09	5.55E-10	5.00E-04	5.00E-04	Liver	0.00001	0.000001	0.00001
Chrysene	1.41E+02	3.37E-06	1.06E-06	NA	NA	---	NA	NA	NA
Dibenz(a,h)anthracene	1.04E+01	2.50E-07	7.84E-08	NA	NA	---	NA	NA	NA
Dibenzofuran	4.48E+01	1.07E-06	7.77E-08	1.00E-03	1.00E-03	Body Weight	0.00	0.00	0.00
Fluoranthene	3.75E+02	8.98E-06	2.82E-06	4.00E-02	4.00E-02	Kidney, Liver, Blood	0.0002	0.00007	0.0003
Heptachlor epoxide	2.22E+00	5.31E-08	NA	1.30E-05	1.30E-05	Liver	0.004	NA	0.004
Indeno(1,2,3-c,d)pyrene	7.30E+01	1.75E-06	5.49E-07	NA	NA	---	NA	NA	NA
1-Methylnaphthalene	2.02E+01	4.83E-07	1.52E-07	7.00E-02	7.00E-02	Respiratory system	0.000007	0.000002	0.000009
2-Methylnaphthalene	6.32E+00	1.52E-07	4.75E-08	4.00E-03	4.00E-03	Respiratory system	0.00004	0.00001	0.00005
Naphthalene	1.46E+01	3.49E-07	1.10E-07	2.00E-02	2.00E-02	Body Weight	0.00002	0.000005	0.00002
Phenanthrene	3.24E+02	7.76E-06	2.43E-06	NA	NA	---	NA	NA	NA
Pyrene	2.90E+02	6.96E-06	2.18E-06	3.00E-02	3.00E-02	Kidney	0.0002	0.00007	0.0003
Antimony	8.67E-01	2.08E-08	NA	4.00E-04	6.00E-05	Blood	0.00005	NA	0.00005
Arsenic	1.13E+01	1.63E-07	1.97E-08	3.00E-04	3.00E-04	Reproductive	0.0005	0.00007	0.0006
Chromium	1.24E+01	2.98E-07	NA	3.00E-03	7.50E-05	None observed	0.0001	NA	0.0001
Cobalt	2.84E+00	6.80E-08	NA	3.00E-04	3.00E-04	Thyroid	0.0002	NA	0.0002
Lead	1.02E+02	2.45E-06	NA	NA	NA	---	NA	NA	NA
						Total	0.02	0.003	0.02

Table 6-63
Calculation of Reasonable Maximum Exposure Cancer Risks - Mutagenic Mode of Action - Future Child Resident
Exposure to Soil/Sediment - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Incidental Soil Ingestion Risk

Where:

$$Risk = EPC \times \sum_{i} \frac{IRS \times FI \times CF \times EF \times ED}{BW \times AT} \times CSFo \times ADAF$$

Exposure Parameters (by age interval, i)			
Parameter	**Units**	**0-<2**	**2-<6**
EPC	mg/kg	See Table 6-6	
IRS	mg/day	200	200
FI	unitless	1	1
CF	kg/mg	1E-06	1E-06
EF	days/year	56	56
ED	years	2	4
BW	kg	15	15
AT	days	25550	25550
CSFo	$(mg/kg\text{-}day)^{-1}$	See Table 6-23	
ADAF	unitless	10	3

Dermal Contact Risk

Where:

$$Risk = EPC \times \sum_{i} \frac{SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT} \times CSFd \times ADAF$$

Exposure Parameters (by age interval, i)			
Parameter	**Units**	**0-<2**	**2-<6**
EPC	mg/kg	See Table 6-6	
SA	cm^2/day	2373	2373
AF	mg/cm^2	0.2	0.2
ABS	unitless	See Table 6-7	
EF	days/year	56	56
ED	years	2	4
CF	kg/mg	1E-06	1E-06
BW	kg	15	15
AT	days	25550	25550
CSFd	$(mg/kg\text{-}day)^{-1}$	See Table 6-23	
ADAF	unitless	10	3

	Incidential Soil Ingestion Risks			
COPC	**EPC**	**CSFo**	**0-<2**	**2-<6**
Benzo(a)anthracene	1.25E+02	1.0E-01	7E-06	4E-06
Benzo(a)pyrene	1.11E+02	1.0E+00	6E-05	4E-05
Benzo(b)fluoranthene	1.49E+02	1.0E-01	9E-06	5E-06
Benzo(k)fluoranthene	6.83E+01	1.0E-02	4E-07	2E-07
Chrysene	1.41E+02	1.0E-03	8E-08	5E-08
Dibenz(a,h)anthracene	1.04E+01	1.0E+00	6E-06	4E-06
Indeno(1,2,3-cd)pyrene	7.30E+01	1.0E-01	4E-06	3E-06
Chromium Total	1.24E+01	5.0E-01	4E-06	2E-06

	Dermal Contact Risks				
COPC	**EPC**	**CSFd**	**ABS**	**0-<2**	**2-<6**
Benzo(a)anthracene	1.25E+02	1.0E-01	0.13	2E-06	1E-06
Benzo(a)pyrene	1.11E+02	1.0E+00	0.13	2E-05	1E-05
Benzo(b)fluoranthene	1.49E+02	1.0E-01	0.13	3E-06	2E-06
Benzo(k)fluoranthene	6.83E+01	1.0E-02	0.13	1E-07	7E-08
Chrysene	1.41E+02	1.0E-03	0.13	3E-08	2E-08
Dibenz(a,h)anthracene	1.04E+01	1.0E+00	0.13	2E-06	1E-06
Indeno(1,2,3-cd)pyrene	7.30E+01	1.0E-01	0.13	1E-06	8E-07
Chromium Total	1.24E+01	2.0E+01	NA	NA	NA

	Total Cancer Risks		
COPC	**Soil Ingestion**	**Dermal Contact**	**Total**
Benzo(a)anthracene	1E-05	4E-06	**2E-05**
Benzo(a)pyrene	1E-04	3E-05	**1E-04**
Benzo(b)fluoranthene	1E-05	4E-06	**2E-05**
Benzo(k)fluoranthene	6E-07	2E-07	**8E-07**
Chrysene	1E-07	4E-08	**2E-07**
Dibenz(a,h)anthracene	1E-05	3E-06	**1E-05**
Indeno(1,2,3-cd)pyrene	7E-06	2E-06	**9E-06**
Chromium Total	6E-06	NA	**6E-06**

Table 6-64

Calculation of Central Tendency Exposure Cancer Risks - Mutagenic Mode of Action - Future Child Resident Exposure to Soil/Sediment - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Incidental Soil Ingestion Risk

Where:

$$Risk = EPC \times \sum_i \frac{IRS \times FI \times CF \times EF \times ED}{BW \times AT} \times CSFo \times ADAF$$

Exposure Parameters (by age interval, i)			
Parameter	**Units**	**0-<2**	**2-<6**
EPC	mg/kg	See Table 6-6	
IRS	mg/day	100	100
FI	unitless	0.5	0.5
CF	kg/mg	1E-06	1E-06
EF	days/year	28	28
ED	years	2	4
BW	kg	15	15
AT	days	25550	25550
CSFo	$(mg/kg\text{-}day)^{-1}$	See Table 6-23	
ADAF	unitless	10	3

Dermal Contact Risk

Where:

$$Risk = EPC \times \sum_i \frac{SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT} \times CSFd \times ADAF$$

Exposure Parameters (by age interval, i)			
Parameter	**Units**	**0-<2**	**2-<6**
EPC	mg/kg	See Table 6-6	
SA	cm^2	2690	2690
AF	mg/cm^2	0.04	0.04
ABS	unitless	See Table 6-7	
EF	days/year	28	28
ED	years	2	4
CF	kg/mg	1E-06	1E-06
BW	kg	15	15
AT	days	25550	25550
CSFd	$(mg/kg\text{-}day)^{-1}$	See Table 6-23	
ADAF	unitless	10	3

	Incidential Soil Ingestion Risks			
COPC	**EPC**	**CSFo**	**0-<2**	**2-<6**
Benzo(a)anthracene	1.44E+00	1.0E-01	1E-08	6E-09
Benzo(a)pyrene	1.27E+00	1.0E+00	9E-08	6E-08
Benzo(b)fluoranthene	1.09E+00	1.0E-01	8E-09	5E-09
Benzo(k)fluoranthene	7.57E-01	1.0E-02	6E-10	3E-10
Dibenz(a,h)anthracene	2.58E-01	1.0E+00	2E-08	1E-08
Indeno(1,2,3-cd)pyrene	5.00E-01	1.0E-01	4E-09	2E-09
Chromium Total	2.44E+01	5.0E-01	9E-07	5E-07

	Dermal Contact Risks				
COPC	**EPC**	**CSFd**	**ABS**	**0-<2**	**2-<6**
Benzo(a)anthracene	1.44E+00	1.0E-01	0.13	3E-09	2E-09
Benzo(a)pyrene	1.27E+00	1.0E+00	0.13	3E-08	2E-08
Benzo(b)fluoranthene	1.09E+00	1.0E-01	0.13	2E-09	1E-09
Benzo(k)fluoranthene	7.57E-01	1.0E-02	0.13	2E-10	9E-11
Dibenz(a,h)anthracene	2.58E-01	1.0E+00	0.13	5E-09	3E-09
Indeno(1,2,3-cd)pyrene	5.00E-01	1.0E-01	0.13	1E-09	6E-10
Chromium Total	2.44E+01	2.0E+01	NA	NA	NA

	Total Cancer Risks		
COPC	**Soil Ingestion**	**Dermal Contact**	**Total**
Benzo(a)anthracene	2E-08	5E-09	**2E-08**
Benzo(a)pyrene	1E-07	4E-08	**2E-07**
Benzo(b)fluoranthene	1E-08	4E-09	**2E-08**
Benzo(k)fluoranthene	9E-10	2E-10	**1E-09**
Dibenz(a,h)anthracene	3E-08	8E-09	**4E-08**
Indeno(1,2,3-cd)pyrene	6E-09	2E-09	**7E-09**
Chromium Total	1E-06	NA	**1E-06**

Table 6-65

Calculation of Reasonable Maximum Exposure Cancer Risks - Mutagenic Mode of Action - Future Adult Resident
Exposure to Soil/Sediment - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Incidental Soil Ingestion Risk

Where:

$$Risk = EPC \times \sum_{i} \frac{IRS \times FI \times CF \times EF \times ED}{BW \times AT} \times CSFo \times ADAF$$

Exposure Parameters (by age interval, i)			
Parameter	**Units**	**6-<16**	**16-<26**
EPC	mg/kg	See Table 6-6	
IRS	mg/day	100	100
FI	unitless	1	1
CF	kg/mg	1E-06	1E-06
EF	days/year	56	56
ED	years	10	10
BW	kg	80	80
AT	days	25550	25550
CSFo	$(mg/kg\text{-}day)^{-1}$	See Table 6-23	
ADAF	unitless	3	1

Dermal Contact Risk

Where:

$$Risk = EPC \times \sum_{i} \frac{SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT} \times CSFd \times ADAF$$

Exposure Parameters (by age interval, i)			
Parameter	**Units**	**6-<16**	**16-<26**
EPC	mg/kg	See Table 6-6	
SA	cm^2/day	6032	6032
AF	mg/cm^2	0.07	0.07
ABS	unitless	See Table 6-7	
EF	days/year	56	56
ED	years	10	10
CF	kg/mg	1E-06	1E-06
BW	kg	80	80
AT	days	25550	25550
CSFd	$(mg/kg\text{-}day)^{-1}$	See Table 6-23	
ADAF	unitless	3	1

	Incidential Soil Ingestion Risks			
COPC	**EPC**	**CSFo**	**6-<16**	**16-<26**
Benzo(a)anthracene	1.25E+02	1.0E-01	1E-06	3E-07
Benzo(a)pyrene	1.11E+02	1.0E+00	9E-06	3E-06
Benzo(b)fluoranthene	1.49E+02	1.0E-01	1E-06	4E-07
Benzo(k)fluoranthene	6.83E+01	1.0E-02	6E-08	2E-08
Chrysene	1.41E+02	1.0E-03	1E-08	4E-09
Dibenz(a,h)anthracene	1.04E+01	1.0E+00	9E-07	3E-07
Indeno(1,2,3-cd)pyrene	7.30E+01	1.0E-01	6E-07	2E-07
Chromium Total	1.24E+01	5.0E-01	5E-07	2E-07

	Dermal Contact Risks				
COPC	**EPC**	**CSFd**	**ABS**	**6-<16**	**16-<26**
Benzo(a)anthracene	1.25E+02	1.0E-01	0.13	6E-07	2E-07
Benzo(a)pyrene	1.11E+02	1.0E+00	0.13	5E-06	2E-06
Benzo(b)fluoranthene	1.49E+02	1.0E-01	0.13	7E-07	2E-07
Benzo(k)fluoranthene	6.83E+01	1.0E-02	0.13	3E-08	1E-08
Chrysene	1.41E+02	1.0E-03	0.13	6E-09	2E-09
Dibenz(a,h)anthracene	1.04E+01	1.0E+00	0.13	5E-07	2E-07
Indeno(1,2,3-cd)pyrene	7.30E+01	1.0E-01	0.13	3E-07	1E-07
Chromium Total	1.24E+01	2.0E+01	NA	NA	NA

	Total Cancer Risks		
COPC	**Soil Ingestion**	**Dermal Contact**	**Total**
Benzo(a)anthracene	1E-06	7E-07	**2E-06**
Benzo(a)pyrene	1E-05	7E-06	**2E-05**
Benzo(b)fluoranthene	2E-06	9E-07	**3E-06**
Benzo(k)fluoranthene	7E-08	4E-08	**1E-07**
Chrysene	2E-08	8E-09	**2E-08**
Dibenz(a,h)anthracene	1E-06	6E-07	**2E-06**
Indeno(1,2,3-cd)pyrene	8E-07	4E-07	**1E-06**
Chromium Total	7E-07	NA	**7E-07**

Table 6-66
Reasonable Maximum Exposure Doses and Cancer Risks for Groundskeeper Exposure to Soil/Sediment - Drainage
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		RME - Cancer						
		Exposure Doses				Cancer Risks		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Dermal CSF $(mg/kg\text{-}day)^{-1}$	Soil Ingestion	Dermal Contact	Total
Aldrin	5.43E-02	1.73E-09	NA	1.70E+01	1.70E+01	3E-08	NA	3E-08
Benzo(a)anthracene	1.25E+02	3.96E-06	2.18E-06	1.00E-01	1.00E-01	4E-07	2E-07	6E-07
Benzo(a)pyrene	1.11E+02	3.52E-06	1.94E-06	1.00E+00	1.00E+00	4E-06	2E-06	5E-06
Benzo(b)fluoranthene	1.49E+02	4.73E-06	2.60E-06	1.00E-01	1.00E-01	5E-07	3E-07	7E-07
Benzo(k)fluoranthene	6.83E+01	2.17E-06	1.20E-06	1.00E-02	1.00E-02	2E-08	1E-08	3E-08
Carbazole	1.34E+02	4.25E-06	2.34E-06	NA	NA	NA	NA	NA
gamma-Chlordane	2.40E-01	7.63E-09	1.29E-09	3.50E-01	3.50E-01	3E-09	5E-10	3E-09
Chrysene	1.41E+02	4.47E-06	2.46E-06	1.00E-03	1.00E-03	4E-09	2E-09	7E-09
Dibenz(a,h)anthracene	1.04E+01	3.32E-07	1.82E-07	1.00E+00	1.00E+00	3E-07	2E-07	5E-07
Dibenzofuran	4.48E+01	1.42E-06	1.81E-07	NA	NA	NA	NA	NA
Fluoranthene	3.75E+02	1.19E-05	6.55E-06	NA	NA	NA	NA	NA
Heptachlor epoxide	2.22E+00	7.05E-08	NA	9.10E+00	9.10E+00	6E-07	NA	6E-07
Indeno(1,2,3-c,d)pyrene	7.30E+01	2.32E-06	1.28E-06	1.00E-01	1.00E-01	2E-07	1E-07	4E-07
1-Methylnaphthalene	2.02E+01	6.41E-07	3.53E-07	2.90E-02	2.90E-02	2E-08	1E-08	3E-08
2-Methylnaphthalene	6.32E+00	2.01E-07	1.11E-07	NA	NA	NA	NA	NA
Naphthalene	1.46E+01	4.63E-07	2.55E-07	NA	NA	NA	NA	NA
Phenanthrene	3.24E+02	1.03E-05	5.66E-06	NA	NA	NA	NA	NA
Pyrene	2.90E+02	9.23E-06	5.08E-06	NA	NA	NA	NA	NA
Antimony	8.67E-01	2.76E-08	NA	NA	NA	NA	NA	NA
Arsenic	1.13E+01	2.16E-07	4.57E-08	1.50E+00	1.50E+00	3E-07	7E-08	4E-07
Chromium	1.24E+01	3.95E-07	NA	5.00E-01	2.00E+01	2E-07	NA	2E-07
Cobalt	2.84E+00	9.02E-08	NA	NA	NA	NA	NA	NA
Lead	1.02E+02	3.25E-06	NA	NA	NA	NA	NA	NA
						6E-06	3E-06	9E-06

Table 6-67
Central Tendency Exposure Doses and Cancer Risks for Groundskeeper Exposure to Soil/Sediment - Drainage Ditch
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		CTE - Cancer						
		Exposure Doses				Cancer Risks		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Dermal CSF $(mg/kg\text{-}day)^{-1}$	Soil Ingestion	Dermal Contact	Total
Aldrin	5.43E-02	1.04E-10	NA	1.70E+01	1.70E+01	2E-09	NA	2E-09
Benzo(a)anthracene	1.25E+02	2.38E-07	8.71E-08	1.00E-01	1.00E-01	2E-08	9E-09	3E-08
Benzo(a)pyrene	1.11E+02	2.11E-07	7.75E-08	1.00E+00	1.00E+00	2E-07	8E-08	3E-07
Benzo(b)fluoranthene	1.49E+02	2.84E-07	1.04E-07	1.00E-01	1.00E-01	3E-08	1E-08	4E-08
Benzo(k)fluoranthene	6.83E+01	1.30E-07	4.78E-08	1.00E-02	1.00E-02	1E-09	5E-10	2E-09
Carbazole	1.34E+02	2.55E-07	9.34E-08	NA	NA	NA	NA	NA
gamma-Chlordane	2.40E-01	4.58E-10	5.17E-11	3.50E-01	3.50E-01	2E-10	2E-11	2E-10
Chrysene	1.41E+02	2.68E-07	9.83E-08	1.00E-03	1.00E-03	3E-10	1E-10	4E-10
Dibenz(a,h)anthracene	1.04E+01	1.99E-08	7.30E-09	1.00E+00	1.00E+00	2E-08	7E-09	3E-08
Dibenzofuran	4.48E+01	8.54E-08	7.23E-09	NA	NA	NA	NA	NA
Fluoranthene	3.75E+02	7.15E-07	2.62E-07	NA	NA	NA	NA	NA
Heptachlor epoxide	2.22E+00	4.23E-09	NA	9.10E+00	9.10E+00	4E-08	NA	4E-08
Indeno(1,2,3-c,d)pyrene	7.30E+01	1.39E-07	5.11E-08	1.00E-01	1.00E-01	1E-08	5E-09	2E-08
1-Methylnaphthalene	2.02E+01	3.85E-08	1.41E-08	2.90E-02	2.90E-02	1E-09	4E-10	2E-09
2-Methylnaphthalene	6.32E+00	1.21E-08	4.42E-09	NA	NA	NA	NA	NA
Naphthalene	1.46E+01	2.78E-08	1.02E-08	NA	NA	NA	NA	NA
Phenanthrene	3.24E+02	6.17E-07	2.26E-07	NA	NA	NA	NA	NA
Pyrene	2.90E+02	5.54E-07	2.03E-07	NA	NA	NA	NA	NA
Antimony	8.67E-01	1.65E-09	NA	NA	NA	NA	NA	NA
Arsenic	1.13E+01	1.30E-08	1.83E-09	1.50E+00	1.50E+00	2E-08	3E-09	2E-08
Chromium	1.24E+01	2.37E-08	NA	5.00E-01	2.00E+01	1E-08	NA	1E-08
Cobalt	2.84E+00	5.41E-09	NA	NA	NA	NA	NA	NA
Lead	1.02E+02	1.95E-07	NA	NA	NA	NA	NA	NA
						4E-07	1E-07	5E-07

Table 6-68
Reasonable Maximum Exposure Doses and Hazard Quotients for Groundskeeper Exposure to Soil/Sediment - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		RME - Noncancer							
		Exposure Doses					Hazard Quotients		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Primary Target Organ	Soil Ingestion	Dermal Contact	Hazard Index
Aldrin	5.43E-02	4.83E-09	NA	3.00E-05	3.00E-05	Liver	0.0002	NA	0.0002
Benzo(a)anthracene	1.25E+02	1.11E-05	6.10E-06	NA	NA	---	NA	NA	NA
Benzo(a)pyrene	1.11E+02	9.87E-06	5.43E-06	3.00E-04	3.00E-04	Developmental	0.03	0.02	0.05
Benzo(b)fluoranthene	1.49E+02	1.32E-05	7.28E-06	NA	NA	---	NA	NA	NA
Benzo(k)fluoranthene	6.83E+01	6.08E-06	3.35E-06	NA	NA	---	NA	NA	NA
Carbazole	1.34E+02	1.19E-05	6.54E-06	NA	NA	---	NA	NA	NA
gamma-Chlordane	2.40E-01	2.14E-08	3.62E-09	5.00E-04	5.00E-04	Liver	0.00004	0.000007	0.00005
Chrysene	1.41E+02	1.25E-05	6.88E-06	NA	NA	---	NA	NA	NA
Dibenz(a,h)anthracene	1.04E+01	9.29E-07	5.11E-07	NA	NA	---	NA	NA	NA
Dibenzofuran	4.48E+01	3.98E-06	5.06E-07	1.00E-03	1.00E-03	Body Weight	0.004	0.0005	0.004
Fluoranthene	3.75E+02	3.33E-05	1.83E-05	4.00E-02	4.00E-02	Kidney, Liver, Blood	0.0008	0.0005	0.001
Heptachlor epoxide	2.22E+00	1.97E-07	NA	1.30E-05	1.30E-05	Liver	0.02	NA	0.02
Indeno(1,2,3-c,d)pyrene	7.30E+01	6.50E-06	3.58E-06	NA	NA	---	NA	NA	NA
1-Methylnaphthalene	2.02E+01	1.80E-06	9.88E-07	7.00E-02	7.00E-02	Respiratory system	0.00003	0.00001	0.00004
2-Methylnaphthalene	6.32E+00	5.63E-07	3.10E-07	4.00E-03	4.00E-03	Respiratory system	0.0001	0.00008	0.0002
Naphthalene	1.46E+01	1.30E-06	7.14E-07	2.00E-02	2.00E-02	Body Weight	0.00006	0.00004	0.0001
Phenanthrene	3.24E+02	2.88E-05	1.58E-05	NA	NA	---	NA	NA	NA
Pyrene	2.90E+02	2.59E-05	1.42E-05	3.00E-02	3.00E-02	Kidney	0.0009	0.0005	0.001
Antimony	8.67E-01	7.72E-08	NA	4.00E-04	6.00E-05	Blood	0.0002	NA	0.0002
Arsenic	1.13E+01	6.05E-07	1.28E-07	3.00E-04	3.00E-04	Reproductive	0.002	0.0004	0.002
Chromium	1.24E+01	1.11E-06	NA	3.00E-03	7.50E-05	None observed	0.0004	NA	0.0004
Cobalt	2.84E+00	2.53E-07	NA	3.00E-04	3.00E-04	Thyroid	0.0008	NA	0.0008
Lead	1.02E+02	9.09E-06	NA	NA	NA	---	NA	NA	NA
						Total	0.06	0.02	0.08

Table 6-69
Central Tendency Exposure Doses and Hazard Quotients for Groundskeeper Exposure to Soil/Sediment - Drainage Ditch EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

		CTE - Noncancer							
		Exposure Doses					Hazard Quotients		
COPC	EPC (mg/kg)	Soil Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Primary Target Organ	Soil Ingestion	Dermal Contact	Hazard Index
Aldrin	5.43E-02	6.04E-10	NA	3.00E-05	3.00E-05	Liver	0.00002	NA	0.00002
Benzo(a)anthracene	1.25E+02	1.39E-06	5.08E-07	NA	NA	---	NA	NA	NA
Benzo(a)pyrene	1.11E+02	1.23E-06	4.52E-07	3.00E-04	3.00E-04	Developmental	0.004	0.002	0.006
Benzo(b)fluoranthene	1.49E+02	1.65E-06	6.07E-07	NA	NA	---	NA	NA	NA
Benzo(k)fluoranthene	6.83E+01	7.60E-07	2.79E-07	NA	NA	---	NA	NA	NA
Carbazole	1.34E+02	1.49E-06	5.45E-07	NA	NA	---	NA	NA	NA
gamma-Chlordane	2.40E-01	2.67E-09	3.01E-10	5.00E-04	5.00E-04	Liver	0.000005	0.0000006	0.000006
Chrysene	1.41E+02	1.56E-06	5.74E-07	NA	NA	---	NA	NA	NA
Dibenz(a,h)anthracene	1.04E+01	1.16E-07	4.26E-08	NA	NA	---	NA	NA	NA
Dibenzofuran	4.48E+01	4.98E-07	4.22E-08	1.00E-03	1.00E-03	Body Weight	0.0005	0.00004	0.0005
Fluoranthene	3.75E+02	4.17E-06	1.53E-06	4.00E-02	4.00E-02	Kidney, Liver, Blood	0.0001	0.00004	0.0001
Heptachlor epoxide	2.22E+00	2.47E-08	NA	1.30E-05	1.30E-05	Liver	0.002	NA	0.002
Indeno(1,2,3-c,d)pyrene	7.30E+01	8.12E-07	2.98E-07	NA	NA	---	NA	NA	NA
1-Methylnaphthalene	2.02E+01	2.24E-07	8.23E-08	7.00E-02	7.00E-02	Respiratory system	0.000003	0.000001	0.000004
2-Methylnaphthalene	6.32E+00	7.04E-08	2.58E-08	4.00E-03	4.00E-03	Respiratory system	0.00002	0.000006	0.00002
Naphthalene	1.46E+01	1.62E-07	5.95E-08	2.00E-02	2.00E-02	Body Weight	0.000008	0.000003	0.00001
Phenanthrene	3.24E+02	3.60E-06	1.32E-06	NA	NA	---	NA	NA	NA
Pyrene	2.90E+02	3.23E-06	1.19E-06	3.00E-02	3.00E-02	Kidney	0.0001	0.00004	0.0001
Antimony	8.67E-01	9.65E-09	NA	4.00E-04	6.00E-05	Blood	0.00002	NA	0.00002
Arsenic	1.13E+01	7.57E-08	1.07E-08	3.00E-04	3.00E-04	Reproductive	0.0003	0.00004	0.0003
Chromium	1.24E+01	1.38E-07	NA	3.00E-03	7.50E-05	None observed	0.00005	NA	0.00005
Cobalt	2.84E+00	3.16E-08	NA	3.00E-04	3.00E-04	Thyroid	0.0001	NA	0.0001
Lead	1.02E+02	1.14E-06	NA	NA	NA	---	NA	NA	NA
						Total	0.007	0.002	0.009

Table 6-70
Summary of Highest cPAH Levels in Investigation Area 18C - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Sample ID	cPAH	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Dibenz(a,h)anthracene	Indeno(1,2,3-cd)pyrene
TP-18C72A	275	58	47	38	41	10	26
TP-18C75A	35.5	6.7	6.4	5.6	5.7	1.4	3.2
TP-18C71A	29.3	5.9	5.2	3.9	4.7	1	2.8

Units in mg/kg.

Table 6-71
Re-Calculation of RME Cancer Risks from cPAHs - Future Residential Exposure - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Carcinogenic PAH	EPC[a] Soil EA (mg/kg)	RME Cancer Risk[b] Future Residents		EPC-Adjusted (mg/kg)	EPC Adjusted Calculation Method	RME Adjusted Cancer Risk Future Residents
Benzo(a)anthracene	1.44E+00	1E-06		3.41E-01	95% KM (BCA) UCL	3E-07
Benzo(a)pyrene	1.27E+00	1E-05		3.74E-01	95% KM (BCA) UCL	3E-06
Benzo(b)fluoranthene	1.09E+00	9E-07		3.85E-01	95% KM (BCA) UCL	3E-07
Benzo(k)fluoranthene	7.57E-01	7E-08		3.48E-01	95% KM (BCA) UCL	3E-08
Dibenz(a,h)anthracene	2.58E-01	2E-06		1.66E-01	95% KM (t) UCL	1E-06
Indeno(1,2,3-c,d)pyrene	5.00E-01	4E-07		2.48E-01	95% KM (BCA) UCL	2E-07
	Total:	**2E-05**			**Total:**	**6E-06**

Notes:

[a] See Table 6-5.

[b] see Table 6-29.

EPC-Adjusted based on Soil EA data except for data from TP-18C71A, TP-18C72A, and TP-18C75A.

Table 6-72
Re-Calculation of RME Cancer Risks from Arsenic - Future Residential Exposure - Soil EA
U.S. EPA and GSA Property Area
Former Raritan Arsenal

Hypothetical Future Residential Exposure to Aggregate Soil

EPC[a] Soil EA (mg/kg)	RME Cancer Risk[b] Future Residents		EPC-Adjusted (mg/kg)	EPC Adjusted Calculation Method	RME Adjusted Cancer Risk Future Residents
2.16E+01	3E-05		6.55E+00	95% KM (Chebyshev) UCL	3E-06

Notes:

[a] See Table 6-5.

[b] see Table 6-29.

EPC-Adjusted based on Soil EA data except for data from the former railroad between former Buildings 202 and 203 within Investigation Area 18F and extending into Investigation Area 18E.

Section 7 Table

Table 7-1
MEC Investigation Activities Completed at the EPA/GSA Area

Area Name	Historical Area Use	History of MEC Use	Steps Taken to Investigate MEC	MEC Finds
Area 1	0.57 acre site that was used as a former demolition ground after WWI and into the early 1930s for the destruction of adapter boosters, point and base detonating fuses, and 37 mm to 6-inch gun projectiles.	Yes	• Early 1960s – 'surface search', no ordnance discovered • Jan 1988 – visual inspection and use of an ordnance locator instrument (MK 26). The ordnance locator identified numerous small ferrous objects 6 to 12-inches below grade. Hand excavation of several locations revealed pieces of wire and steel reinforcing bars and half of a small can. No MEC was found. • June 1988 – prior to site clearing and the geophysical survey, an additional visual inspection revealed no MEC on the surface. An ordnance locator identified eight metal objects below grade. Each item was excavated. None were MEC. • Sept/Oct 1988 – Magnetometer (MAG) and ground penetrating radar (GPR) surveys conducted. The surveys were completed on a 25-ft square grid over a 200-ft square area. The grid was established such that the stream which bisects the site did not interfere with data collection. The MAG survey showed no magnetic anomalies that could be associated with subsurface objects. The GPR survey identified no detectable subsurface anomalies which indicated buried objects or evidence of previous excavations. Therefore, there is no evidence that subsurface objects or bulk waste materials are present in Area 1. • May 1992 – entire area was surveyed with a GA-52B magnetometer. Hits were marked with red flagging and excavated using a shovel and/or backhoe. Only metallic scraps were found. No MEC related items were found.	None
Area 18A	3 acre site that was formerly a man-made pond, first appearing in a 1951 aerial photograph. Area went through extensive removal actions for HTW in 1992 and 1998	No	• MEC was not observed during the 1992 and 1998 removal actions that included extensive excavations over an area of approximately 12,100 ft^2.	None
Area 18B	Approximately 50 acres, surrounding Area 18A. Includes the location of a former firing range. Little information regarding specific operations at the firing range was available, but it appears that only small arms firing occurred. The extent of the former firing range was roughly delineated by historical ground scars noted while reviewing historical aerial photographs.	No	• July 1993 – geophysical mapping and sampling investigation for MEC was performed at four areas Area 1: 2,500 ft^2, Anomalies = 18, Anomalies Sampled = 18, MEC found = none Area 2: 11,250 ft^2, Anomalies = 55, Anomalies Sampled = 21, MEC found = none Area 3: 10,000 ft^2, Anomalies = 56, Anomalies Sampled = 14, MEC found = none Area 4: 625 ft^2, Anomalies = 4, Anomalies Sampled = 4, MEC found = none • 2002 – debris consisting of expended small arms embedded in the former firing range backstop area was removed • 2002 – removals were conducted at 3 areas for lead contamination in soil. MEC was not observed during the excavations.	None
Area 18C	58 acres that includes the foundations of two former buildings (Buildings 255 and 256) that were demolished in August 2014, asphalt and railroad areas, and undeveloped land. A portion of the site was historically used as a dumping ground for building debris.	No	• July 1993 – geophysical mapping and sampling investigation for MEC was performed at one area Area 1: 150 ft^2, Anomalies = 0, Anomalies Sampled = 0, MEC found = none • April 1996 – Electromagnetic (EM) and MAG surveys completed to locate and delineate suspected buried drum areas. The survey area was approximately 18.6 acres EM survey conducted with Geonics EM-31 terrain conductivity meter MAG survey conducted with GEOMETRICS G-858 cesium vapor Gradiometer/Magnetometer 25 anomalies were noted and investigated by test trenches No MEC related items were found • Aug 1999 – EM, GPR, and MAG surveys completed. The survey area was approximately 1.57 acres. • 1998 and 2002 – extensive excavations for HTW completed for approximately 1.1 acres. MEC was not observed.	None

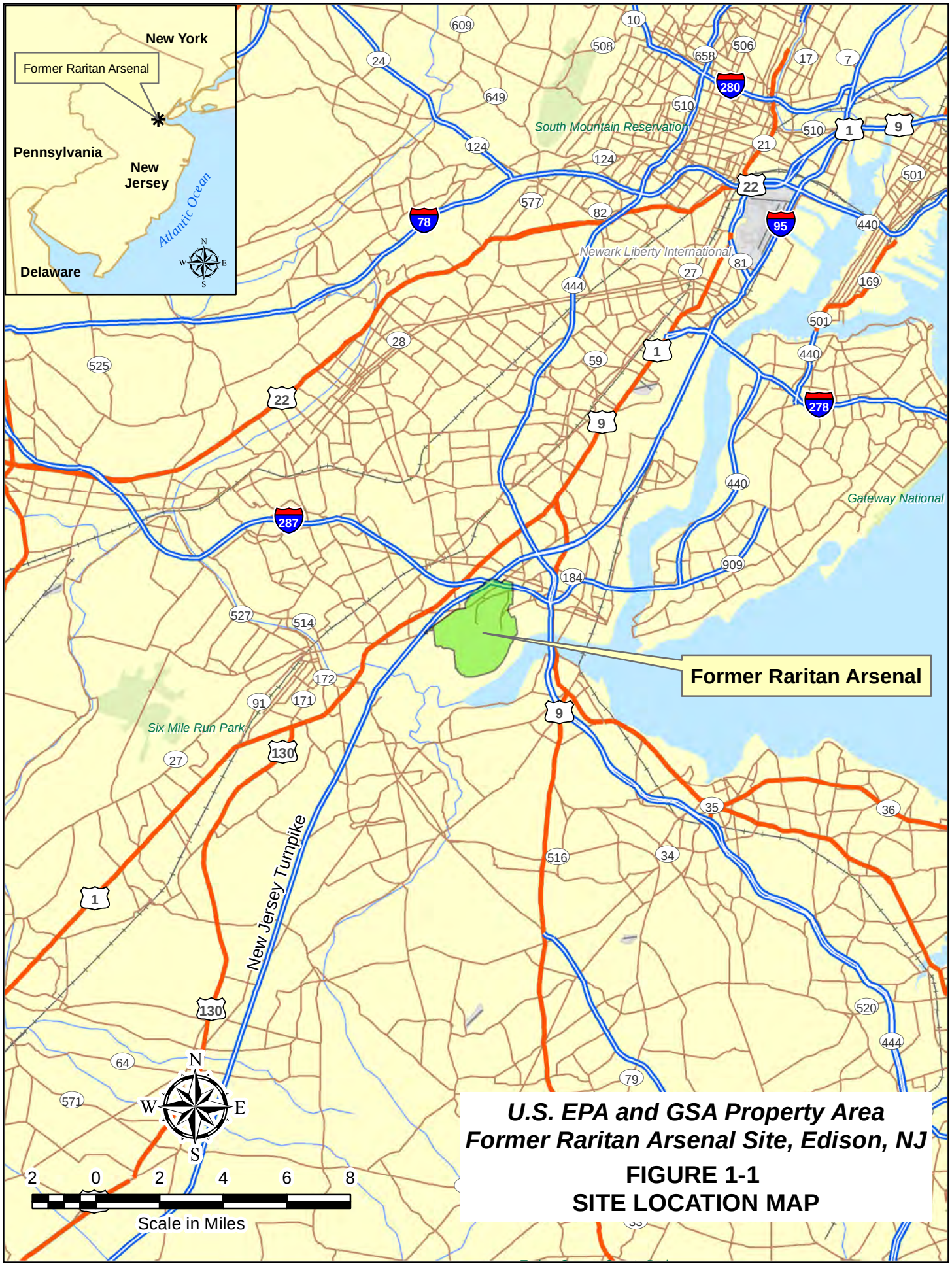
Table 7-1
MEC Investigation Activities Completed at the EPA/GSA Area

Area Name	Historical Area Use	History of MEC Use	Steps Taken to Investigate MEC	MEC Finds
Area 18E	3 former Army buildings: Buildings 14, 15, and 19. Building 14 served as a small arms shop; Building 15 served as a machine shop; and Building 19 was referred to as a vehicle rebuild assembly shop. Review of historical aerial photography indicated that the three buildings were joined together as of 1940. Buildings were demolished in 1997.	No	• Sometime between 1991 and 1994, an inert 75-mm projectile was found. The location of the item (considered munition debris) and the manner in which it was discovered are unknown. • Aug 1999 – EM, GPR, and MAG surveys completed to locate USTs at two areas. The survey area was approximately 3,650 ft^2 Geophysical Survey Systems SIR System 2 was used for the GPR survey MAG survey conducted with GEOMETRICS G-858 cesium vapor Gradiometer/Magnetometer No anomalies were noted • Oct 2004 – MEC clearance performed at 17 proposed soil boring locations Downhole clearance was performed using combination of Schonstedt GA-52cd magnetic locator and MK-26 ferrous magnetic locator in conjunction with hand auger to advance the boring to maximum depth of 10 feet bgs. No anomalies requiring further investigation were identified. The results of the survey did not indicate the presence of MEC. • 2009 – MEC clearance performed at 61 locations. Clearance was performed using a combination of Schonstedt GA-52cd magnetic locator and MK-26 ferrous magnetic locator in conjunction with a hand auger to advance the boring to a maximum depth of 4 feet bgs. No anomalies requiring further investigation were identified in the 57 soil borings or the four monitoring well locations. The results of the survey did not indicate the presence of MEC. • 2011 - Excavations were performed at five areas (approximately 12,183 ft^2) to remove elevated concentrations of TCE and other VOCs. No MEC or related items were discovered	No

Table 7-1
MEC Investigation Activities Completed at the EPA/GSA Area

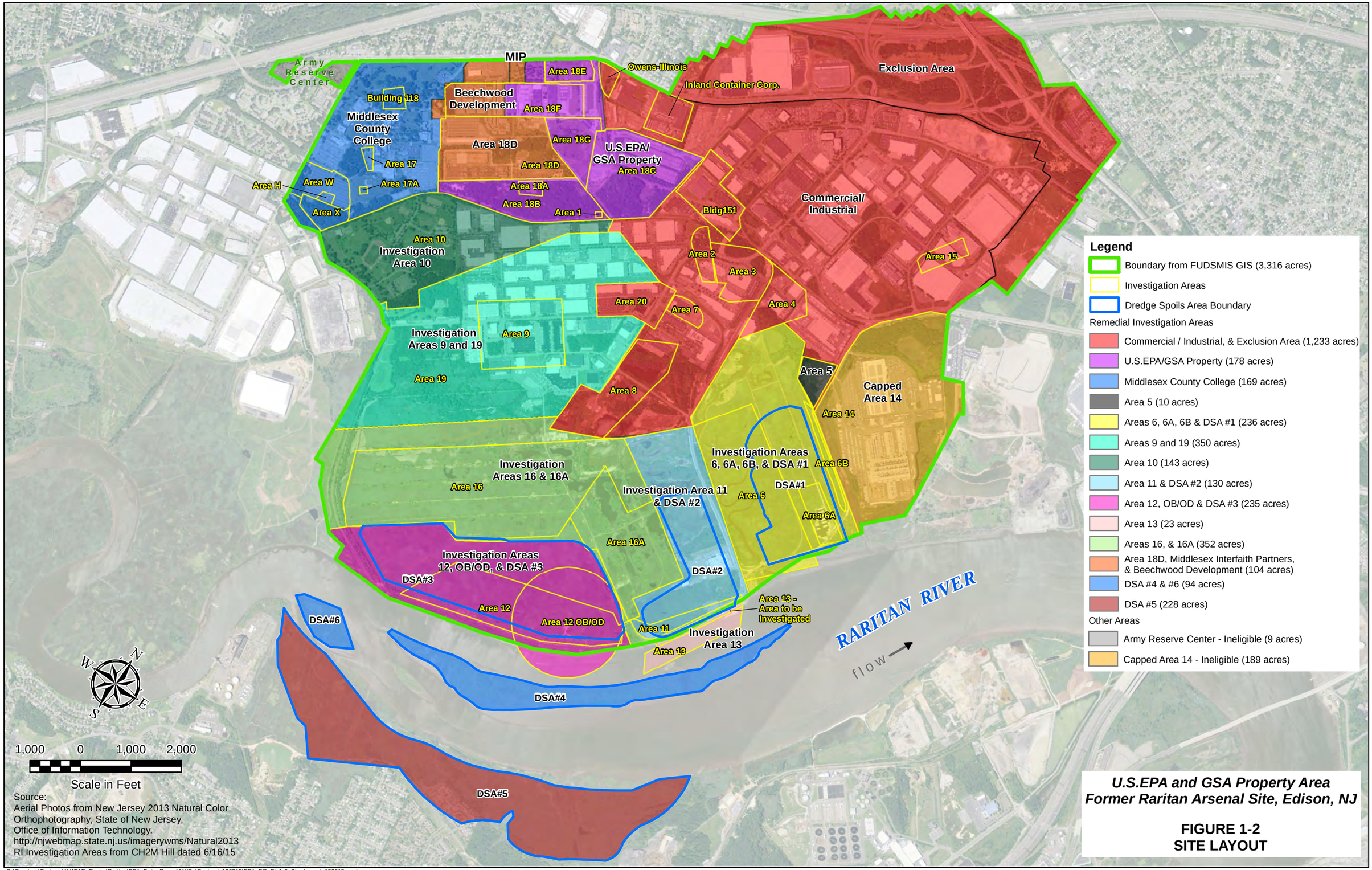
Area Name	Historical Area Use	History of MEC Use	Steps Taken to Investigate MEC	MEC Finds
Area 18F	Approximately 43 acres that historically contained a small arms packing operation and several warehouses. The Archives Search Report indicated Building 202 was used for parts storage and truck storage in 1918 and 1919. A fire occurred in Building 202 in 1929. Inert ordnance materials including fuses, bomb casings, wooden containers, and cartridge cases were stored in Building 202 in 1935. A reproduction office including blueprint machines, dark rooms, and sinks was located at an unspecified location within Building 202. However, this building was referred to as the packing and shipping shed in 1943. Wrenches, ordnance tools, and shovels were stored in Building 202 in 1946. The GSA owned Building 202 from 1963 until the early 1970s when the EPA acquired the property. Building 202 was demolished in 1994. Inert ordnance materials including fuses, bomb casings, wooden containers, and cartridge cases were stored in Building 203 in 1935. A pit of unspecified size was located along a steam pipe trench at an unknown location within Building 203. The GSA owned Building 203 from 1963 until the early 1970s, when it was transferred to the EPA. Building 203 was demolished by EPA in 1994.	Possible small arms packing in a building	Reported historical use in one building for small arms packing suggest the possibility of MEC. However, the area was surface cleared prior to closure of the arsenal in 1963. No subsequent MEC investigations have been conducted, but since the area is almost entirely covered by original Raritan Arsenal structures, the likelihood of subsurface MEC is small.	No
Area 18G	Approximately 21 acres that was historically used for equipment storage, as a gasoline station and automotive shop, and as a dump. Information reported in the Archive Search Report indicated that a dump was historically located in this area and had been covered over with concrete. The dump was reportedly used by Columbia Salvage Company to dispose of scrap material generated during ammunition salvage operations. The timeframe associated with dumping activities is not known. A gasoline station storage building and automotive shop were historically located near the northern corner of Area 18G, where it borders Area 18F. The exact dates for when the station was constructed and when the station was removed are unknown. However, the station was actively utilized by GSA/EPA into the 1980s. Two USTs previously located there were removed by the EPA in 1991.	No	• A single machine gun shell (considered to be munition debris) was discovered on the surface during a cultural resources survey. The location and date of this discovery is unknown. • 1998 – objective of the geophysical investigation was to determine the physical extent of historical dump. EM, GPR, and MAG surveys completed over 0.5 acres The extent of the former dump was delineated	No

FIGURES



U.S. EPA and GSA Property Area
Former Raritan Arsenal Site, Edison, NJ

FIGURE 1-1
SITE LOCATION MAP



Source:
Aerial Photos from New Jersey 2013 Natural Color Orthophotography, State of New Jersey, Office of Information Technology.
http://njwebmap.state.nj.us/imagerywms/Natural2013
RI Investigation Areas from CH2M Hill dated 6/16/15

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U.S.EPA and GSA Property Area
Former Raritan Arsenal Site, Edison, NJ

FIGURE 1-2
SITE LAYOUT

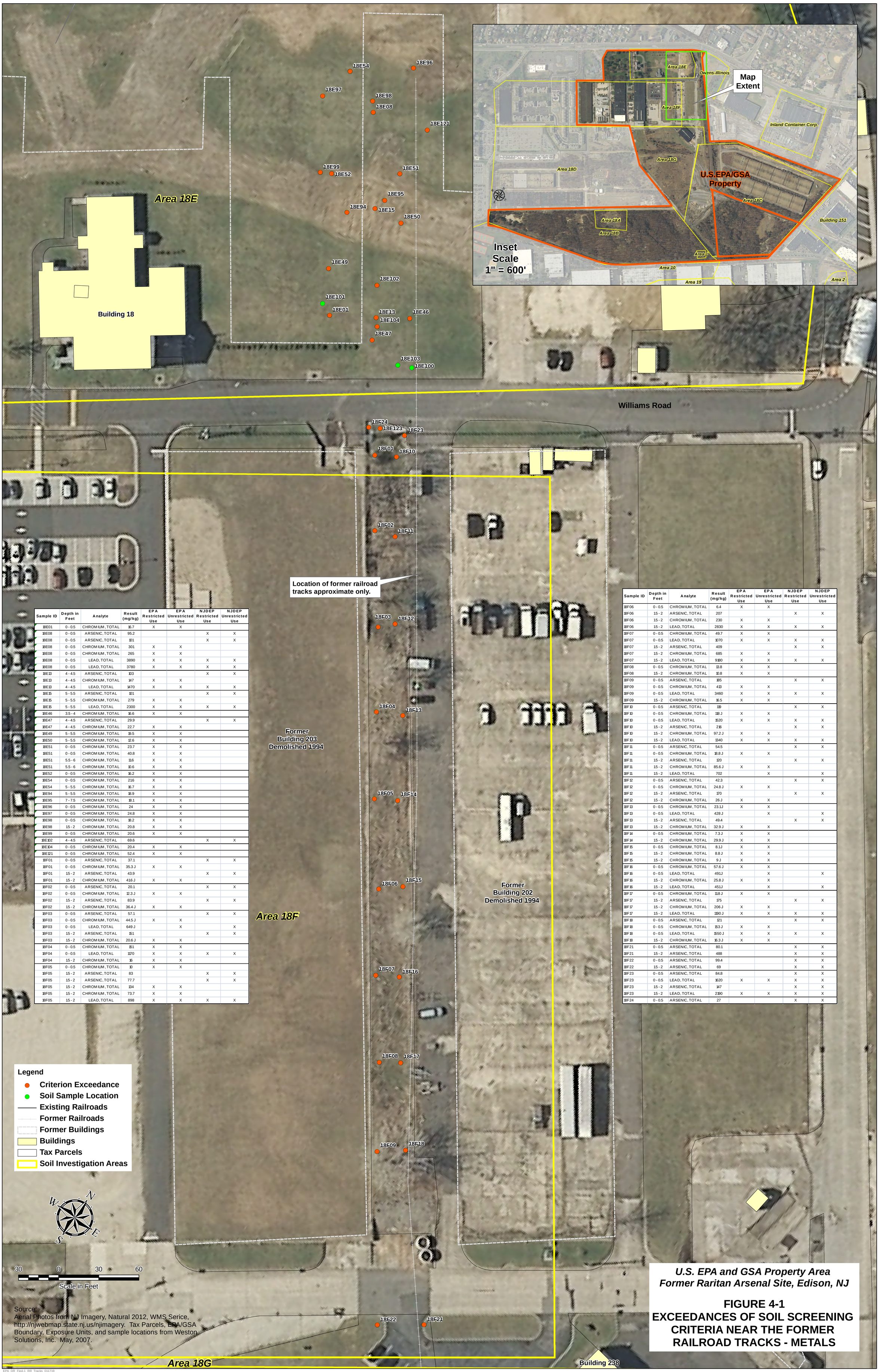


Source:
Aerial Photos from NJ Imagery, Natural 2012, WMS Serice, http://njwebmap.state.nj.us/njimagery. Tax Parcels, EPA/GSA Boundary, Exposure Units, and sample locations from Weston Solutions, Inc. May, 2007.

U.S. EPA and GSA Property Area
Former Raritan Arsenal Site, Edison, NJ

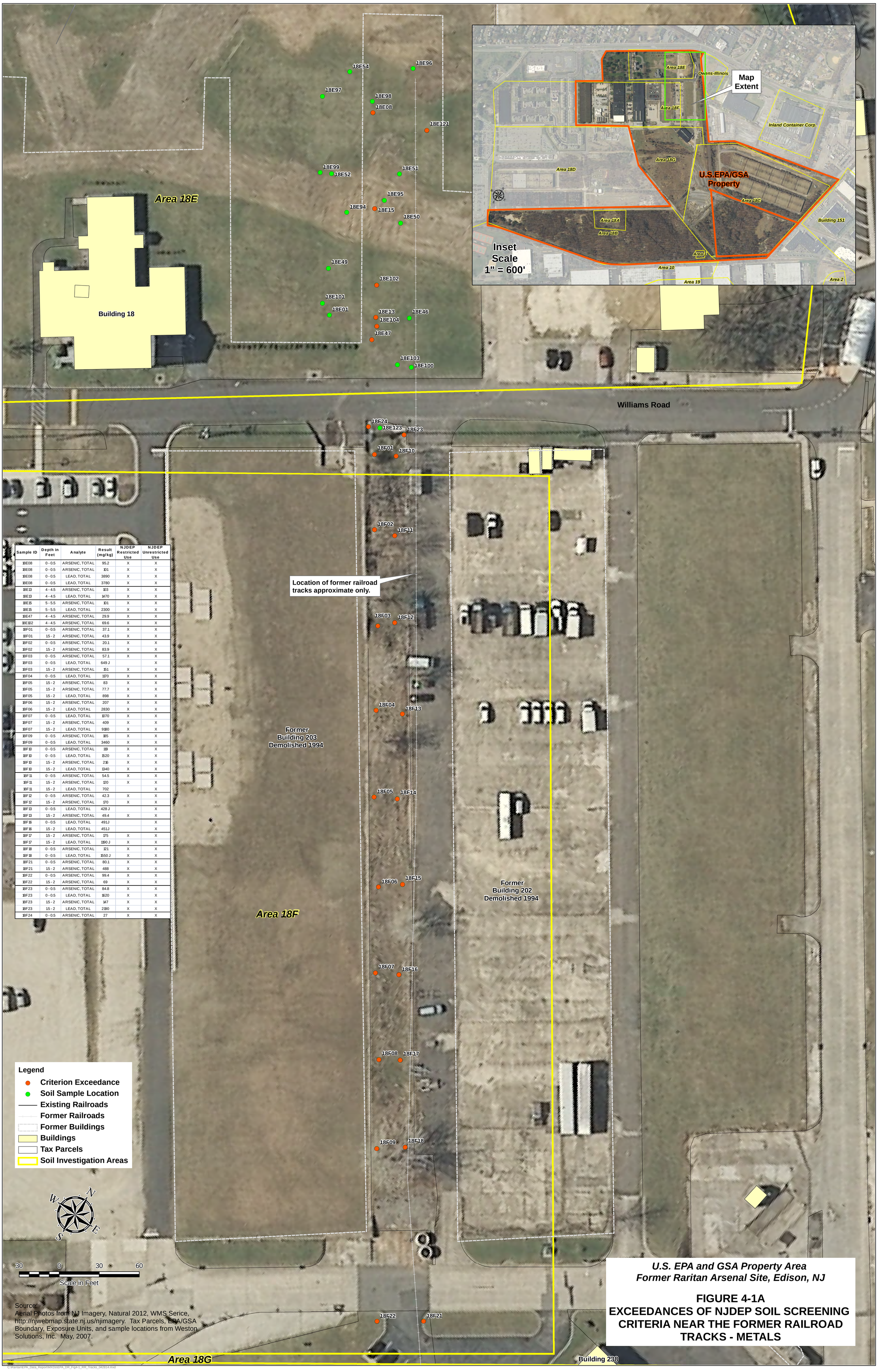
FIGURE 2-1
LOCATION OF SOIL SAMPLES, SITE FEATURES, AND HISTORIC REMOVAL AREAS

EPA_DR_Fig2-1_EPA_Soil_Sample_Locations_011719



Sample ID	Depth in Feet	Analyte	Result (mg/kg)	EPA Restricted Use	EPA Unrestricted Use	NJDEP Restricted Use	NJDEP Unrestricted Use
18E01	0 - 0.5	CHROMIUM, TOTAL	16.7	X	X		
18E08	0 - 0.5	ARSENIC, TOTAL	95.2			X	X
18E08	0 - 0.5	ARSENIC, TOTAL	101			X	X
18E08	0 - 0.5	CHROMIUM, TOTAL	301	X	X		
18E08	0 - 0.5	CHROMIUM, TOTAL	265	X	X		
18E08	0 - 0.5	LEAD, TOTAL	3890	X	X	X	X
18E08	0 - 0.5	LEAD, TOTAL	3780	X	X	X	X
18E13	4 - 4.5	ARSENIC, TOTAL	103			X	X
18E13	4 - 4.5	CHROMIUM, TOTAL	147	X	X		
18E13	4 - 4.5	LEAD, TOTAL	1470	X	X	X	X
18E15	5 - 5.5	ARSENIC, TOTAL	101			X	X
18E15	5 - 5.5	CHROMIUM, TOTAL	279	X	X		
18E15	5 - 5.5	LEAD, TOTAL	2300	X	X	X	X
18E46	3.5 - 4	CHROMIUM, TOTAL	16.6	X	X		
18E47	4 - 4.5	ARSENIC, TOTAL	29.9			X	X
18E47	4 - 4.5	CHROMIUM, TOTAL	22.7	X	X		
18E49	5 - 5.5	CHROMIUM, TOTAL	19.5	X	X		
18E50	5 - 5.5	CHROMIUM, TOTAL	12.6	X	X		
18E51	0 - 0.5	CHROMIUM, TOTAL	23.7	X	X		
18E51	0 - 0.5	CHROMIUM, TOTAL	40.8	X	X		
18E51	5.5 - 6	CHROMIUM, TOTAL	11.6	X	X		
18E51	5.5 - 6	CHROMIUM, TOTAL	10.6	X	X		
18E52	0 - 0.5	CHROMIUM, TOTAL	16.2	X	X		
18E54	0 - 0.5	CHROMIUM, TOTAL	21.6	X	X		
18E54	5 - 5.5	CHROMIUM, TOTAL	16.7	X	X		
18E94	5 - 5.5	CHROMIUM, TOTAL	18.9	X	X		
18E95	7 - 7.5	CHROMIUM, TOTAL	18.1	X	X		
18E96	0 - 0.5	CHROMIUM, TOTAL	24	X	X		
18E97	0 - 0.5	CHROMIUM, TOTAL	24.8	X	X		
18E98	0 - 0.5	CHROMIUM, TOTAL	18.2	X	X		
18E98	15 - 2	CHROMIUM, TOTAL	20.8	X	X		
18E99	0 - 0.5	CHROMIUM, TOTAL	20.6	X	X		
18E102	4 - 4.5	ARSENIC, TOTAL	69.6			X	X
18E104	0 - 0.5	CHROMIUM, TOTAL	20.4	X	X		
18E121	0 - 0.5	CHROMIUM, TOTAL	52.4	X	X		
18F01	0 - 0.5	ARSENIC, TOTAL	37.1			X	X
18F01	0 - 0.5	CHROMIUM, TOTAL	35.3 J	X	X		
18F01	15 - 2	ARSENIC, TOTAL	43.9			X	X
18F01	15 - 2	CHROMIUM, TOTAL	416 J	X	X		
18F02	0 - 0.5	ARSENIC, TOTAL	20.1			X	X
18F02	0 - 0.5	CHROMIUM, TOTAL	12.3 J	X	X		
18F02	15 - 2	ARSENIC, TOTAL	83.9			X	X
18F02	15 - 2	CHROMIUM, TOTAL	36.4 J	X	X		
18F03	0 - 0.5	ARSENIC, TOTAL	57.1			X	X
18F03	0 - 0.5	CHROMIUM, TOTAL	44.5 J	X	X		
18F03	0 - 0.5	LEAD, TOTAL	649 J		X		X
18F03	15 - 2	ARSENIC, TOTAL	151			X	X
18F03	15 - 2	CHROMIUM, TOTAL	20.6 J	X	X		
18F04	0 - 0.5	CHROMIUM, TOTAL	151	X	X		
18F04	0 - 0.5	LEAD, TOTAL	1170	X	X	X	X
18F04	15 - 2	CHROMIUM, TOTAL	16	X	X		
18F05	0 - 0.5	CHROMIUM, TOTAL	10	X	X		
18F05	15 - 2	ARSENIC, TOTAL	83			X	X
18F05	15 - 2	ARSENIC, TOTAL	77.7			X	X
18F05	15 - 2	CHROMIUM, TOTAL	134	X	X		
18F05	15 - 2	CHROMIUM, TOTAL	73.7	X	X		
18F05	15 - 2	LEAD, TOTAL	898	X	X	X	X

Sample ID	Depth in Feet	Analyte	Result (mg/kg)	EPA Restricted Use	EPA Unrestricted Use	NJDEP Restricted Use	NJDEP Unrestricted Use
18F06	0 - 0.5	CHROMIUM, TOTAL	6.4	X	X		
18F06	15 - 2	ARSENIC, TOTAL	207			X	X
18F06	15 - 2	CHROMIUM, TOTAL	230	X	X		
18F06	15 - 2	LEAD, TOTAL	2830	X	X	X	X
18F07	0 - 0.5	CHROMIUM, TOTAL	49.7	X	X		
18F07	0 - 0.5	LEAD, TOTAL	1070	X	X	X	X
18F07	15 - 2	ARSENIC, TOTAL	409			X	X
18F07	15 - 2	CHROMIUM, TOTAL	685	X	X		
18F07	15 - 2	LEAD, TOTAL	9180	X	X	X	X
18F08	0 - 0.5	CHROMIUM, TOTAL	13.8	X	X		
18F08	15 - 2	CHROMIUM, TOTAL	10.8	X	X		
18F09	0 - 0.5	ARSENIC, TOTAL	185			X	X
18F09	0 - 0.5	CHROMIUM, TOTAL	413	X	X		
18F09	0 - 0.5	LEAD, TOTAL	3460	X	X	X	X
18F09	15 - 2	CHROMIUM, TOTAL	16.5	X	X		
18F10	0 - 0.5	ARSENIC, TOTAL	119			X	X
18F10	0 - 0.5	CHROMIUM, TOTAL	118 J	X	X		
18F10	0 - 0.5	LEAD, TOTAL	1520	X	X	X	X
18F10	15 - 2	ARSENIC, TOTAL	216			X	X
18F10	15 - 2	CHROMIUM, TOTAL	97.2 J	X	X		
18F10	15 - 2	LEAD, TOTAL	1340	X	X	X	X
18F11	0 - 0.5	ARSENIC, TOTAL	54.5			X	X
18F11	0 - 0.5	CHROMIUM, TOTAL	18.8 J	X	X		
18F11	15 - 2	ARSENIC, TOTAL	120			X	X
18F11	15 - 2	CHROMIUM, TOTAL	85.6 J	X	X		
18F11	15 - 2	LEAD, TOTAL	702		X		X
18F12	0 - 0.5	ARSENIC, TOTAL	42.3			X	X
18F12	0 - 0.5	CHROMIUM, TOTAL	24.8 J	X	X		
18F12	15 - 2	ARSENIC, TOTAL	170			X	X
18F12	15 - 2	CHROMIUM, TOTAL	26 J	X	X		
18F13	0 - 0.5	CHROMIUM, TOTAL	23.1 J	X	X		
18F13	0 - 0.5	LEAD, TOTAL	428 J		X		X
18F13	15 - 2	ARSENIC, TOTAL	49.4			X	X
18F13	15 - 2	CHROMIUM, TOTAL	32.9 J	X	X		
18F14	0 - 0.5	CHROMIUM, TOTAL	7.3 J	X	X		
18F14	15 - 2	CHROMIUM, TOTAL	29.9 J	X	X		
18F15	0 - 0.5	CHROMIUM, TOTAL	8.1 J	X	X		
18F15	15 - 2	CHROMIUM, TOTAL	8.8 J	X	X		
18F15	15 - 2	CHROMIUM, TOTAL	9 J	X	X		
18F16	0 - 0.5	CHROMIUM, TOTAL	57.6 J	X	X		
18F16	0 - 0.5	LEAD, TOTAL	491 J		X		X
18F16	15 - 2	CHROMIUM, TOTAL	25.8 J	X	X		
18F16	15 - 2	LEAD, TOTAL	451 J		X		X
18F17	0 - 0.5	CHROMIUM, TOTAL	118 J	X	X		
18F17	15 - 2	ARSENIC, TOTAL	175			X	X
18F17	15 - 2	CHROMIUM, TOTAL	206 J	X	X		
18F17	15 - 2	LEAD, TOTAL	1190 J	X	X	X	X
18F18	0 - 0.5	ARSENIC, TOTAL	121			X	X
18F18	0 - 0.5	CHROMIUM, TOTAL	153 J	X	X		
18F18	0 - 0.5	LEAD, TOTAL	1550 J	X	X	X	X
18F18	15 - 2	CHROMIUM, TOTAL	16.3 J	X	X		
18F21	0 - 0.5	ARSENIC, TOTAL	80.1			X	X
18F21	15 - 2	ARSENIC, TOTAL	488			X	X
18F22	0 - 0.5	ARSENIC, TOTAL	99.4			X	X
18F22	15 - 2	ARSENIC, TOTAL	69			X	X
18F23	0 - 0.5	ARSENIC, TOTAL	84.8			X	X
18F23	0 - 0.5	LEAD, TOTAL	1620	X	X	X	X
18F23	15 - 2	ARSENIC, TOTAL	147			X	X
18F23	15 - 2	LEAD, TOTAL	2190	X	X	X	X
18F24	0 - 0.5	ARSENIC, TOTAL	27			X	X



Sample ID	Depth in Feet	Analyte	Result (mg/kg)	NJDEP Restricted Use	NJDEP Unrestricted Use
18E08	0 - 0.5	ARSENIC, TOTAL	95.2	X	X
18E08	0 - 0.5	ARSENIC, TOTAL	101	X	X
18E08	0 - 0.5	LEAD, TOTAL	3890	X	X
18E08	0 - 0.5	LEAD, TOTAL	3780	X	X
18E13	4 - 4.5	ARSENIC, TOTAL	103	X	X
18E13	4 - 4.5	LEAD, TOTAL	1470	X	X
18E15	5 - 5.5	ARSENIC, TOTAL	101	X	X
18E15	5 - 5.5	LEAD, TOTAL	2300	X	X
18E47	4 - 4.5	ARSENIC, TOTAL	29.9	X	X
18E102	4 - 4.5	ARSENIC, TOTAL	69.6	X	X
18F01	0 - 0.5	ARSENIC, TOTAL	37.1	X	X
18F01	1.5 - 2	ARSENIC, TOTAL	43.9	X	X
18F02	0 - 0.5	ARSENIC, TOTAL	20.1	X	X
18F02	1.5 - 2	ARSENIC, TOTAL	83.9	X	X
18F03	0 - 0.5	ARSENIC, TOTAL	57.1	X	X
18F03	0 - 0.5	LEAD, TOTAL	649 J		X
18F03	1.5 - 2	ARSENIC, TOTAL	151	X	X
18F04	0 - 0.5	LEAD, TOTAL	1170	X	X
18F05	1.5 - 2	ARSENIC, TOTAL	83	X	X
18F05	1.5 - 2	ARSENIC, TOTAL	77.7	X	X
18F05	1.5 - 2	LEAD, TOTAL	898	X	X
18F06	1.5 - 2	ARSENIC, TOTAL	207	X	X
18F06	1.5 - 2	LEAD, TOTAL	2830	X	X
18F07	0 - 0.5	LEAD, TOTAL	1070	X	X
18F07	1.5 - 2	ARSENIC, TOTAL	409	X	X
18F07	1.5 - 2	LEAD, TOTAL	9180	X	X
18F09	0 - 0.5	ARSENIC, TOTAL	185	X	X
18F09	0 - 0.5	LEAD, TOTAL	3460	X	X
18F10	0 - 0.5	ARSENIC, TOTAL	119	X	X
18F10	0 - 0.5	LEAD, TOTAL	1520	X	X
18F10	1.5 - 2	ARSENIC, TOTAL	216	X	X
18F10	1.5 - 2	LEAD, TOTAL	1340	X	X
18F11	0 - 0.5	ARSENIC, TOTAL	54.5	X	X
18F11	1.5 - 2	ARSENIC, TOTAL	120	X	X
18F11	1.5 - 2	LEAD, TOTAL	702		X
18F12	0 - 0.5	ARSENIC, TOTAL	42.3	X	X
18F12	1.5 - 2	ARSENIC, TOTAL	170	X	X
18F13	0 - 0.5	LEAD, TOTAL	428 J		X
18F13	1.5 - 2	ARSENIC, TOTAL	49.4	X	X
18F16	0 - 0.5	LEAD, TOTAL	491 J		X
18F16	1.5 - 2	LEAD, TOTAL	451 J		X
18F17	1.5 - 2	ARSENIC, TOTAL	175	X	X
18F17	1.5 - 2	LEAD, TOTAL	1190 J	X	X
18F18	0 - 0.5	ARSENIC, TOTAL	121	X	X
18F18	0 - 0.5	LEAD, TOTAL	1550 J	X	X
18F21	0 - 0.5	ARSENIC, TOTAL	80.1	X	X
18F21	1.5 - 2	ARSENIC, TOTAL	488	X	X
18F22	0 - 0.5	ARSENIC, TOTAL	99.4	X	X
18F22	1.5 - 2	ARSENIC, TOTAL	69	X	X
18F23	0 - 0.5	ARSENIC, TOTAL	84.8	X	X
18F23	0 - 0.5	LEAD, TOTAL	1620	X	X
18F23	1.5 - 2	ARSENIC, TOTAL	147	X	X
18F23	1.5 - 2	LEAD, TOTAL	2190	X	X
18F24	0 - 0.5	ARSENIC, TOTAL	27	X	X

INVESTIGATION AREA DESCRIPTIONS

Area 1 – Former Demolition Area
Area 18A – Former GSA/U.S. Army Pond Area
Area 18B – Former Firing Range
Area 18C – Former Landfill, Disposal, and Vehicle Processing Area
Area 18D – Trench of Shell Casings
Area 18E – Former Maintenance Area
Area 18F – Former Warehouses
Area 18G – Former Dump

Legend

- Criterion Exceedance
- PAH Sample Locations
- Stormwater Discharge
- Former Railroads
- Existing Railroads
- Monitoring Wells
- Former UST Locations
- Former Buildings
- EPA/GSA Property
- GSA Property
- Tax Parcels
- 1992 Removal Areas
- Excavation Areas
- Soil Investigation Areas
- GW Plume Boundary (2017)
- Former Dump/Landfill
- Beechwood Development
- Geophysical/MEC Survey

Analyte	Human Health Screening Criteria (mg/kg)			
	EPA Restricted Use	EPA Unrestricted Use	NJDEP Restricted Use	NJDEP Unrestricted Use
Benzo(a)anthracene	21	1.1	17	5
Benzo(a)pyrene	2.1	0.11	2	0.5
Benzo(b)fluoranthene	21	1.1	17	5
Benzo(k)fluoranthene	210	11	170	45
Dibenz(a,h)anthracene	2.1	0.11	2	0.5
Indeno(1,2,3,cd)pyrene	21	1.1	17	5
Naphthalene	17	3.8	17	6

Beechwood Development
Area 18E
1999 Geophysical Survey Area
Area 18E Excavation Areas 2011 (HTW)
One 57-mm projectile (inert) was recovered from 18E sometime between 1991 and 1994
Building 15 demo'd 1997
Building 19 demo'd 1997
Building 17 demo'd 1997
Building 18
Building 212
Area 18F
Building 209
Building 205
Building 203 demo'd 1994
Building 202 demo'd 1994
AOC8AB
Owens-Illinois
Former Gas Station
Former UST
Former UST
Former Bldg.241 Automotive Shop
Building 241 demo'd 1994
Building 238
Former Columbia Salvage Company dump
1999 Geophysical Survey Area
Numerous sinkholes and mounds. A cultural Resource Survey including installation of two trenches 360 and 60 ft. long, 2-4 ft. deep - 1 machine gun shell on ground surface.
Area 18G
Trench Area MEC Removal
Building 229
Building 231
Area 18D
UST removal in 2004 located at 529783.2, 609711.6
Former UST
Wash Out Area
Former USTs
Building 256 demo'd 2014
Building 255 demo'd 2014
Grit Blast Room
1998 and 2002 Removal Areas (HTW)
Leach field
2004 Removal (concrete sumps)
Building 245 demo'd 2015
Building 246 demo'd 2015
Meadow Road
1992 Removal Area (HTW)
1998 Removal Area (HTW)
Two 48" Stormwater Discharge Pipes
2002 Removal of small arms ammunition debris
Avenue D
AOC8C
Asbestos Landfill (Approx.)
GSA stored 55 gallon drums of unknown origin or contents. In 1992, EPA investigation of marshy area (18C) revealed no OE.
1998 and 2002 Buried Drum Removal Area
1999 Geophysical Survey Area
1993 MEC Survey Area
1993 MEC Survey Area
1993 MEC Survey Area
1993 MEC Survey Area
2002 Lead Removal Area
2002 Lead Removal Area
2002 Lead Removal Area
Area 18A
Area 18B
Area 18C
Building 151
Building 165
AOC2
1996 Geophysical Survey Area
AOC8D
Area 1
AOC4
Building 409
Building 410
Building 422
Building 423
Building 424
Building 425
Building 426
Building 427
1989 MEC Survey Area
Area 1 - 0.57 acres inspected by the Office of the Chief of Ordnance and Surface Investigations completed by UXB Int'l. over entire area. - no OE found

200 0 200 400
Scale in Feet

Source:
Aerial Photos from NJ Imagery, Natural 2012, WMS Serice, http://njwebmap.state.nj.us/njimagery. Tax Parcels, EPA/GSA Boundary, Exposure Units, and sample locations from Weston Solutions, Inc. May, 2007.

EPA_DR_Fig4-2_HH_Exceed_011719

U.S. EPA and GSA Property Area
Former Raritan Arsenal Site, Edison, NJ

FIGURE 4-2
EXCEEDANCES OF HUMAN HEALTH SOIL SCREENING CRITERIA - PAHs

Legend

- Criterion Exceedance
- PAH Sample Locations
- Stormwater Discharge
- Former Railroads
- Existing Railroads
- Monitoring Wells
- Former UST Locations
- Former Buildings
- EPA/GSA Property
- GSA Property
- Tax Parcels
- 1992 Removal Areas
- Excavation Areas
- Soil Investigation Areas
- GW Plume Boundary (2017)
- Former Dump/Landfill
- Beechwood Development
- Geophysical/MEC Survey

INVESTIGATION AREA DESCRIPTIONS

Area 1 – Former Demolition Area
Area 18A – Former GSA/U.S. Army Pond Area
Area 18B – Former Firing Range
Area 18C – Former Landfill, Disposal, and Vehicle Processing Area
Area 18D – Trench of Shell Casings
Area 18E – Former Maintenance Area
Area 18F – Former Warehouses
Area 18G – Former Dump

Human Health Screening Criteria (mg/kg)

Analyte	NJDEP Restricted Use	NJDEP Unrestricted Use
Benzo(a)anthracene	17	5
Benzo(a)pyrene	2	0.5
Benzo(b)fluoranthene	17	5
Dibenz(a,h)anthracene	2	0.5
Indeno(1,2,3,cd)pyrene	17	5
Naphthalene	17	6

Beechwood Development
Area 18E
1999 Geophysical Survey Area
Area 18E Excavation Areas 2011 (HTW)
One 57-mm projectile (inert)was recovered from 18E sometime between 1991 and 1994
Building 15 demo'd 1997
Building 19 demo'd 1997
Building 17 demo'd 1997
Building 18
Owens-Illinois
Inland Container
Area 18F
Building 212
Building 209
Building 205
Building 203 demo'd 1994
Building 202 demo'd 1994
AOC8AB
Former Gas Station
Former UST
Former UST
Former Bldg.241 Automotive Shop
Building 241 demo'd 1994
Building 238
Former Columbia Salvage Company dump
1999 Geophysical Survey Area
Numerous sinkholes and mounds. A cultural Resource Survey including installation of two trenches 360 and 60 ft. long, 2-4 ft. deep - 1 machine gun shell on ground surface.
Area 18G
Former UST
Former USTs
Wash Out Area
Grit Blast Room
Building 256 demo'd 2014
Building 255 demo'd 2014
2004 Removal (concrete sumps)
1998 and 2002 Removal Areas (HTW)
Leach field
Building 229
Building 231
Trench Area MEC Removal
Area 18D
Building 245 demo'd 2015
Building 246 demo'd 2015
Meadow Road
Avenue D
1992 Removal Area (HTW)
1998 Removal Area (HTW)
Two 48" Stormwater Discharge Pipes
2002 Removal of small arms ammunition debris
AOC8C
Asbestos Landfill (Approx.)
GSA stored 55 gallon drums of unknown origin or contents. In 1992, EPA investigation of marshy area (18C) revealed no OE.
1998 and 2002 Buried Drum Removal Area
1999 Geophysical Survey Area
Area 18C
1993 MEC Survey Area
1993 MEC Survey Area
1993 MEC Survey Area
1993 MEC Survey Area
2002 Lead Removal Area
2002 Lead Removal Area
2002 Lead Removal Area
Area 18A
Area 18B
AOC8D
Area 1
1989 MEC Survey Area
1996 Geophysical Survey Area
Building 151
Building 165
AOC2
AOC4
Building 409
Building 410
Building 422
Building 423
Building 424
Building 425
Building 426
Area 1 - 0.57 acres inspected by the Office of the Chief of Ordnance and Surface Investigations completed by UXB Int'l. over entire area. - no OE found

200 0 200 400
Scale in Feet

Source:
Aerial Photos from NJ Imagery, Natural 2012, WMS Serice, http://njwebmap.state.nj.us/njimagery. Tax Parcels, EPA/GSA Boundary, Exposure Units, and sample locations from Weston Solutions, Inc. May, 2007.

U.S. EPA and GSA Property Area
Former Raritan Arsenal Site, Edison, NJ

FIGURE 4-2A
EXCEEDANCES OF NJDEP HUMAN HEALTH SOIL SCREENING CRITERIA - PAHs

EPA_SR_Fig4-2A_HH_Exceed_011710

Sample ID	Depth in Feet	Analyte	Result (mg/kg)	EPA Restricted Use	EPA Unrestricted Use	NJDEP Restricted Use	NJDEP Unrestricted Use
AREA1-1	4 - 4.5	ARSENIC, TOTAL	32.5			X	X
AREA1-2	3.5 - 4	ARSENIC, TOTAL	614			X	X
AREA1-3	3.5 - 4	ARSENIC, TOTAL	28			X	X
AREA1-4	3.5 - 4	ARSENIC, TOTAL	39.5			X	X
AREA1-5	4 - 4.5	ARSENIC, TOTAL	211			X	X
AREA1-6	4 - 4.5	ARSENIC, TOTAL	517			X	X
AREA1-7	4 - 4.5	ARSENIC, TOTAL	35.8			X	X
AREA1-8	4 - 4.5	ARSENIC, TOTAL	29.8			X	X
AREA1E-1	4 - 4.5	ARSENIC, TOTAL	24.4			X	X
AREA1E-2	4 - 4.5	ARSENIC, TOTAL	25.1			X	X
PE-18C187A	6.5 - 7	VANADIUM, TOTAL	101				X
PE-18C191A	6.5 - 7	VANADIUM, TOTAL	95.3				X
SS-18A02A	0 - 0.5	LEAD, TOTAL	576 J		X		X
SS-18A04A	0 - 0.5	AROCLOR-1260	0.47		X		X
SS-18A04A	0 - 0.5	LEAD, TOTAL	1600	X	X	X	X
SS-18A28B	4.5 - 5	THALLIUM, TOTAL	17 J		X		
SS-18B23A	0 - 0.5	ARSENIC, TOTAL	22.3			X	X
SS-18B25A	0 - 0.5	LEAD, TOTAL	416		X		X
SS-18C07A	0 - 0.5	TRICHLOROETHYLENE	15		X		
SS-18C18	1.5 - 2	ARSENIC, TOTAL	111			X	X
SS-18C28A	0 - 0.5	ARSENIC, TOTAL	94.8			X	X
SS-18C29A	0 - 0.5	ARSENIC, TOTAL	28.4			X	X
SS-18C41A	0 - 0.5	PENTACHLOROPHENOL	48	X	X	X	X
SS-18C67A	0 - 0.5	PENTACHLOROPHENOL	91 J	X	X	X	X
SS-18E02A	0 - 0.5	THALLIUM, TOTAL	0.8		X		
SS-18E08A	0 - 0.5	ARSENIC, TOTAL	95.2			X	X
SS-18E08A	0 - 0.5	LEAD, TOTAL	3890	X	X	X	X
SS-18E09A	0 - 0.5	THALLIUM, TOTAL	12		X		
SS-18E12A	4 - 4.5	ARSENIC, TOTAL	69.6			X	X
SS-18E11	1.5 - 2	THALLIUM, TOTAL	12		X		
SS-18E23A	0 - 0.5	ARSENIC, TOTAL	260			X	X
SS-18E23B	3.5 - 4	ARSENIC, TOTAL	198			X	X
SS-18E23C	5 - 5.5	ARSENIC, TOTAL	236			X	X
SS-18E23Z	0 - 0.5	ARSENIC, TOTAL	176			X	X
SS-18E33B	6 - 6.5	ARSENIC, TOTAL	35.9			X	X
SS-18E20A	0 - 0.5	ARSENIC, TOTAL	101			X	X
SS-18E20A	0 - 0.5	LEAD, TOTAL	3780	X	X	X	X
SS-18E47A	4 - 4.5	ARSENIC, TOTAL	29.9			X	X
SS-18F01A	0 - 0.5	ARSENIC, TOTAL	37.1			X	X
SS-18F01B	1.5 - 2	ARSENIC, TOTAL	43.9			X	X
SS-18F02A	0 - 0.5	ARSENIC, TOTAL	20.1			X	X
SS-18F02B	1.5 - 2	ARSENIC, TOTAL	83.9			X	X
SS-18F03A	0 - 0.5	ARSENIC, TOTAL	57.1			X	X
SS-18F03A	0 - 0.5	LEAD, TOTAL	649 J		X		
SS-18F03B	1.5 - 2	ARSENIC, TOTAL	151			X	X
SS-18F04A	0 - 0.5	LEAD, TOTAL	1170	X	X	X	X
SS-18F05B	1.5 - 2	ARSENIC, TOTAL	83			X	X
SS-18F05B	1.5 - 2	LEAD, TOTAL	898	X	X	X	X
SS-18F06B	1.5 - 2	ARSENIC, TOTAL	207			X	X
SS-18F06B	1.5 - 2	LEAD, TOTAL	2830	X	X	X	X
SS-18F07A	0 - 0.5	ANTIMONY, TOTAL	69.7		X		
SS-18F07A	0 - 0.5	LEAD, TOTAL	1070	X	X	X	X
SS-18F07B	1.5 - 2	ARSENIC, TOTAL	409			X	X
SS-18F07B	1.5 - 2	LEAD, TOTAL	3180	X	X	X	X
SS-18F09A	0 - 0.5	ARSENIC, TOTAL	185			X	X
SS-18F09A	0 - 0.5	LEAD, TOTAL	3460	X	X	X	X
SS-18F10A	0 - 0.5	ARSENIC, TOTAL	119			X	X
SS-18F10A	0 - 0.5	LEAD, TOTAL	1520	X	X	X	X
SS-18F10B	1.5 - 2	ARSENIC, TOTAL	216			X	X
SS-18F10B	1.5 - 2	LEAD, TOTAL	1340	X	X	X	X
SS-18F11A	0 - 0.5	ARSENIC, TOTAL	54.5			X	X
SS-18F11B	1.5 - 2	ARSENIC, TOTAL	120			X	X
SS-18F11B	1.5 - 2	LEAD, TOTAL	702		X		X
SS-18F12A	0 - 0.5	ARSENIC, TOTAL	42.3			X	X
SS-18F12B	1.5 - 2	ARSENIC, TOTAL	170			X	X
SS-18F13A	0 - 0.5	LEAD, TOTAL	428 J		X		X
SS-18F13B	1.5 - 2	ARSENIC, TOTAL	49.4			X	X
SS-18F16A	0 - 0.5	LEAD, TOTAL	491 J		X		X
SS-18F16B	1.5 - 2	LEAD, TOTAL	451 J		X		X
SS-18F17B	1.5 - 2	ARSENIC, TOTAL	175			X	X
SS-18F17B	1.5 - 2	LEAD, TOTAL	1160 J	X	X	X	X
SS-18F18A	0 - 0.5	ARSENIC, TOTAL	121			X	X
SS-18F18A	0 - 0.5	LEAD, TOTAL	1550 J	X	X	X	X
SS-18F18B	1.5 - 2	ARSENIC, TOTAL	777			X	X
SS-18F21A	0 - 0.5	ARSENIC, TOTAL	80.1			X	X
SS-18F21B	1.5 - 2	ARSENIC, TOTAL	488			X	X
SS-18F22A	0 - 0.5	ARSENIC, TOTAL	99.4			X	X
SS-18F22B	1.5 - 2	ARSENIC, TOTAL	69			X	X
SS-18F23A	0 - 0.5	ARSENIC, TOTAL	84.8			X	X
SS-18F23A	0 - 0.5	LEAD, TOTAL	1020	X	X	X	X
SS-18F23B	1.5 - 2	ARSENIC, TOTAL	147			X	X
SS-18F23B	1.5 - 2	LEAD, TOTAL	2190	X	X	X	X
SS-18F24A	0 - 0.5	ARSENIC, TOTAL	27			X	X
SS-18G01B	6 - 6.5	ANTIMONY, TOTAL	242		X		X
SS-18G01B	6 - 6.5	LEAD, TOTAL	1470	X	X	X	X
SS-18G02B	8.5 - 9	LEAD, TOTAL	2470	X	X	X	X
SS-18G18Z	1 - 1.5	ARSENIC, TOTAL	212			X	X
SS-AOC2MIP05-07	7 - 7.5	TRICHLOROETHYLENE	6.1	X	X		X
TP-18A08A	3.5 - 4	ETHYLBENZENE	10 J		X		
TP-18A08A	3.5 - 4	VINYL CHLORIDE	0.48 J		X		
TP-18B09B	1.5 - 2	LEAD, TOTAL	1000	X	X	X	X
TP-18C15A	3.5 - 4	AROCLOR-1260	0.25		X		X
TP-18E09B	1.5 - 2	LEAD, TOTAL	1000	X	X	X	X
TP-18C15A	3.5 - 4	AROCLOR-1260	0.25		X		X
TP-18C58B	9.5 - 10	ETHYLBENZENE	8.8		X		
TP-18C70B	3.5 - 4	DIELDRIN	0.041		X		X
TP-18C70B	3.5 - 4	LEAD, TOTAL	576 J		X		X
TP-18C71A	3.5 - 4	AROCLOR-1260	0.37		X		X
TP-18C72A	5.5 - 6	4,4-DDT	3.8		X		X
TP-18C72A	5.5 - 6	LEAD, TOTAL	4651		X		X
TP-18E13A	4 - 4.5	AROCLOR-1260	0.31		X		X
TP-18E13A	4 - 4.5	ARSENIC, TOTAL	103			X	X
TP-18E13A	4 - 4.5	LEAD, TOTAL	1470	X	X	X	X
TP-18E13A	4 - 4.5	THALLIUM, TOTAL	1		X		
TP-18E15A	5 - 5.5	AROCLOR-1260	0.97		X		X
TP-18E15A	5 - 5.5	ARSENIC, TOTAL	131			X	X
TP-18E15A	5 - 5.5	LEAD, TOTAL	2300	X	X	X	X
TP-18E16A	5.5 - 6	CHLOROFORM	3.5	X	X	X	X
TP-18E16A	5.5 - 6	TRICHLOROETHYLENE	2.1		X		

Human Health Screening Criteria (mg/kg)				
Analyte	EPA Restricted Use	EPA Unrestricted Use	NJDEP Restricted Use	NJDEP Unrestricted Use
4,4-DDT	8.5	1.9	8	2
Dieldrin	0.14	0.034	0.2	0.04
Aroclor 1260	0.99	0.24	1	0.2
Chloroform	1.4	0.32	2	0.6
Ethylbenzene	25	5.8	110,000	7,800
Pentachlorophenol	4	1	3	0.9
Trichloroethylene	6	0.94	10	3
Vinyl chloride	1.7	0.06	2	0.7
Antimony	470	31	450	31
Arsenic	NA	NA	19	19
Lead	800	400	800	400
Thallium	12	0.78	NA	NA
Vanadium	5,800	390	1,100	78
Units in mg/kg.				

Legend
- Criterion Exceedance
- Soil Sample Location
- Stormwater Discharge
- Monitoring Wells
- Former UST Locations
- Existing Railroads
- Former Railroads
- Former Buildings
- EPA/GSA Property
- GSA Property
- Tax Parcels
- Excavation Areas
- Soil Investigation Areas
- GW Plume Boundary (2107)
- Former Dump/Landfill
- Beechwood Development
- Geophysical/MEC Survey

INVESTIGATION AREA DESCRIPTIONS
Area 1 – Former Demolition Area
Area 18A – Former GSA/U.S. Army Pond Area
Area 18B – Former Firing Range
Area 18C – Former Landfill, Disposal, and Vehicle Processing Area
Area 18D – Trench of Shell Casings
Area 18E – Former Maintenance Area
Area 18F – Former Warehouses
Area 18G – Former Dump

Beechwood Development
Area 18E
Area 18F
Area 18A
Area 18B
Area 18C
Area 18D
Area 18G
Area 1
AOC8AB
AOC8C
AOC8D
AOC4
AOC2
Building 212
Building 209
Building 205
Building 203 demo'd 1994
Building 202 demo'd 1994
Building 18
Building 15 demo'd 1997
Building 19 demo'd 1997
Building 14 demo'd 1997
Building 238
Building 241 demo'd 1994
Building 256 demo'd 2014
Building 255 demo'd 2014
Building 231
Building 165
Building 151
Building 409
Building 410
Building 422
Building 423
Building 424
Building 425
Building 426
Owens-Illinois
Inland Container
Avenue D
Meadow Road
One 57-mm projectile (inert)was recovered from 18E sometime between 1991 and 1994
1999 Geophysical Survey Area
Area 18E Excavation Areas 2011 (HTW)
Former Columbia Salvage Company dump
Former Gas Station
Former UST
Former Bldg.241 Automotive Shop
Trench Area MEC Removal
Numerous sinkholes and mounds. A cultural Resource Survey including installation of two trenches 360 and 60 ft. long, 2-4 ft. deep - 1 machine gun shell on ground surface.
Wash Out Area
Former USTs
Grit Blast Room
1998 and 2002 Removal Area (HTW)
Leach field
2004 Removal (concrete sumps)
Asbestos Landfill (Approx.)
GSA stored 55 gallon drums of unknown origin or contents. In 1992, EPA investigation of marshy area (18C) revealed no OE.
1999 Geophysical Survey Area
1998 and 2002 Buried Drum Removal Area
1993 MEC Survey Area
2002 Lead Removal Area
1996 Geophysical Survey Area
1989 MEC Survey Area
Area 1 - 0.57 acres inspected by the Office of the Chief of Ordnance and Surface Investigations completed by UXB Int'l. over entire area. - no OE found
1992 Removal Area (HTW)
1998 Removal Area (HTW)
2002 Removal of small arms ammunition debris
Two 48" Stormwater Discharge Pipes
1993 MEC Survey Area
2002 Lead Removal Area
Scale in Feet: 200 0 200 400
Source: Aerial Photos from NJ Imagery, Natural 2012, WMS Serice, http://njwebmap.state.nj.us/njimagery. Tax Parcels, EPA/GSA Boundary, Exposure Units, and sample locations from Weston Solutions, Inc. May, 2007.

U.S. EPA and GSA Property Area
Former Raritan Arsenal Site, Edison, NJ

FIGURE 4-3
EXCEEDANCES OF HUMAN HEALTH SOIL SCREENING CRITERIA - OTHER ANALYTES

epa_Soil_Fig4-3_Hth_AllExc_011719

Area 2

Sample ID	Depth in Feet	Analyte	Result (mg/kg)	NJDEP Restricted Use	NJDEP Unrestricted Use
AREA1-1	4-4.5	ARSENIC, TOTAL	32.5	X	X
AREA1-2	3.5-4	ARSENIC, TOTAL	614	X	X
AREA1-3	3.5-4	ARSENIC, TOTAL	28	X	X
AREA1-4	3.5-4	ARSENIC, TOTAL	39.5	X	X
AREA1-5	4-4.5	ARSENIC, TOTAL	211	X	X
AREA1-6	4-4.5	ARSENIC, TOTAL	517	X	X
AREA1-7	4-4.5	ARSENIC, TOTAL	35.8	X	X
AREA1-8	4-4.5	ARSENIC, TOTAL	29.8	X	X
AREA1E-1	4-4.5	ARSENIC, TOTAL	24.4	X	X
AREA1E-2	4-4.5	ARSENIC, TOTAL	25.1	X	X
PE-18C18A	6.5-7	VANADIUM, TOTAL	101		X
PE-18C19A	6.5-7	VANADIUM, TOTAL	95.3		X
SS-18A02A	0-0.5	LEAD, TOTAL	576 J		X
SS-18A04A	0-0.5	AROCLOR-1260	0.47		X
SS-18A04A	0-0.5	LEAD, TOTAL	1800	X	X
SS-18B23A	0-0.5	ARSENIC, TOTAL	22.3	X	X
SS-18B25A	0-0.5	LEAD, TOTAL	416		X
SS-18C14B	1.5-2	ARSENIC, TOTAL	111	X	X
SS-18C28A	0-0.5	ARSENIC, TOTAL	94.8	X	X
SS-18C29A	0-0.5	ARSENIC, TOTAL	28.4	X	X
SS-18C41A	0-0.5	PENTACHLOROPHENOL	48	X	X
SS-18C67A	0-0.5	PENTACHLOROPHENOL	19 J	X	X
SS-18E08A	0-0.5	ARSENIC, TOTAL	95.2	X	X
SS-18E08A	0-0.5	LEAD, TOTAL	3890	X	X
SS-18E12A	4-4.5	ARSENIC, TOTAL	69.6	X	X
SS-18E12A	0-0.5	ARSENIC, TOTAL	260	X	X
SS-18E23B	3.5-4	ARSENIC, TOTAL	138	X	X
SS-18E23C	5-5.5	ARSENIC, TOTAL	236	X	X
SS-18E23Z	0-0.5	ARSENIC, TOTAL	176	X	X
SS-18E38B	6-6.5	ARSENIC, TOTAL	35.9	X	X
SS-18E20A	0-0.5	ARSENIC, TOTAL	101	X	X
SS-18E20A	0-0.5	LEAD, TOTAL	3780	X	X
SS-18E47A	4-4.5	ARSENIC, TOTAL	29.9	X	X
SS-18F01A	0-0.5	ARSENIC, TOTAL	37.1	X	X
SS-18F01B	1.5-2	ARSENIC, TOTAL	43.9	X	X
SS-18F02A	0-0.5	ARSENIC, TOTAL	20.1	X	X
SS-18F02B	1.5-2	ARSENIC, TOTAL	83.9	X	X
SS-18F03A	0-0.5	ARSENIC, TOTAL	57.1	X	X
SS-18F03A	0-0.5	LEAD, TOTAL	649 J		X
SS-18F03B	1.5-2	ARSENIC, TOTAL	151	X	X
SS-18F04A	0-0.5	LEAD, TOTAL	1170	X	X
SS-18F05B	1.5-2	ARSENIC, TOTAL	83	X	X
SS-18F05B	1.5-2	LEAD, TOTAL	898	X	X
SS-18F06B	1.5-2	ARSENIC, TOTAL	207	X	X
SS-18F06B	1.5-2	LEAD, TOTAL	2630	X	X
SS-18F07A	0-0.5	ANTIMONY, TOTAL	89.7		X
SS-18F07A	0-0.5	LEAD, TOTAL	1070	X	X
SS-18F07B	1.5-2	ARSENIC, TOTAL	409	X	X
SS-18F07B	1.5-2	LEAD, TOTAL	9180	X	X
SS-18F09A	0-0.5	ARSENIC, TOTAL	185	X	X
SS-18F09A	0-0.5	LEAD, TOTAL	3460	X	X
SS-18F10A	0-0.5	ARSENIC, TOTAL	119	X	X
SS-18F10A	0-0.5	LEAD, TOTAL	1520	X	X
SS-18F10B	1.5-2	ARSENIC, TOTAL	216	X	X
SS-18F10B	1.5-2	LEAD, TOTAL	1340	X	X
SS-18F11A	0-0.5	ARSENIC, TOTAL	54.5	X	X
SS-18F11B	1.5-2	ARSENIC, TOTAL	120	X	X
SS-18F11B	1.5-2	LEAD, TOTAL	702		X
SS-18F12A	0-0.5	ARSENIC, TOTAL	42.3	X	X
SS-18F12B	1.5-2	ARSENIC, TOTAL	170	X	X
SS-18F19A	0-0.5	LEAD, TOTAL	428 J		X
SS-18F19B	1.5-2	ARSENIC, TOTAL	49.4	X	X
SS-18F19A	0-0.5	LEAD, TOTAL	491 J		X
SS-18F19B	1.5-2	LEAD, TOTAL	451 J		X
SS-18F17B	1.5-2	ARSENIC, TOTAL	175	X	X
SS-18F17B	1.5-2	LEAD, TOTAL	1190 J	X	X
SS-18F18A	0-0.5	ARSENIC, TOTAL	121	X	X
SS-18F18A	0-0.5	LEAD, TOTAL	1550 J	X	X
SS-18F18B	1.5-2	ARSENIC, TOTAL	77.7	X	X
SS-18F21A	0-0.5	ARSENIC, TOTAL	80.1	X	X
SS-18F21B	1.5-2	ARSENIC, TOTAL	488	X	X
SS-18F22A	0-0.5	ARSENIC, TOTAL	99.4	X	X
SS-18F22B	1.5-2	ARSENIC, TOTAL	69	X	X
SS-18F23A	0-0.5	ARSENIC, TOTAL	84.8	X	X
SS-18F23A	0-0.5	LEAD, TOTAL	1620	X	X
SS-18F23B	1.5-2	ARSENIC, TOTAL	147	X	X
SS-18F23B	1.5-2	LEAD, TOTAL	2190	X	X
SS-18F24A	0-0.5	ARSENIC, TOTAL	27	X	X
SS-18G01B	6-6.5	ANTIMONY, TOTAL	242		X
SS-18G01B	6-6.5	LEAD, TOTAL	1470	X	X
SS-18G02B	8.5-9	LEAD, TOTAL	2470	X	X
SS-18G18Z	1-1.5	ARSENIC, TOTAL	212	X	X
TP-18B09B	1.5-2	LEAD, TOTAL	1000	X	X
TP-18C15A	3.5-4	AROCLOR-1260	0.25		X
TP-18C70B	3.5-4	DIELDRIN	0.041		X
TP-18C70B	3.5-4	LEAD, TOTAL	576 J		X
TP-18C71A	3.5-4	AROCLOR-1260	0.37		X
TP-18C72A	5.5-6	4,4-DDT	3.8		X
TP-18C72A	5.5-6	LEAD, TOTAL	461 J		X
TP-18E15A	4-4.5	AROCLOR-1260	0.31		X
TP-18E19A	4-4.5	ARSENIC, TOTAL	103	X	X
TP-18E19A	4-4.5	LEAD, TOTAL	1470	X	X
TP-18E15A	5-5.5	AROCLOR-1260	0.97		X
TP-18E15A	5-5.5	ARSENIC, TOTAL	101	X	X
TP-18E15A	5-5.5	LEAD, TOTAL	2300	X	X
TP-18E16A	5.5-6	CHLOROFORM	3.5	X	X
TP-18B09B	1.5-2	LEAD, TOTAL	1000	X	X
SSAOC2M_P05-07	7-7.5	TRICHLOROETHYLENE	6.1		X

Legend

- Criterion Exceedance
- Soil Sample Location
- Stormwater Discharge
- Monitoring Wells
- Former UST Locations
- Existing Railroads
- Former Railroads
- Former Buildings
- EPA/GSA Property
- GSA Property
- Tax Parcels
- Excavation Areas
- Soil Investigation Areas
- GW Plume Boundary (2017)
- Former Dump/Landfill
- Beechwood Development
- Geophysical/MEC Survey

Human Health Screening Criteria (mg/kg)

Analyte	NJDEP Restricted Use	NJDEP Unrestricted Use
4,4-DDT	8	2
Dieldrin	0.2	0.04
Aroclor 1260	1	0.2
Chloroform	2	0.6
Pentachlorophenol	10	3.9
Antimony	450	31
Arsenic	19	19
Lead	800	400
Vanadium	1,100	78
Trichloroethylene	10	3

Units in mg/kg.

INVESTIGATION AREA DESCRIPTIONS

Area 1 – Former Demolition Area
Area 18A – Former GSA/U.S. Army Pond Area
Area 18B – Former Firing Range
Area 18C – Former Landfill, Disposal, and Vehicle Processing Area
Area 18D – Trench of Shell Casings
Area 18E – Former Maintenance Area
Area 18F – Former Warehouses
Area 18G – Former Dump

Beechwood Development
One 57-mm projectile (inert) was recovered from 18E sometime between 1991 and 1994
1999 Geophysical Survey Area
Area 18E Excavation Areas 2011 (HTW)
Area 18E
Building 15 demo'd 1997
Building 19 demo'd 1997
Building 18
Building 17 demo'd 1997
Owens-Illinois
Inland Container
Building 212
Area 18F
Building 209
Building 205
Building 203 demo'd 1994
Building 202 demo'd 1994
AOC8AB
Former Gas Station
Former UST
Former UST
Former Columbia Salvage Company dump
Building 238
Former Bldg.241 Automotive Shop
Building 241 demo'd 1994
1999 Geophysical Survey Area
Area 18G
Numerous sinkholes and mounds. A cultural Resource Survey including installation of two trenches 360 and 60 ft. long, 2-4 ft. deep - 1 machine gun shell on ground surface.
Former UST
Trench Area MEC Removal
Wash Out Area
Former USTs
Building 231
Area 18D
Building 245 demo'd 2015
Building 246 demo'd 2015
Building 256 demo'd 2014
Grit Blast Room
1998 and 2002 Removal Areas (HTW)
Leach field
2004 Removal (concrete sumps)
Building 255 demo'd 2014
Meadow Road
Asbestos Landfill (Approx.)
GSA stored 55 gallon drums of unknown origin or contents. In 1992, EPA investigation of marshy area (18C) revealed no OE.
1999 Geophysical Survey Area
Two 48" Stormwater Discharge Pipes
1992 Removal Area (HTW)
1998 Removal Area (HTW)
2002 Removal of small arms ammunition debris
Avenue D
AOC8C
1993 MEC Survey Area
1993 MEC Survey Area
1993 MEC Survey Area
2002 Lead Removal Area
Area 18A
Area 18B
Area 18c
1998 and 2002 Buried Drum Removal Area
2002 Lead Removal Area
1993 MEC Survey Area
1999 Geophysical Survey Area
1996 Geophysical Survey Area
Building 151
Building 165
AOC2
AOC8D
Area 1
AOC4
1989 MEC Survey Area
Area 1 - 0.57 acres inspected by the Office of the Chief of Ordnance and Surface Investigations completed by UXB Int'l. over entire area. - no OE found
Building 409
Building 410
Building 422
Building 423
Building 424
Building 425
Building 426
1998 and 2002 Removal Areas (HTW)
Leach field
1999 Geophysical Survey Area

N W E S

200 0 200 400
Scale in Feet

Source:
Aerial Photos from NJ Imagery, Natural 2012, WMS Serice, http://njwebmap.state.nj.us/njimagery. Tax Parcels, EPA/GSA Boundary, Exposure Units, and sample locations from Weston Solutions, Inc. May, 2007.

U.S. EPA and GSA Property Area
Former Raritan Arsenal Site, Edison, NJ

FIGURE 4-3A
EXCEEDANCES OF NJDEP HUMAN HEALTH SOIL SCREENING CRITERIA - OTHER ANALYTES

EPA_DR_Fig4-3A_HH_AllExc_071719

Sample ID	Depth in Feet	Analyte	Result (mg/kg)
SS18A41	0 - 0.5	ALUMINUM, TOTAL	4180 J
SS18A41	0 - 0.5	ANTIMONY, TOTAL	0.62 J
SS18A41	0 - 0.5	IRON, TOTAL	6720 J
SS18A41	0 - 0.5	LEAD, TOTAL	30.2 J
SS18A41	0 - 0.5	MERCURY, TOTAL	0.047
SS18A41	0 - 0.5	VANADIUM, TOTAL	26.7 J
SS18A42	0 - 0.5	ALUMINUM, TOTAL	792 J
SS18A42	0 - 0.5	ANTIMONY, TOTAL	0.36 J
SS18A42	0 - 0.5	IRON, TOTAL	3300 J
SS18A42	0 - 0.5	LEAD, TOTAL	18.4 J
SS18A42	0 - 0.5	VANADIUM, TOTAL	15.2 J
SS18A43	0 - 0.5	4,4-DDT	0.004 J
SS18A43	0 - 0.5	ALUMINUM, TOTAL	1020 J
SS18A43	0 - 0.5	ANTIMONY, TOTAL	0.52 J
SS18A43	0 - 0.5	IRON, TOTAL	6040 J
SS18A43	0 - 0.5	LEAD, TOTAL	25.5 J
SS18A43	0 - 0.5	VANADIUM, TOTAL	18.9 J
SS18B81	0 - 0.5	4,4-DDT	0.028
SS18B81	0 - 0.5	ALUMINUM, TOTAL	1730 J
SS18B81	0 - 0.5	ANTIMONY, TOTAL	1.6 J
SS18B81	0 - 0.5	COPPER, TOTAL	28.5 J
SS18B81	0 - 0.5	IRON, TOTAL	7670 J
SS18B81	0 - 0.5	LEAD, TOTAL	57.7 J
SS18B81	0 - 0.5	MERCURY, TOTAL	0.21
SS18B81	0 - 0.5	SELENIUM, TOTAL	1 J
SS18B81	0 - 0.5	VANADIUM, TOTAL	22.9 J

Ecological Soil Screening Benchmarks	
Analyte	*Benchmark (mg/kg)*
4,4-DDT	0.0035
Aluminum	600
Antimony	0.27
Cadmium	0.36
Copper	28
Iron	200
Lead	11
Mercury	0.000051
Selenium	0.52
Vanadium	7.8
Zinc	46

Ecological Sediment Screening Benchmarks	
Analyte	*Benchmark (mg/kg)*
2-Methylnaphthalene	0.02
4,4-DDD	0.0049
4,4-DDT	0.0042
Acenaphthene	0.0067
Acenaphthylene	0.0059
Anthracene	0.027
Benzo(a)anthracene	0.11
Benzo(a)pyrene	0.14
Benzo(g,h,i)perylene	0.17
Benzo(k)fluoranthene	0.24
Chrysene	0.17
delta-BHC	0.0002
Dibenz(a,h)anthracene	0.033
Dibenzofuran	0.42
Dieldrin	0.0006
Endosulfan II	0.014
Endrin aldehyde	0.0005
Endrin ketone	0.0005
Fluoranthene	0.42
Fluorene	0.077
Heptachlor	0.0003
Indeno(1,2,3-c,d)pyrene	0.017
Methoxychlor	0.019
Naphthalene	0.18
Phenanthrene	0.2
Pyrene	0.2
Copper	16
Lead	31

Sample ID	Depth in Feet	Analyte	Result (mg/kg)
SD1811	0 - 0.5	4,4-DDT	0.0096 J
SD1811	0 - 0.5	COPPER, TOTAL	53.9 J
SD1811	0 - 0.5	LEAD, TOTAL	37.2 J
SD1812	0 - 0.5	COPPER, TOTAL	163 J
SD1812	0 - 0.5	DELTA-BHC	0.0048 P
SD1812	0 - 0.5	DIBENZOFURAN	15
SD1812	0 - 0.5	ENDOSULFAN II	0.027 J
SD1812	0 - 0.5	HEPTACHLOR	0.0035 J
SD1812	0 - 0.5	METHOXYCHLOR	1 J
SD1813	0 - 0.5	DIBENZOFURAN	0.89
SD1813	0 - 0.5	METHOXYCHLOR	0.035 J
SD1814	0 - 0.5	DIBENZOFURAN	2.9 JD
SD1814	0 - 0.5	DIELDRIN	0.0036 J
SD1814	0 - 0.5	ENDRIN ALDEHYDE	0.0031 J
SD1814	0 - 0.5	ENDRIN KETONE	0.0053 J
SD1814	0 - 0.5	METHOXYCHLOR	0.071 J
SD1815	0 - 0.5	4,4-DDD	0.027 J
SD1815	0 - 0.5	DIBENZOFURAN	9.5 JD
SD1815	0 - 0.5	ENDOSULFAN II	0.031 J
SD1815	0 - 0.5	HEPTACHLOR	0.0034 J
SD1815	0 - 0.5	LEAD, TOTAL	59.5 J
SD1815	0 - 0.5	METHOXYCHLOR	0.49 J
SD1816	0 - 0.5	COPPER, TOTAL	97.7 J
SD1816	0 - 0.5	DIBENZOFURAN	6.9 JD
SD1816	0 - 0.5	DIELDRIN	0.0083 J
SD1816	0 - 0.5	ENDRIN ALDEHYDE	0.0068 J
SD1816	0 - 0.5	METHOXYCHLOR	0.33 J
SD-1819	0 - 0.5	ANTHRACENE	0.035 J
SD-1819	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	0.084
SD-1819	0 - 0.5	PYRENE	0.22
SD-1820	0 - 0.5	2-METHYLNAPHTHALENE	3.4
SD-1820	0 - 0.5	ACENAPHTHENE	12
SD-1820	0 - 0.5	ACENAPHTHYLENE	0.45 J
SD-1820	0 - 0.5	ANTHRACENE	13
SD-1820	0 - 0.5	BENZO(A)ANTHRACENE	36
SD-1820	0 - 0.5	BENZO(A)PYRENE	30
SD-1820	0 - 0.5	BENZO(G,H,I)PERYLENE	19
SD-1820	0 - 0.5	BENZO(K)FLUORANTHENE	24
SD-1820	0 - 0.5	CHRYSENE	38
SD-1820	0 - 0.5	DIBENZ(A,H)ANTHRACENE	5.4
SD-1820	0 - 0.5	FLUORANTHENE	98
SD-1820	0 - 0.5	FLUORENE	12
SD-1820	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	17
SD-1820	0 - 0.5	NAPHTHALENE	6.9
SD-1820	0 - 0.5	PHENANTHRENE	99
SD-1820	0 - 0.5	PYRENE	77
SD-1821A	0 - 0.5	2-METHYLNAPHTHALENE	20
SD-1821A	0 - 0.5	ACENAPHTHENE	79
SD-1821A	0 - 0.5	ACENAPHTHYLENE	17 J
SD-1821A	0 - 0.5	ANTHRACENE	150
SD-1821A	0 - 0.5	BENZO(A)ANTHRACENE	150
SD-1821A	0 - 0.5	BENZO(A)PYRENE	150
SD-1821A	0 - 0.5	BENZO(G,H,I)PERYLENE	93
SD-1821A	0 - 0.5	BENZO(K)FLUORANTHENE	86
SD-1821A	0 - 0.5	CHRYSENE	180
SD-1821A	0 - 0.5	DIBENZ(A,H)ANTHRACENE	26
SD-1821A	0 - 0.5	FLUORANTHENE	500
SD-1821A	0 - 0.5	FLUORENE	77
SD-1821A	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	80
SD-1821A	0 - 0.5	NAPHTHALENE	41
SD-1821A	0 - 0.5	PHENANTHRENE	470
SD-1821A	0 - 0.5	PYRENE	400
SD-1822A	0 - 0.5	2-METHYLNAPHTHALENE	3.4 J
SD-1822A	0 - 0.5	ACENAPHTHENE	15
SD-1822A	0 - 0.5	ACENAPHTHYLENE	0.84 J
SD-1822A	0 - 0.5	ANTHRACENE	23
SD-1822A	0 - 0.5	BENZO(A)ANTHRACENE	63
SD-1822A	0 - 0.5	BENZO(A)PYRENE	55
SD-1822A	0 - 0.5	BENZO(G,H,I)PERYLENE	37
SD-1822A	0 - 0.5	BENZO(K)FLUORANTHENE	53
SD-1822A	0 - 0.5	CHRYSENE	69
SD-1822A	0 - 0.5	DIBENZ(A,H)ANTHRACENE	10
SD-1822A	0 - 0.5	FLUORANTHENE	180
SD-1822A	0 - 0.5	FLUORENE	16

Sample ID	Depth in Feet	Analyte	Result (mg/kg)
SD-1822A	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	32
SD-1822A	0 - 0.5	NAPHTHALENE	10
SD-1822A	0 - 0.5	PHENANTHRENE	130
SD-1822A	0 - 0.5	PYRENE	140
SD-824A	0 - 0.5	2-METHYLNAPHTHALENE	13 J
SD-824A	0 - 0.5	ACENAPHTHENE	5.4
SD-824A	0 - 0.5	ANTHRACENE	14
SD-824A	0 - 0.5	BENZO(A)ANTHRACENE	25
SD-824A	0 - 0.5	BENZO(A)PYRENE	19
SD-824A	0 - 0.5	BENZO(G,H,I)PERYLENE	14
SD-824A	0 - 0.5	BENZO(K)FLUORANTHENE	15
SD-824A	0 - 0.5	CHRYSENE	26
SD-824A	0 - 0.5	DIBENZ(A,H)ANTHRACENE	3.7
SD-824A	0 - 0.5	FLUORANTHENE	62
SD-824A	0 - 0.5	FLUORENE	5.2
SD-824A	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	12
SD-824A	0 - 0.5	NAPHTHALENE	3.5
SD-824A	0 - 0.5	PHENANTHRENE	43
SD-824A	0 - 0.5	PYRENE	50
SD-824A-DUP	0 - 0.5	2-METHYLNAPHTHALENE	2.6 J
SD-824A-DUP	0 - 0.5	ACENAPHTHENE	12
SD-824A-DUP	0 - 0.5	ANTHRACENE	16
SD-824A-DUP	0 - 0.5	BENZO(A)ANTHRACENE	42
SD-824A-DUP	0 - 0.5	BENZO(A)PYRENE	35
SD-824A-DUP	0 - 0.5	BENZO(G,H,I)PERYLENE	23
SD-824A-DUP	0 - 0.5	BENZO(K)FLUORANTHENE	22
SD-824A-DUP	0 - 0.5	CHRYSENE	43
SD-824A-DUP	0 - 0.5	DIBENZ(A,H)ANTHRACENE	6.2
SD-824A-DUP	0 - 0.5	FLUORANTHENE	110
SD-824A-DUP	0 - 0.5	FLUORENE	10
SD-824A-DUP	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	20
SD-824A-DUP	0 - 0.5	NAPHTHALENE	6.2
SD-824A-DUP	0 - 0.5	PHENANTHRENE	98
SD-824A-DUP	0 - 0.5	PYRENE	90
SD-825	0 - 0.5	2-METHYLNAPHTHALENE	0.11 J
SD-825	0 - 0.5	ACENAPHTHENE	0.49
SD-825	0 - 0.5	ACENAPHTHYLENE	0.16
SD-825	0 - 0.5	ANTHRACENE	12
SD-825	0 - 0.5	BENZO(A)ANTHRACENE	5.4
SD-825	0 - 0.5	BENZO(A)PYRENE	6
SD-825	0 - 0.5	BENZO(G,H,I)PERYLENE	4.9
SD-825	0 - 0.5	BENZO(K)FLUORANTHENE	4
SD-825	0 - 0.5	CHRYSENE	7
SD-825	0 - 0.5	DIBENZ(A,H)ANTHRACENE	1.1
SD-825	0 - 0.5	FLUORANTHENE	14
SD-825	0 - 0.5	FLUORENE	0.53
SD-825	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	5.2
SD-825	0 - 0.5	NAPHTHALENE	0.24
SD-825	0 - 0.5	PHENANTHRENE	6.1
SD-825	0 - 0.5	PYRENE	11
SD-826	0 - 0.5	2-METHYLNAPHTHALENE	0.33
SD-826	0 - 0.5	ACENAPHTHENE	14
SD-826	0 - 0.5	ACENAPHTHYLENE	0.083 J
SD-826	0 - 0.5	ANTHRACENE	2.4
SD-826	0 - 0.5	BENZO(A)ANTHRACENE	4.8
SD-826	0 - 0.5	BENZO(A)PYRENE	4.4
SD-826	0 - 0.5	BENZO(G,H,I)PERYLENE	4
SD-826	0 - 0.5	BENZO(K)FLUORANTHENE	2.4
SD-826	0 - 0.5	CHRYSENE	5.5
SD-826	0 - 0.5	DIBENZ(A,H)ANTHRACENE	0.98
SD-826	0 - 0.5	FLUORANTHENE	12
SD-826	0 - 0.5	FLUORENE	0.99
SD-826	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	4.2
SD-826	0 - 0.5	NAPHTHALENE	0.84
SD-826	0 - 0.5	PHENANTHRENE	9.9
SD-826	0 - 0.5	PYRENE	10
SD-827	0 - 0.5	2-METHYLNAPHTHALENE	0.048 J
SD-827	0 - 0.5	ACENAPHTHENE	0.21
SD-827	0 - 0.5	ACENAPHTHYLENE	0.046 J
SD-827	0 - 0.5	ANTHRACENE	0.43
SD-827	0 - 0.5	BENZO(A)ANTHRACENE	1.5
SD-827	0 - 0.5	BENZO(A)PYRENE	1.5
SD-827	0 - 0.5	BENZO(G,H,I)PERYLENE	1.1
SD-827	0 - 0.5	BENZO(K)FLUORANTHENE	0.99
SD-827	0 - 0.5	CHRYSENE	2
SD-827	0 - 0.5	DIBENZ(A,H)ANTHRACENE	0.26
SD-827	0 - 0.5	FLUORANTHENE	4.2
SD-827	0 - 0.5	FLUORENE	0.19
SD-827	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	12
SD-827	0 - 0.5	PHENANTHRENE	2.5
SD-827	0 - 0.5	PYRENE	3.4
SD-827-DUP	0 - 0.5	2-METHYLNAPHTHALENE	0.14
SD-827-DUP	0 - 0.5	ACENAPHTHENE	0.47
SD-827-DUP	0 - 0.5	ACENAPHTHYLENE	0.046 J
SD-827-DUP	0 - 0.5	ANTHRACENE	0.78
SD-827-DUP	0 - 0.5	BENZO(A)ANTHRACENE	2.2
SD-827-DUP	0 - 0.5	BENZO(A)PYRENE	2.1
SD-827-DUP	0 - 0.5	BENZO(G,H,I)PERYLENE	1.5
SD-827-DUP	0 - 0.5	BENZO(K)FLUORANTHENE	1.2
SD-827-DUP	0 - 0.5	CHRYSENE	2.7
SD-827-DUP	0 - 0.5	DIBENZ(A,H)ANTHRACENE	0.34
SD-827-DUP	0 - 0.5	FLUORANTHENE	5.5
SD-827-DUP	0 - 0.5	FLUORENE	0.47
SD-827-DUP	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	16
SD-827-DUP	0 - 0.5	NAPHTHALENE	0.36
SD-827-DUP	0 - 0.5	PHENANTHRENE	4.7
SD-827-DUP	0 - 0.5	PYRENE	4.9

INVESTIGATION AREA DESCRIPTIONS

Area 1 – Former Demolition Area
Area 18A – Former GSA/U.S. Army Pond Area
Area 18B – Former Firing Range
Area 18C – Former Landfill, Disposal, and Vehicle Processing Area
Area 18D – Trench of Shell Casings
Area 18E – Former Maintenance Area
Area 18F – Former Warehouses
Area 18G – Former Dump

Legend
- Soil Standard Exceedance
- Sediment Standard Exceedance
- Soil Sample Location
- Sediment Sample Location
- Stormwater Discharge
- Monitoring Wells
- Former UST Locations
- Existing Railroads
- Former Railroads
- Former Buildings
- EPA/GSA Property
- GSA Property
- Tax Parcels
- Excavation Areas
- Soil Investigation Areas
- GW Plume Boundary (2017)
- Former Dump/Landfill
- Beechwood Development
- Geophysical/MEC Survey

Source:
Aerial Photos from NJ Imagery, Natural 2012, WMS Serice, http://njwebmap.state.nj.us/njimagery. Tax Parcels, EPA/GSA Boundary, Exposure Units, and sample locations from Weston Solutions, Inc. May, 2007.

U.S. EPA and GSA Property Area
Former Raritan Arsenal Site, Edison, NJ

FIGURE 4-4
EXCEEDANCES OF ECOLOGICAL SOIL AND SEDIMENTSCREENING STANDARDS

WA_DR_Fig4-4_Eco_Exceed_011719

Sample ID	Depth in Feet	Analyte	Result (mg/kg)	EPA Restricted Use	EPA Unrestricted Use	NJDEP Restricted Use	NJDEP Unrestricted Use
SD-0101	0-0.5	BENZO(A)PYRENE	0.19 J		X		
SD-0101	0-0.5	CHROMIUM, TOTAL	5.8 J		X		
SD-0102	0-0.5	CHROMIUM, TOTAL	3.4 J		X		
SD-0103	0-0.5	CHROMIUM, TOTAL	2.8 J		X		
SD-1801	0-0.5	BENZO(A)PYRENE	0.71		X		X
SD-1801	0-0.5	CHROMIUM, TOTAL	16.8	X	X		
SD-1801	0-0.5	LEAD, TOTAL	586		X		X
SD-1802	0-0.5	BENZO(A)PYRENE	0.35 J		X		
SD-1802	0-0.5	CHROMIUM, TOTAL	22.8	X	X		
SD-1803	0-0.5	ALDRIN	0.69 J	X	X	X	X
SD-1803	0-0.5	CARBAZOLE	260			X	X
SD-1803	0-0.5	CHROMIUM, TOTAL	12.7 J	X	X		
SD-1803	0-0.5	HEPTACHLOR EPOXIDE	3.6	X	X	X	X
SD-1804	0-0.5	ALDRIN	0.35 J	X	X	X	X
SD-1804	0-0.5	CARBAZOLE	160			X	X
SD-1804	0-0.5	CHROMIUM, TOTAL	10.5	X	X		
SD-1804	0-0.5	HEPTACHLOR EPOXIDE	2	X	X	X	X
SD-1805	0-0.5	ALDRIN	0.32 J	X	X	X	X
SD-1805	0-0.5	CHROMIUM, TOTAL	10.1	X	X		
SD-1805	0-0.5	HEPTACHLOR EPOXIDE	18	X	X	X	X
SD-1806	0-0.5	CHROMIUM, TOTAL	3.8 J		X		
SD-1807	0-0.5	CHROMIUM, TOTAL	8.7 J	X	X		
SD-1808	0-0.5	CHROMIUM, TOTAL	3.7		X		
SD-1809	0-0.5	BENZO(A)PYRENE	0.97 J		X		
SD-1809	0-0.5	CHROMIUM, TOTAL	5.1		X		
SD-1810	0-0.5	CHROMIUM, TOTAL	4.7 J		X		
SD-1810	0-0.5	ARSENIC, TOTAL	32.9 J-	X	X	X	X
SD-1810	0-0.5	BENZO(A)ANTHRACENE	6.4		X		X
SD-1810	0-0.5	BENZO(A)PYRENE	4.7	X	X	X	X
SD-1810	0-0.5	BENZO(B)FLUORANTHENE	4.4		X		
SD-1810	0-0.5	CHROMIUM, TOTAL	20.8	X	X		
SD-1810	0-0.5	DIBENZ(A,H)ANTHRACENE	0.58		X		X
SD-1810	0-0.5	HEPTACHLOR EPOXIDE	0.087		X		X
SD-1810	0-0.5	INDENO(1,2,3-C,D)PYRENE	2.5		X		
SD-1811	0-0.5	CHROMIUM, TOTAL	8.9 J	X	X		
SD-1811	0-0.5	CHROMIUM, TOTAL	7.8	X	X		
SD-1812	0-0.5	CHROMIUM, TOTAL	8.2 J	X	X		
SD-1812	0-0.5	GAMMA-CHLORDANE	0.24 J				X
SD-1812	0-0.5	CHROMIUM, TOTAL	12.6	X	X		
SD-1813	0-0.5	CHROMIUM, TOTAL	4.5 J		X		
SD-1813	0-0.5	CHROMIUM, TOTAL	25.8	X	X		
SD-1814	0-0.5	CHROMIUM, TOTAL	8.9 J	X	X		
SD-1814	0-0.5	CHROMIUM, TOTAL	5.7		X		
SD-1815	0-0.5	CHROMIUM, TOTAL	5.8 J		X		
SD-1815	0-0.5	CHROMIUM, TOTAL	20.5	X	X		
SD-1815	0-0.5	HEPTACHLOR EPOXIDE	0.084		X		X
SD-1816	0-0.5	CHROMIUM, TOTAL	9.6 J	X	X		
SD-1816	0-0.5	CHROMIUM, TOTAL	3.1		X		
SD-1817	0-0.5	CHROMIUM, TOTAL	6.2		X		
SD-1818	0-0.5	CHROMIUM, TOTAL	9.6	X	X		
SD-1820	0-0.5	BENZO(A)ANTHRACENE	36	X	X	X	X
SD-1820	0-0.5	BENZO(A)PYRENE	30	X	X	X	X
SD-1820	0-0.5	BENZO(B)FLUORANTHENE	36	X	X	X	X
SD-1820	0-0.5	BENZO(K)FLUORANTHENE	24		X		
SD-1820	0-0.5	DIBENZ(A,H)ANTHRACENE	5.4	X	X	X	X
SD-1820	0-0.5	INDENO(1,2,3-C,D)PYRENE	17		X		X
SD-1820	0-0.5	NAPHTHALENE	6.9		X		X
SD-1821A	0-0.5	BENZO(A)ANTHRACENE	160	X	X	X	X
SD-1821A	0-0.5	BENZO(A)PYRENE	150	X	X	X	X
SD-1821A	0-0.5	BENZO(B)FLUORANTHENE	190	X	X	X	X
SD-1821A	0-0.5	BENZO(K)FLUORANTHENE	86		X		X
SD-1821A	0-0.5	CHRYSENE	180		X		
SD-1821A	0-0.5	DIBENZ(A,H)ANTHRACENE	26	X	X	X	X
SD-1821A	0-0.5	INDENO(1,2,3-C,D)PYRENE	80	X	X	X	X
SD-1821A	0-0.5	NAPHTHALENE	41	X	X	X	X
SD-1821B	1-1.5	BENZO(A)ANTHRACENE	30	X	X	X	X
SD-1821B	1-1.5	BENZO(A)PYRENE	26	X	X	X	X
SD-1821B	1-1.5	BENZO(B)FLUORANTHENE	28	X	X	X	X
SD-1821B	1-1.5	BENZO(K)FLUORANTHENE	22		X		
SD-1821B	1-1.5	DIBENZ(A,H)ANTHRACENE	4.4	X	X	X	X
SD-1821B	1-1.5	INDENO(1,2,3-C,D)PYRENE	14		X		X
SD-1821B	1-1.5	NAPHTHALENE	8.1		X		X
SD-1822A	0-0.5	BENZO(A)ANTHRACENE	63	X	X	X	X
SD-1822A	0-0.5	BENZO(A)PYRENE	55	X	X	X	X
SD-1822A	0-0.5	BENZO(B)FLUORANTHENE	62	X	X	X	X
SD-1822A	0-0.5	BENZO(K)FLUORANTHENE	53		X		X
SD-1822A	0-0.5	DIBENZ(A,H)ANTHRACENE	10	X	X	X	X
SD-1822A	0-0.5	INDENO(1,2,3-C,D)PYRENE	32	X	X	X	X
SD-1822A	0-0.5	NAPHTHALENE	10		X		X
SD-1822B	1-1.5	1METHYLNAPHTHALENE	34 J		X		
SD-1822B	1-1.5	BENZO(A)ANTHRACENE	420	X	X	X	X
SD-1822B	1-1.5	BENZO(A)PYRENE	380	X	X	X	X
SD-1822B	1-1.5	BENZO(B)FLUORANTHENE	520	X	X	X	X
SD-1822B	1-1.5	BENZO(K)FLUORANTHENE	230	X	X	X	X
SD-1822B	1-1.5	CHRYSENE	490		X		X
SD-1822B	1-1.5	DIBENZ(A,H)ANTHRACENE	62	X	X	X	X
SD-1822B	1-1.5	INDENO(1,2,3-C,D)PYRENE	260	X	X	X	X
SD-1822B	1-1.5	NAPHTHALENE	84	X	X	X	X
SD-1824A	0-0.5	BENZO(A)ANTHRACENE	25	X	X	X	X
SD-1824A	0-0.5	BENZO(A)PYRENE	19	X	X	X	X
SD-1824A	0-0.5	BENZO(B)FLUORANTHENE	25	X	X	X	X
SD-1824A	0-0.5	BENZO(K)FLUORANTHENE	15		X		
SD-1824A	0-0.5	DIBENZ(A,H)ANTHRACENE	3.7	X	X	X	X
SD-1824A	0-0.5	INDENO(1,2,3-C,D)PYRENE	12		X		X
SD-1824A-DUP	0-0.5	BENZO(A)ANTHRACENE	42	X	X	X	X
SD-1824A-DUP	0-0.5	BENZO(A)PYRENE	35	X	X	X	X
SD-1824A-DUP	0-0.5	BENZO(B)FLUORANTHENE	46	X	X	X	X
SD-1824A-DUP	0-0.5	BENZO(K)FLUORANTHENE	22		X		
SD-1824A-DUP	0-0.5	DIBENZ(A,H)ANTHRACENE	6.2	X	X	X	X
SD-1824A-DUP	0-0.5	INDENO(1,2,3-C,D)PYRENE	20		X	X	X
SD-1824A-DUP	0-0.5	NAPHTHALENE	6.2		X		X
SD-1825	0-0.5	BENZO(A)ANTHRACENE	5.4		X		X
SD-1825	0-0.5	BENZO(A)PYRENE	6	X	X	X	X
SD-1825	0-0.5	BENZO(B)FLUORANTHENE	9.1		X		X
SD-1825	0-0.5	DIBENZ(A,H)ANTHRACENE	1.1		X		X
SD-1825	0-0.5	INDENO(1,2,3-C,D)PYRENE	5.2		X		X
SD-1826	0-0.5	BENZO(A)ANTHRACENE	4.8		X		
SD-1826	0-0.5	BENZO(A)PYRENE	4.4	X	X	X	X
SD-1826	0-0.5	BENZO(B)FLUORANTHENE	6		X		X
SD-1826	0-0.5	DIBENZ(A,H)ANTHRACENE	0.98		X		X
SD-1826	0-0.5	INDENO(1,2,3-C,D)PYRENE	4.2		X		
SD-1827	0-0.5	BENZO(A)ANTHRACENE	15		X		
SD-1827	0-0.5	BENZO(A)PYRENE	15		X		X
SD-1827	0-0.5	BENZO(B)FLUORANTHENE	2.2		X		
SD-1827	0-0.5	DIBENZ(A,H)ANTHRACENE	0.26		X		
SD-1827	0-0.5	INDENO(1,2,3-C,D)PYRENE	1.2		X		
SD-1827-DUP	0-0.5	BENZO(A)ANTHRACENE	2.2		X		
SD-1827-DUP	0-0.5	BENZO(A)PYRENE	2.1		X	X	X
SD-1827-DUP	0-0.5	BENZO(B)FLUORANTHENE	3		X		
SD-1827-DUP	0-0.5	DIBENZ(A,H)ANTHRACENE	0.34		X		
SD-1827-DUP	0-0.5	INDENO(1,2,3-C,D)PYRENE	16		X		

INVESTIGATION AREA DESCRIPTIONS

Area 1 – Former Demolition Area
Area 18A – Former GSA/U.S. Army Pond Area
Area 18B – Former Firing Range
Area 18C – Former Landfill, Disposal, and Vehicle Processing Area
Area 18D – Trench of Shell Casings
Area 18E – Former Maintenance Area
Area 18F – Former Warehouses
Area 18G – Former Dump

SCREENING CRITERIA				
Analyte	EPA Restricted Use	EPA Unrestricted Use	NJDEP Restricted Use	NJDEP Unrestricted Use
1-Methylnapalene	73	18	NA	NA
Aldrin	0.18	0.039	0.2	0.04
Arsenic	NA	NA	19	19
Benzo(a)anthracene	21	1.1	17	5
Benzo(a)pyrene	2.1	0.11	2	0.5
Benzo(b)fluoranthene	21	1.1	17	5
Benzo(k)fluoranthene	210	11	170	45
Carbazole	NA	NA	96	24
Chromium	6.3	0.3	NA	NA
Chrysene	2100	110	1700	450
Dibenz(a,h)athracene	2.1	0.11	2	0.5
Gamma-Chlordane	7.5	1.7	NA	0.2
Heptachlor Epoxide	0.33	0.07	0.3	0.07
Indeno(1,2,3-cd)pyrene	21	11	17	5
Lead	800	400	800	400
Naphthalene	17	3.8	16	6
Note: Units in mg/kg.				

Legend

- CriterionExceedance
- Sediment Sample Location
- Stormwater Discharge
- Monitoring Wells
- Former Railroads
- Existing Railroads
- Former UST Locations
- Former Buildings
- EPA/GSA Property
- GSA Property
- Tax Parcels
- Excavation Areas
- Soil Investigation Areas
- GW Plume Boundary (2017)
- Former Dump/Landfill
- Beechwood Development
- Geophysical/MEC Survey

Beechwood Development
1999 Geophysical Survey Area
Area 18E Excavation Areas 2011 (HTW)
One 57-mm projectile (inert) was recovered from 18E sometime between 1991 and 1994
Building 15 demo'd 1997
Building 19 demo'd 1997
Building 14 demo'd 1997
Building 18
Area 18E
Building 212
Area 18F
Building 209
Building 205
Building 203 demo'd 1994
Building 202 demo'd 1994
AOC8AB
Owens-Illinois
Inland Container
Former Gas Station
Former UST
Former UST
Former Columbia Salvage Company dump
Building 238
Former Bldg.241 Automotive Shop
Numerous sinkholes and mounds. A cultural Resource Survey including installation of two trenches 360 and 60 ft. long, 2-4 ft. deep - 1 machine gun shell on ground surface.
1999 Geophysical Survey Area
Area 18G
Former UST
Building 231
Trench Area MEC Removal
Area 18D
Wash Out Area
Former USTs
Building 256 demo'd 2014
Grit Blast Room
1998 and 2002 Removal Areas
Leach field
2004 Removal (concrete sumps)
Building 255 demo'd 2014
Asbestos Landfill (Approx.)
GSA stored 55 gallon drums of unknown origin or contents. In 1992, EPA investigation of marshy area (18C) revealed no OE.
1999 Geophysical Survey Area
Meadow Road
Avenue D
AOC8C
2002 Removal of small arms ammunition debris
Two 48" Stormwater Discharge Pipes
1998 Removal Area (HTW)
1992 Removal Area (HTW)
1993 MEC Survey Area
1993 MEC Survey Area
1993 MEC Survey Area
2002 Lead Removal Area
Area 18A
Area 18B
Area 18C
1998 and 2002 Buried Drum Removal Area
1993 MEC Survey Area
2002 Lead Removal Area
1999 Geophysical Survey Area
1996 Geophysical Survey Area
Building 151
Building 165
AOC2
AOC8D
Area 1
AOC4
Building 409
Building 410
Building 426
Building 427
Area 1 - 0.57 acres inspected by the Office of the Chief of Ordnance and Surface Investigations completed by UXB Int'l. over entire area. - no OE found
1989 MEC Survey Area
OB-6A
MW-46A
MW-57
MW-64
MW-89C
MW-89A
MW-87C
MW-87A
MW-78
MW-79
MW-80
MW-80A
MW-82A
MW-82B
MW-82C
MW-82D
MW-83
MW-84
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MW-148
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MW-150
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MW-156
MW-157
MW-158

Sample ID	Depth in Feet	Analyte	Result (mg/kg)	NJDEP Restricted Use	NJDEP Unrestricted Use
SD-1801	0 - 0.5	BENZO(A)PYRENE	0.71		X
SD-1801	0 - 0.5	LEAD, TOTAL	586		X
SD-1803	0 - 0.5	ALDRIN	0.69 J	X	X
SD-1803	0 - 0.5	CARBAZOLE	260	X	X
SD-1803	0 - 0.5	HEPTACHLOR EPOXIDE	3.6	X	X
SD-1804	0 - 0.5	ALDRIN	0.35 J	X	X
SD-1804	0 - 0.5	CARBAZOLE	160	X	X
SD-1804	0 - 0.5	HEPTACHLOR EPOXIDE	2	X	X
SD-1805	0 - 0.5	ALDRIN	0.32 J	X	X
SD-1805	0 - 0.5	HEPTACHLOR EPOXIDE	18	X	X
SD-181D	0 - 0.5	ARSENIC, TOTAL	32.9 J-	X	X
SD-181D	0 - 0.5	BENZO(A)ANTHRACENE	6.4		X
SD-181D	0 - 0.5	BENZO(A)PYRENE	4.7	X	X
SD-181D	0 - 0.5	DIBENZ(A,H)ANTHRACENE	0.58		X
SD-181D	0 - 0.5	HEPTACHLOR EPOXIDE	0.087		X
SD-181E	0 - 0.5	GAMMA-CHLORDANE	0.24 J		X
SD-181E	0 - 0.5	HEPTACHLOR EPOXIDE	0.084		X
SD-1820	0 - 0.5	BENZO(A)ANTHRACENE	36	X	X
SD-1820	0 - 0.5	BENZO(A)PYRENE	30	X	X
SD-1820	0 - 0.5	BENZO(B)FLUORANTHENE	36	X	X
SD-1820	0 - 0.5	DIBENZ(A,H)ANTHRACENE	5.4	X	X
SD-1820	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	17		X
SD-1820	0 - 0.5	NAPHTHALENE	6.9		X
SD-1821A	0 - 0.5	BENZO(A)ANTHRACENE	180	X	X
SD-1821A	0 - 0.5	BENZO(A)PYRENE	150	X	X
SD-1821A	0 - 0.5	BENZO(B)FLUORANTHENE	190	X	X
SD-1821A	0 - 0.5	BENZO(K)FLUORANTHENE	66		X
SD-1821A	0 - 0.5	DIBENZ(A,H)ANTHRACENE	26	X	X
SD-1821A	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	80	X	X
SD-1821A	0 - 0.5	NAPHTHALENE	41	X	X
SD-1821B	1- 1.5	BENZO(A)ANTHRACENE	30	X	X
SD-1821B	1- 1.5	BENZO(A)PYRENE	26	X	X
SD-1821B	1- 1.5	BENZO(B)FLUORANTHENE	28	X	X
SD-1821B	1- 1.5	DIBENZ(A,H)ANTHRACENE	4.4	X	X
SD-1821B	1- 1.5	INDENO(1,2,3-C,D)PYRENE	14		X
SD-1821B	1- 1.5	NAPHTHALENE	8.1		X
SD-1822A	0 - 0.5	BENZO(A)ANTHRACENE	63	X	X
SD-1822A	0 - 0.5	BENZO(A)PYRENE	55	X	X
SD-1822A	0 - 0.5	BENZO(B)FLUORANTHENE	62	X	X
SD-1822A	0 - 0.5	BENZO(K)FLUORANTHENE	53		X
SD-1822A	0 - 0.5	DIBENZ(A,H)ANTHRACENE	10	X	X
SD-1822A	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	32	X	X
SD-1822A	0 - 0.5	NAPHTHALENE	10		X
SD-1822B	1- 1.5	BENZO(A)ANTHRACENE	420	X	X
SD-1822B	1- 1.5	BENZO(A)PYRENE	380	X	X
SD-1822B	1- 1.5	BENZO(B)FLUORANTHENE	520	X	X
SD-1822B	1- 1.5	BENZO(K)FLUORANTHENE	230		X
SD-1822B	1- 1.5	CHRYSENE	490		X
SD-1822B	1- 1.5	DIBENZ(A,H)ANTHRACENE	62	X	X
SD-1822B	1- 1.5	INDENO(1,2,3-C,D)PYRENE	260	X	X
SD-1822B	1- 1.5	NAPHTHALENE	84	X	X
SD-1824A	0 - 0.5	BENZO(A)ANTHRACENE	25	X	X
SD-1824A	0 - 0.5	BENZO(A)PYRENE	19	X	X
SD-1824A	0 - 0.5	BENZO(B)FLUORANTHENE	25	X	X
SD-1824A	0 - 0.5	DIBENZ(A,H)ANTHRACENE	3.7	X	X
SD-1824A	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	12		X
SD-1824A-DUP	0 - 0.5	BENZO(A)ANTHRACENE	42	X	X
SD-1824A-DUP	0 - 0.5	BENZO(A)PYRENE	35	X	X
SD-1824A-DUP	0 - 0.5	BENZO(B)FLUORANTHENE	46	X	X
SD-1824A-DUP	0 - 0.5	BENZO(K)FLUORANTHENE	22		X
SD-1824A-DUP	0 - 0.5	DIBENZ(A,H)ANTHRACENE	6.2	X	X
SD-1824A-DUP	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	20	X	X
SD-1824A-DUP	0 - 0.5	NAPHTHALENE	6.2		X
SD-1825	0 - 0.5	BENZO(A)ANTHRACENE	5.4		X
SD-1825	0 - 0.5	BENZO(A)PYRENE	6	X	X
SD-1825	0 - 0.5	BENZO(B)FLUORANTHENE	9.1		X
SD-1825	0 - 0.5	DIBENZ(A,H)ANTHRACENE	1.1		X
SD-1825	0 - 0.5	INDENO(1,2,3-C,D)PYRENE	5.2		X
SD-1826	0 - 0.5	BENZO(A)PYRENE	4.4	X	X
SD-1826	0 - 0.5	BENZO(B)FLUORANTHENE	6		X
SD-1826	0 - 0.5	DIBENZ(A,H)ANTHRACENE	0.98		X
SD-1827	0 - 0.5	BENZO(A)PYRENE	15		X
SD-1827-DUP	0 - 0.5	BENZO(A)PYRENE	2.1	X	X

INVESTIGATION AREA DESCRIPTIONS

Area 1 – Former Demolition Area
Area 18A – Former GSA/U.S. Army Pond Area
Area 18B – Former Firing Range
Area 18C – Former Landfill, Disposal, and Vehicle Processing Area
Area 18D – Trench of Shell Casings
Area 18E – Former Maintenance Area
Area 18F – Former Warehouses
Area 18G – Former Dump

SCREENING CRITERIA		
Analyte	NJDEP Restricted Use	NJDEP Unrestricted Use
Aldrin	0.2	0.04
Arsenic	19	19
Benzo(a)anthracene	17	5
Benzo(a)pyrene	2	0.5
Benzo(b)fluoranthene	17	5
Benzo(k)fluoranthene	170	45
Carbazole	96	24
Chrysene	1700	450
Dibenz(a,h)athracene	2	0.5
Gamma-Chlordane	NA	0.2
Heptachlor Epoxide	0.3	0.07
Indeno(1,2,3-cd)pyrene	17	5
Lead	800	400
Naphthalene	16	6
Note: Units in mg/kg.		

Legend
- CriterionExceedance
- Sediment Sample Location
- Stormwater Discharge
- Monitoring Wells
- Former Railroads
- Existing Railroads
- Former UST Locations
- Former Buildings
- EPA/GSA Property
- GSA Property
- Tax Parcels
- Excavation Areas
- Soil Investigation Areas
- GW Plume Boundary (2017)
- Former Dump/Landfill
- Beechwood Development
- Geophysical/MEC Survey

Beechwood Development
Exclusion Area
1999 Geophysical Survey Area
Area 18E Excavation Areas 2011 (HTW)
One 57-mm projectile (inert) was recovered from 18E sometime between 1991 and 1994
Building 15 demo'd 1997
Building 19 demo'd 1997
Building 14 demo'd 1997
Building 18
Area 18E
Building 212
Area 18F
Building 209
Building 205
Building 203 demo'd 1994
Building 202 demo'd 1994
AOC8AB
Owens-Illinois
Inland Container
Former Gas Station
Former UST
Former UST
Former Columbia Salvage Company dump
Building 238
Former Bldg.241 Automotive Shop
Building 241 demo'd 1994
1999 Geophysical Survey Area
Area 18G
Numerous sinkholes and mounds. A cultural Resource Survey including installation of two trenches 360 and 60 ft. long, 2-4 ft. deep - 1 machine gun shell on ground surface.
Former UST
Trench Area MEC Removal
Building 231
Area 18D
Wash Out Area
Former USTs
Building 256 demo'd 2014
Grit Blast Room
1998 and 2002 Removal Areas (HTW)
Leach field
2004 Removal (concrete sumps)
Building 255 demo'd 2014
Building 245 demo'd 2015
Building 246 demo'd 2015
Meadow Road
Avenue D
AOC8C
Two 48" Stormwater Discharge Pipes
1998 Removal Area (HTW)
1992 Removal Area (HTW)
2002 Removal of small arms ammunition debris
Asbestos Landfill (Approx.)
GSA stored 55 gallon drums of unknown origin or contents. In 1992, EPA investigation of marshy area (18C) revealed no OE.
1998 and 2002 Buried Drum Removal Area
1999 Geophysical Survey Area
Building 151
1993 MEC Survey Area
1993 MEC Survey Area
1993 MEC Survey Area
1993 MEC Survey Area
2002 Lead Removal Area
2002 Lead Removal Area
Area 18A
Area 18B
Area 18C
AOC2
Building 165
AOC4
AOC8D
Area 1
1996 Geophysical Survey Area
1989 MEC Survey Area
Area 1 - 0.57 acres inspected by the Office of the Chief of Ordnance and Surface Investigations completed by UXB Int'l. over entire area. - no OE found
Building 409
Building 410
Building 426
Building 427
200 0 200 400
Scale in Feet

Source:
Aerial Photos from NJ Imagery, Natural 2012, WMS Serice, http://njwebmap.state.nj.us/njimagery. Tax Parcels, EPA/GSA Boundary, Exposure Units, and sample locations from Weston Solutions, Inc. May, 2007.

U.S. EPA and GSA Property Area
Former Raritan Arsenal Site, Edison, NJ

FIGURE 4-5A
EXCEEDANCES OF NJDEP HUMAN HEALTH SEDIMENT SCREENING CRITERIA

EPA_GR_Fig4-5A_SED_Exceed_011713

MW-114	NJDEP GWQS (ug/L)	4/22/2010	5/23/2012	9/12/2012	7/2/2013	9/26/2017
CIS-1,2-DICHLOROETHENE	70	**77**	0.2 J	1.6	14.5	**100 D**
TRICHLOROETHENE	1	**2.5**	0.12 J	0.56 J	1 U	**9.1**
VINYL CHLORIDE	1	**9.7**	0.77	**2.5**	**44.9**	**76 D**

MW-311	NJDEP GWQS (ug/L)	4/21/2010	5/23/2012	9/10/2012	7/8/2013	9/25/2017
CIS-1,2-DICHLOROETHENE	70	63	16	31	32	28
TRICHLOROETHENE	1	**100**	**11**	**24**	**13.9**	**5**
VINYL CHLORIDE	1	**5.9**	**5.4**	**4.4**	**7.2**	**17**

MW-314	NJDEP GWQS (ug/L)	4/21/2010	5/23/2012	9/10/2012	7/8/2013	9/25/2017
CIS-1,2-DICHLOROETHENE	70	21	9.6	10	11.8	5.4
TRICHLOROETHENE	1	**4.6**	**2.3**	**1.6**	**2.8**	**1.6**
VINYL CHLORIDE	1	0.82 J	**1.2**	0.73 J	0.78 J	**1.1 J**

MW-160-1	NJDEP GWQS (ug/L)	5/25/2012	9/11/2012	7/8/2013	9/25/2017
CIS-1,2-DICHLOROETHENE	70	0.18 U	0.18 U	1 U	5.9
TRICHLOROETHENE	1	0.09 U	0.09 UJ	1 U	**5.9**
VINYL CHLORIDE	1	0.14 U	0.14 U	1 U	0.75 J

MW-140	NJDEP GWQS (ug/L)	5/23/2012	9/10/2012	7/2/2013	9/25/2017
CIS-1,2-DICHLOROETHENE	70	**100**	**110**	**105**	49
TRICHLOROETHENE	1	**69**	**61**	**60.6**	**29**
VINYL CHLORIDE	1	**30**	**26**	**18.9**	**9.6**

MW-CP-IV-1	NJDEP GWQS (ug/L)	5/23/2012	9/11/2012	7/2/2013	9/25/2017
CIS-1,2-DICHLOROETHENE	70	1.5	7.8	4	2.7
TRICHLOROETHENE	1	**7.6**	**27 J**	**9.3**	**7.5**
VINYL CHLORIDE	1	0.14 U	0.14 U	1 U	0.2 U

MW-139	NJDEP GWQS (ug/L)	5/23/2012	9/10/2012	7/2/2013	9/25/2017
CIS-1,2-DICHLOROETHENE	70	**91**	**77**	**75.2**	54
TRICHLOROETHENE	1	**120**	**53**	**82.3**	**57**
VINYL CHLORIDE	1	**24**	**20**	**15.6**	**7.1**

MW-127/MW-320	NJDEP GWQS (ug/L)	MW-127 5/23/2012	MW-127 9/11/2012	MW-127 7/2/2013	MW-320 11/20/2017
CIS-1,2-DICHLOROETHENE	70	2.4	2.7	2.8	3.6
TRICHLOROETHENE	1	**4.2**	**4.4 J**	**4.2**	**5**
VINYL CHLORIDE	1	0.14 U	0.14 U	1 U	0.2 U

MW-317
0.48 J

MW-318
0.53 J

AOC8D

AOC2

AOC9

ANALYTE	NJDEP GWQS (ug/L)	MCL (ug/L)
CIS-1,2-DICHLOROETHENE	70	70
TRICHLOROETHENE	1	5
VINYL CHLORIDE	1	2

Note: **Red cell** indicates that the concentration exceeds the NJDEP GWQS.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

0 500 1,000 Feet

Legend

- 2017 Groundwater Sampling Location
- Investigation Areas
- Approximate AOC Boundaries 2017
- Boundary from FUDSMIS GIS (3,316 acres)

FIGURE 4-6

AOC 2 GROUNDWATER EXCEEDANCES

FORMER RARITAN ARSENAL

EDISON, NEW JERSEY

MW-EPA-2A	NJDEP GWQS (ug/L)	7/2/2010	9/13/2012	9/26/2017
CIS-1,2-DICHLOROETHENE	70	4.9	0.85 J	2.4 J
TRICHLOROETHENE	1	1 U	0.26 J	0.4 U
VINYL CHLORIDE	1	**2.1**	0.65 J	**1 J**

MW-46A	NJDEP GWQS (ug/L)	7/6/2010	9/10/2012	9/27/2017
CIS-1,2-DICHLOROETHENE	70	19	20	12 J
TRICHLOROETHENE	1	**7**	**7.4**	**5 J**
VINYL CHLORIDE	1	**2.7**	**3.5**	0.92 J

MW-120	NJDEP GWQS (ug/L)	7/6/2010	9/10/2012	9/27/2017
CIS-1,2-DICHLOROETHENE	70	8.3	16	12
TRICHLOROETHENE	1	**1.5**	**2.3**	**1.5**
VINYL CHLORIDE	1	1 U	**5.7**	**4.3**

OB-7A	NJDEP GWQS (ug/L)	8/6/2010	9/10/2012	9/25/2017
CIS-1,2-DICHLOROETHENE	70	7	5.4	3.8
TRICHLOROETHENE	1	**1.3**	**1.2**	0.89 J
VINYL CHLORIDE	1	0.55 J	0.14 U	0.6 J

MW-128/MW-321	NJDEP GWQS (ug/L)	7/6/2010	9/7/2012	11/20/2017
CIS-1,2-DICHLOROETHENE	70	1 U	0.18 U	0.4 U
TRICHLOROETHENE	1	1 U	0.09 U	0.4 U
VINYL CHLORIDE	1	1 U	0.14 U	0.2 U

MW-122	NJDEP GWQS (ug/L)	7/6/2010	9/7/2012	9/28/2017
CIS-1,2-DICHLOROETHENE	70	0.7 J	0.81 J	0.81 J
TRICHLOROETHENE	1	0.72 J	0.4 J	0.37 J
VINYL CHLORIDE	1	**1.5**	0.79 J	0.77 J

ANALYTE	NJDEP GWQS (ug/L)	MCL (ug/L)
CIS-1,2-DICHLOROETHENE	70	70
TRICHLOROETHENE	1	5
VINYL CHLORIDE	1	2

Note: **Red cell** indicates that the concentration exceeds the NJDEP GWQS.

AOC4A

AOC2

AOC6A

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

0 500 1,000 Feet

Legend

- 2017 Groundwater Sampling Location
- Investigation Areas
- Approximate AOC Boundaries 2017
- Boundary from FUDSMIS GIS (3,316 acres)

FIGURE 4-7
AOC 4 GROUNDWATER EXCEEDANCES
FORMER RARITAN ARSENAL
EDISON, NEW JERSEY

MW-134	NJDEP GWQS (ug/L)	5/22/2012	9/12/2012	7/2/2013	9/26/2017
TRICHLOROETHENE	1	1.5	7.4	1.5	0.36 J

MW-EPA-10A	NJDEP GWQS (ug/L)	5/22/2012	9/12/2012	7/2/2013	9/26/2017
TRICHLOROETHENE	1	8.6	10	1 U	1.9

MW-121	NJDEP GWQS (ug/L)	5/22/2012	9/12/2012	7/2/2013	9/26/2017
TRICHLOROETHENE	1	81	67	47.3	50

MW-87A	NJDEP GWQS (ug/L)	7/2/2010	9/13/2012	9/26/2017
TRICHLOROETHENE	1	1.6	1.4	1.1

SW-8-01	NJDEP Criteria (ug/L)	9/26/2017
TRICHLOROETHENE	47	8

MW-125	NJDEP GWQS (ug/L)	7/2/2010	9/13/2012	9/26/2017
TRICHLOROETHENE	1	13	5.6	18

MW-136	NJDEP GWQS (ug/L)	5/22/2012	5/22/2012	9/11/2012	7/2/2013	9/27/2017
TRICHLOROETHENE	1	39	39	49 J	4.2	1.7 J

MW-156	NJDEP GWQS (ug/L)	5/22/2012	9/12/2012	7/2/2013	9/26/2017
TRICHLOROETHENE	1	240	330	185	130 J

MW-153	NJDEP GWQS (ug/L)	5/22/2012	9/12/2012	7/2/2013	9/26/2017
TRICHLOROETHENE	1	22	25	25.6	34

MW-88A	NJDEP GWQS (ug/L)	5/22/2012	9/12/2012	7/2/2014	9/26/2017
TRICHLOROETHENE	1	0.09 U	0.09 U	0.23 J	0.4 U

MW-106A	NJDEP GWQS (ug/L)	5/22/2012	9/12/2012	7/2/2013	9/26/2017
TRICHLOROETHENE	1	0.98 J	7.3	4.4	5.8

MW-8	NJDEP GWQS (ug/L)	7/2/2010	9/13/2012	9/26/2017
TRICHLOROETHENE	1	150	120	98 D

SW-8-06	NJDEP Criteria (ug/L)	9/26/2017
TRICHLOROETHENE	47	9.8

MW-89A	NJDEP GWQS (ug/L)	7/6/2010	9/10/2012	9/27/2017
TRICHLOROETHENE	1	1 U	0.09 U	0.4 U

ANALYTE	NJDEP GWQS (ug/L)	MCL (ug/L)
TRICHLOROETHENE	1	5

Note: **Red cell** indicates that the concentration exceeds the NJDEP GWQS.

AOC8AB
AOC3
AOC8C
AOC8D
AOC4A
AOC2

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

0 500 1,000 Feet

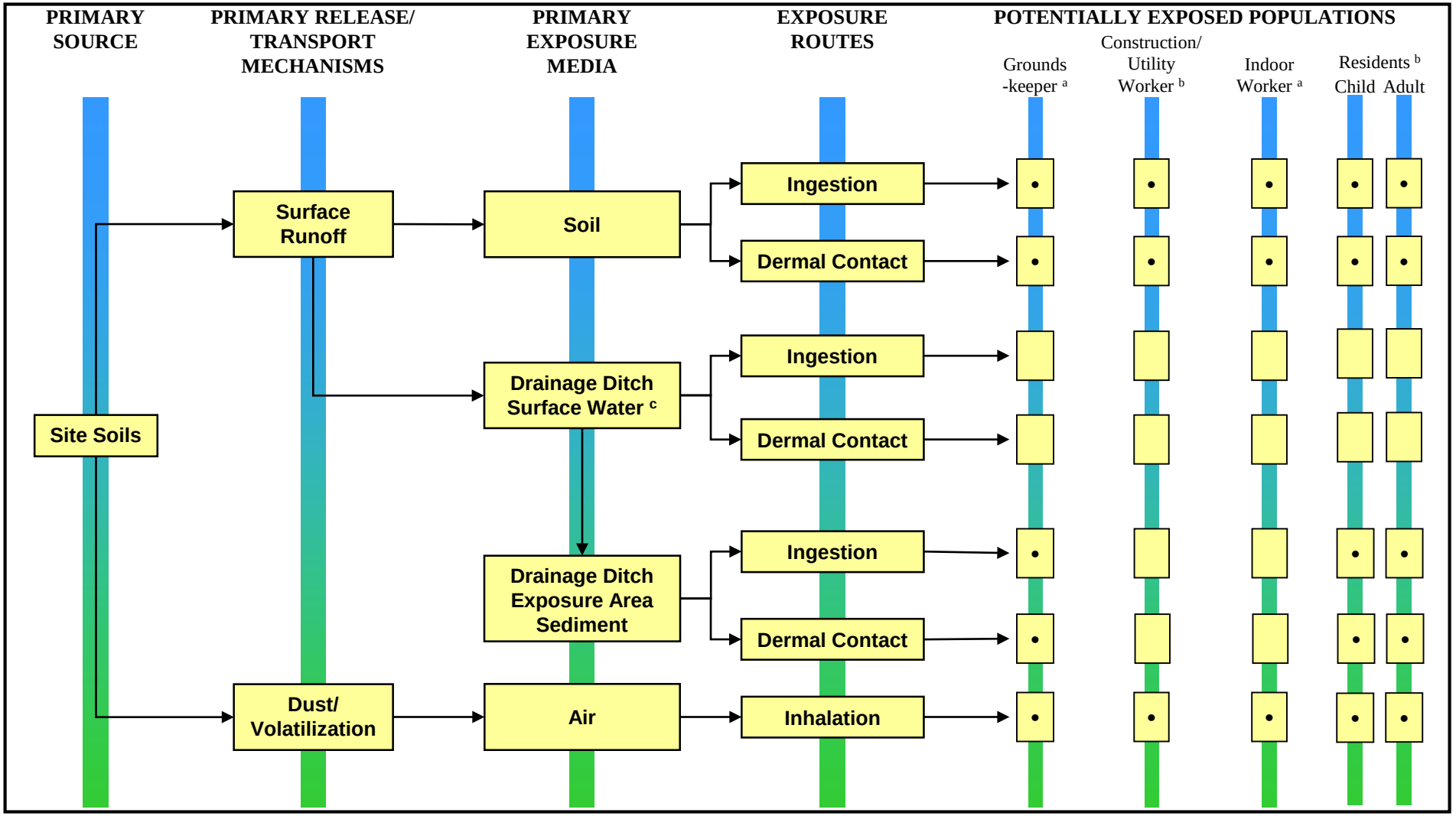
Legend

- 2017 Groundwater Sampling Location
- 2017 Surface Water Sampling Location
- Investigation Areas
- Approximate AOC Boundaries 2017
- Boundary from FUDSMIS GIS (3,316 acres)

FIGURE 4-8

AOC 8 GROUNDWATER EXCEEDANCES

FORMER RARITAN ARSENAL
EDISON, NEW JERSEY



LEGEND:

[a] Assumed exposure to surface soil (0-2 ft bgs).

[b] Assumed exposure to aggregate soil (0-10 ft bgs).

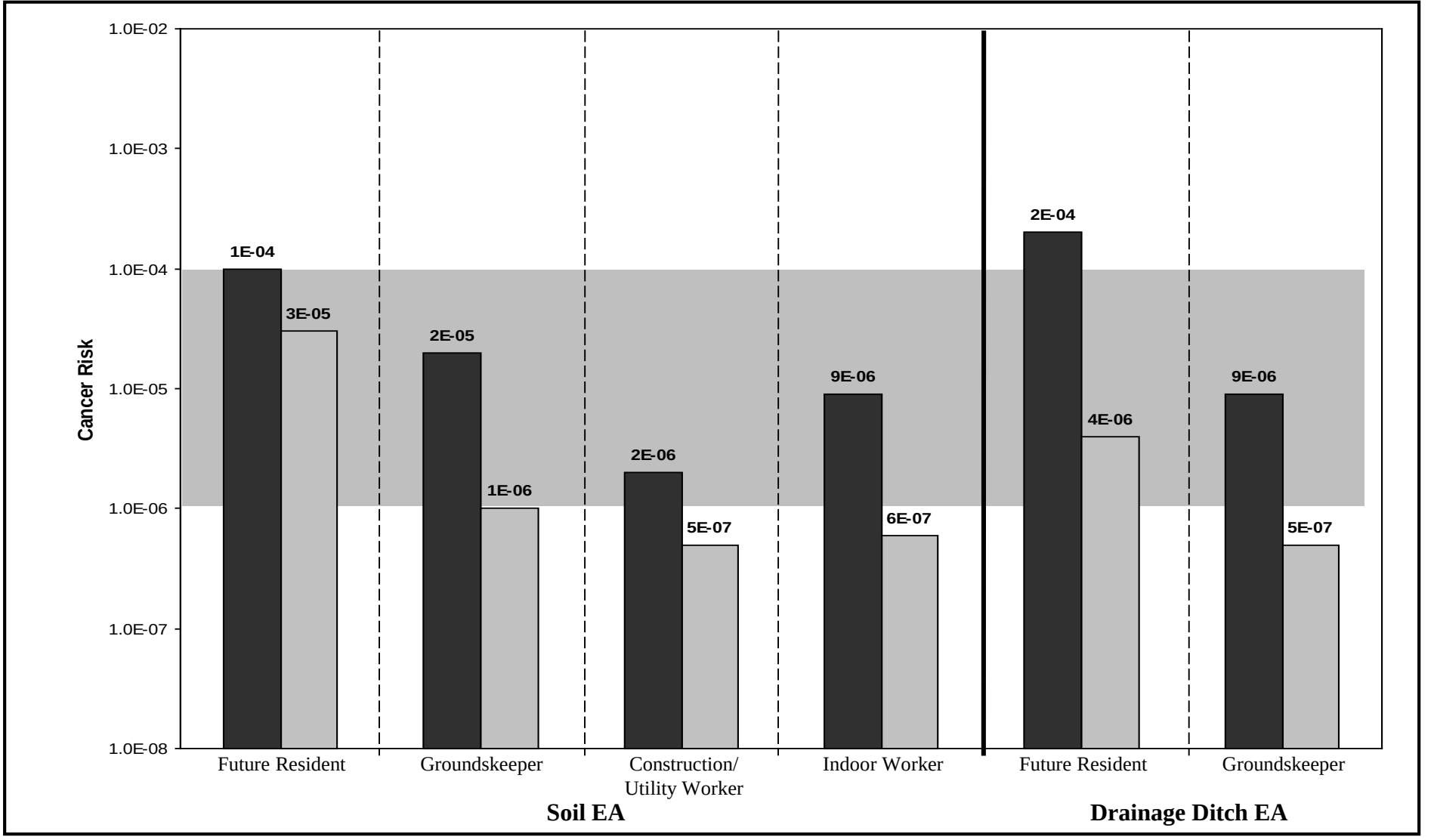
[c] Surface water in the drainage ditches is shallow and is present only after precipitation events. The water dries up during periods without precipitation. Based on this, there is limited exposure potential.

FUDS Project Number C02NJ0084-15

FIGURE 6-1
CONCEPTUAL SITE MODEL
HUMAN HEALTH RISK ASSESSMENT

U.S. EPA AND GSA PROPERTY AREA

FORMER RARITAN ARSENAL



Legend:

= RME cancer risk.

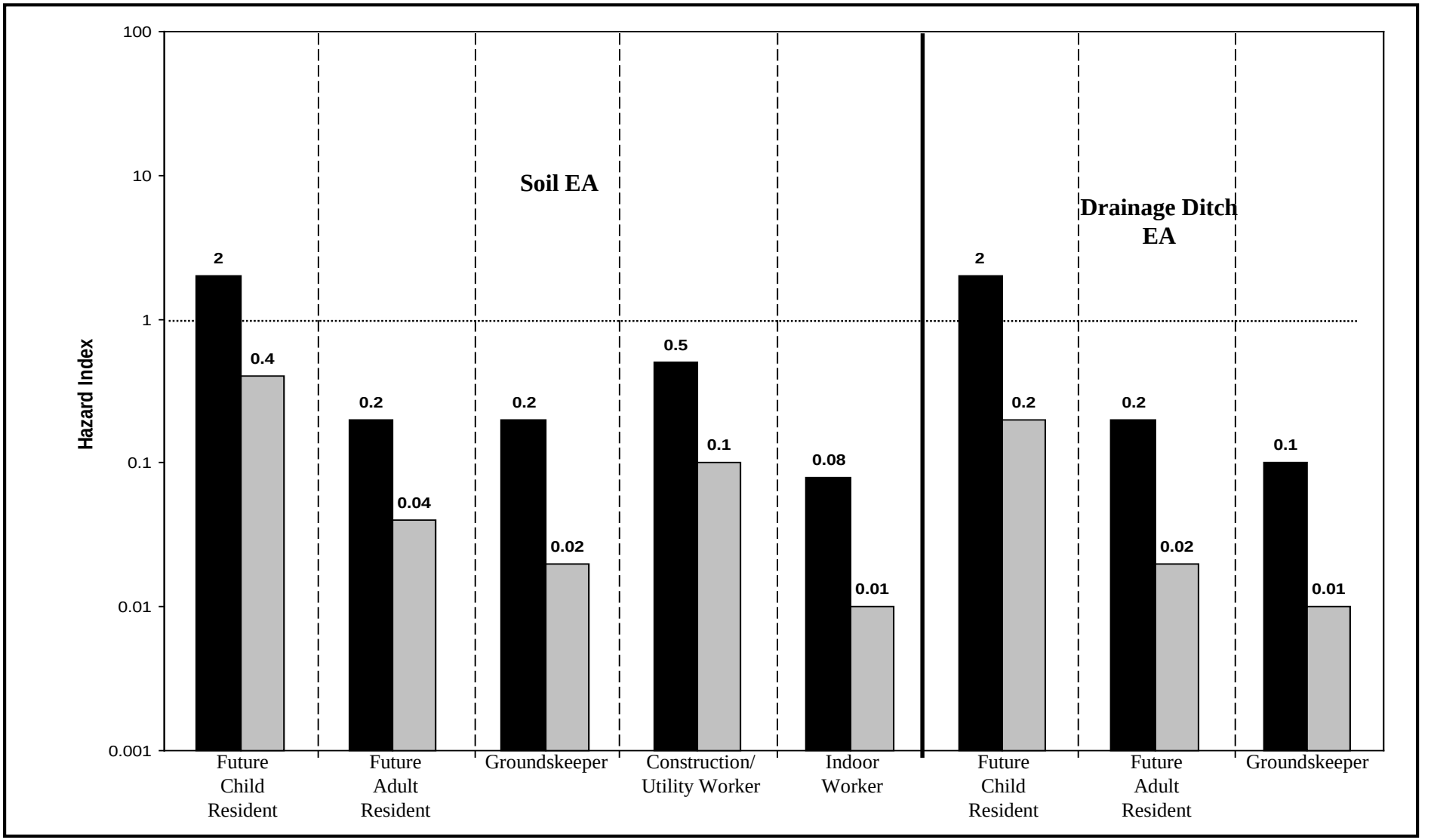
= CTE cancer risk.

Gray shaded area represents EPA's cancer risk range (1E-06 to 1E-04).

FUDS Project Number C02NJ0084-15

FIGURE 6-2
SUMMARY OF CANCER RISKS
U.S. EPA AND GSA PROPERTY AREA

FORMER RARITAN ARSENAL



Legend:

= RME hazard index.

= CTE hazard index.

Horizontal dashed line represents EPA's noncancer benchmark of one.

FUDS Project Number C02NJ0084-15

FIGURE 6-3
SUMMARY OF HAZARD INDICES
U.S. EPA AND GSA PROPERTY AREA

FORMER RARITAN ARSENAL

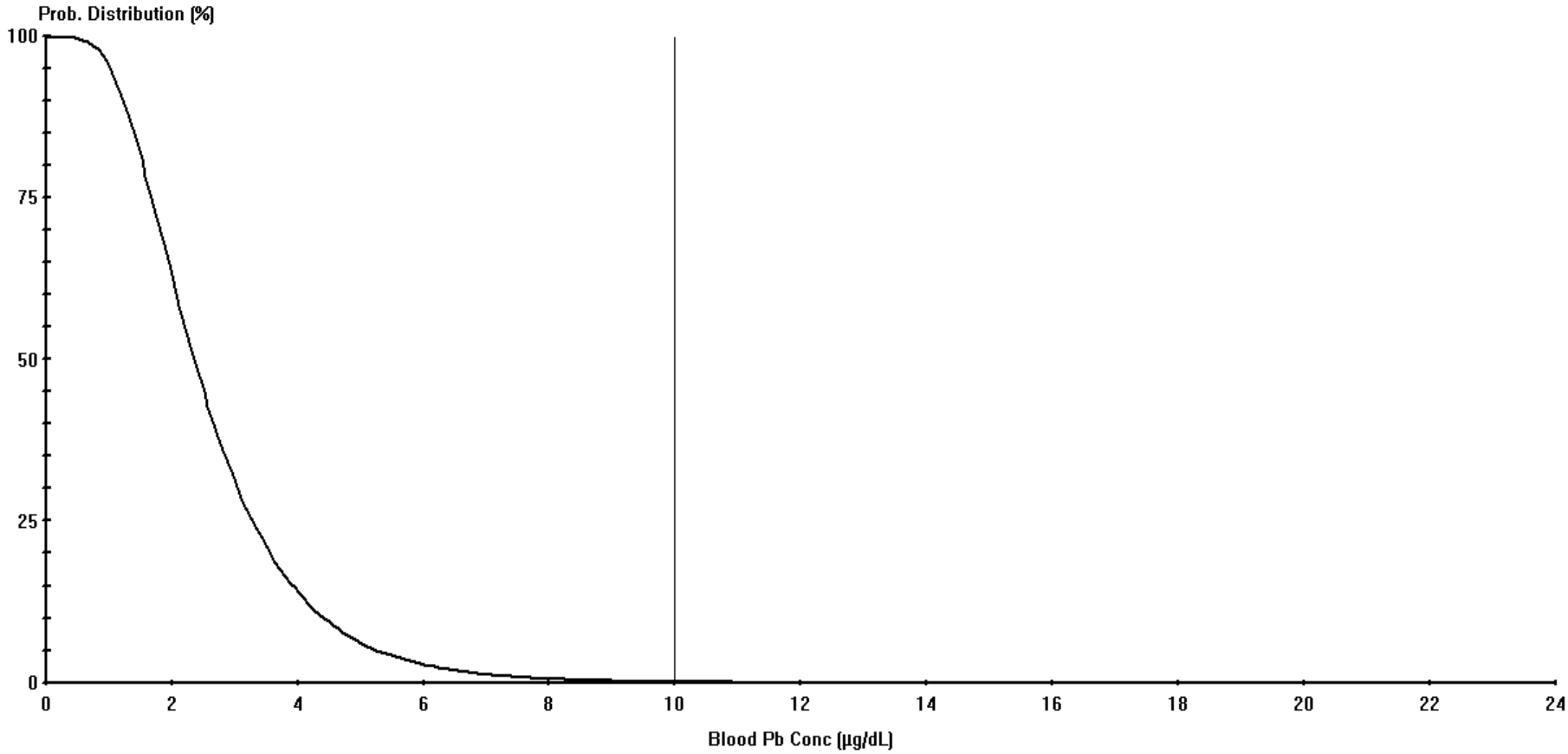


FIGURE 6-4
IEUBK MODEL OUTPUT – SOIL EA
U.S. EPA AND GSA PROPERTY AREA

FORMER RARITAN ARSENAL

FUDS Project Number C02NJ0084-15

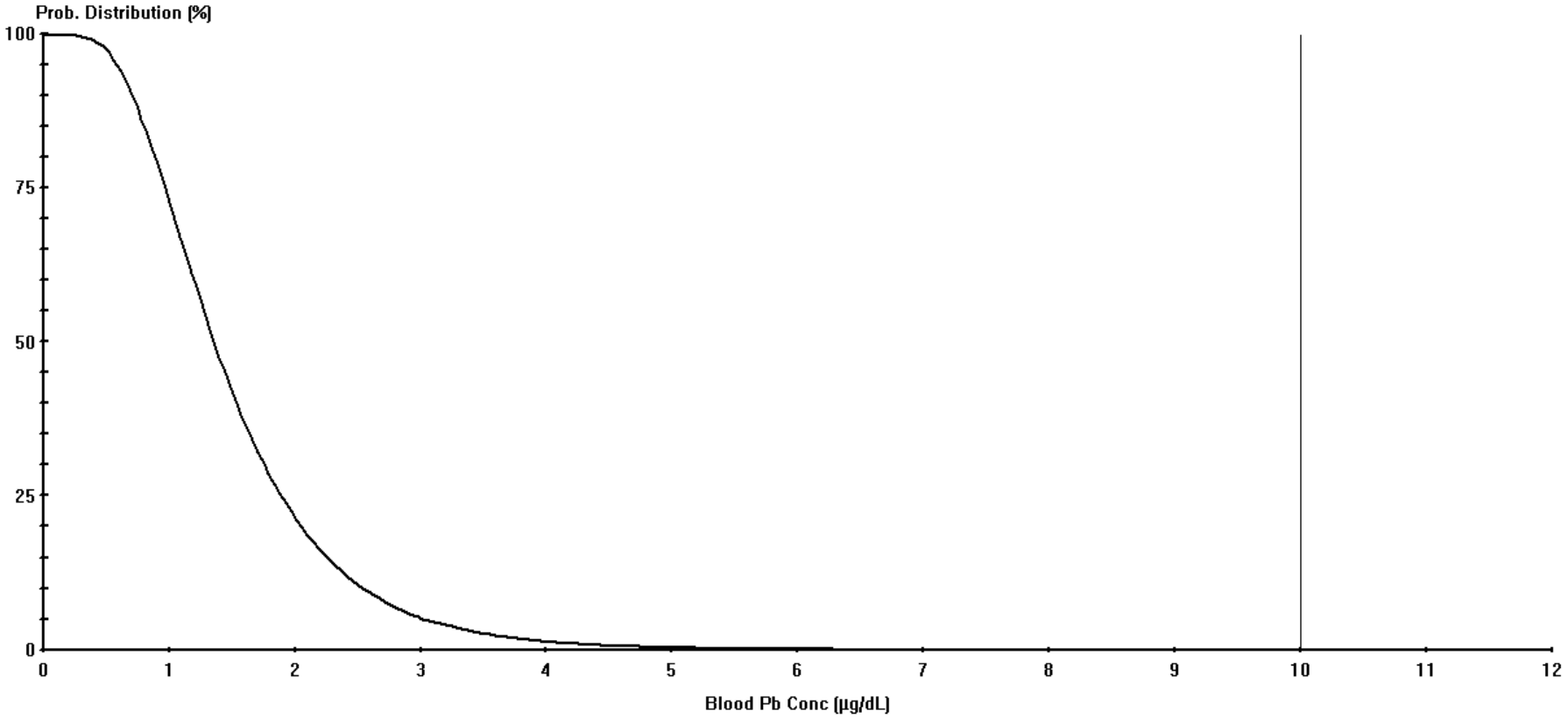
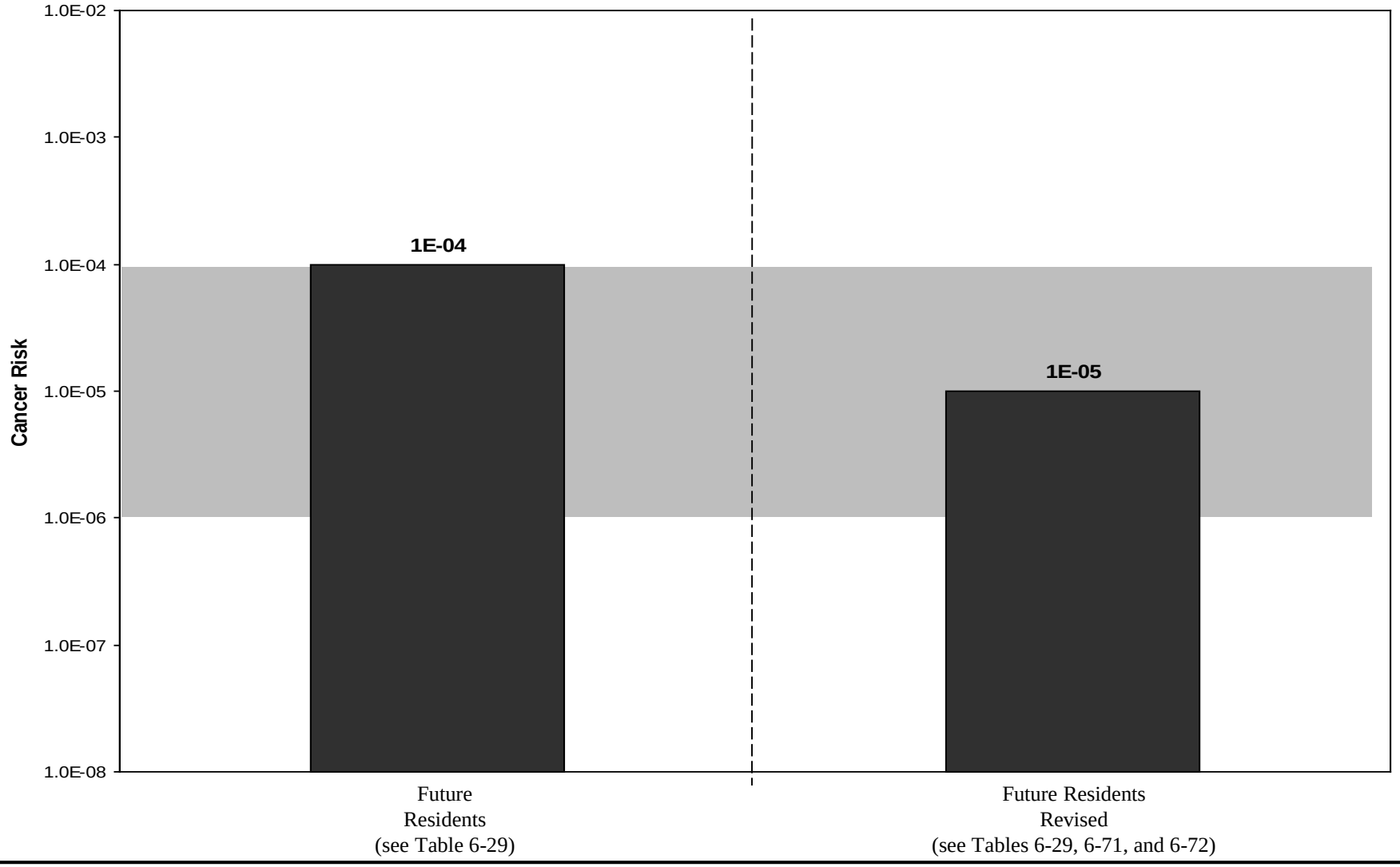


FIGURE 6-5
IEUBK MODEL OUTPUT – DRAINAGE DITCH EA
U.S. EPA AND GSA PROPERTY AREA

FORMER RARITAN ARSENAL

FUDS Project Number C02NJ0084-15



Legend:

■ = RME cancer risk.

Gray shaded area represents EPA's cancer risk range (1E-06 to 1E-04).

The revised cancer risks were derived based on the issues discussed in Section 6.5.4. Specifically, the following was performed to estimate the revised risks:

- The cPAHs levels from samples TP-18C71A, TP-18C72A, and TP-18C75A were removed from the soil dataset and the cPAH risks were re-calculated (see Table 6-71).
- The arsenic levels from along the former railroad between former Buildings 202 and 203 within Investigation Area 18F and extending into Investigation Area 18E were removed from the soil dataset and the arsenic risks were re-calculated (see Table 6-72).
- The chromium risks were removed based on the likelihood that chromium is not present in site soil in the hexavalent form as was conservatively assumed when calculating the chromium risks.

FIGURE 6-6
FINAL CANCER RISKS – FUTURE RESIDENTS
SOIL EA
U.S. EPA AND GSA PROPERTY AREA

FORMER RARITAN ARSENAL

FUDS Project Number C02NJ0084-15

APPENDICES

Appendix A (CD only)

CD of Available U.S. EPA and GSA Property Area Documents

Appendix B

Areas 18A and 18B Sampling Memorandum

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA; ROOM 1811
NEW YORK, N.Y. 10278-0090

26 February 2014

REPLY TO
ATTENTION OF
Programs and Project Management Division

Mr. Anthony Cinque, Case Manager
State of New Jersey
Department of Environmental Protection
Bureau of Case Management
Site Remediation Program
Mail Code 401-05F
P.O. Box 420
Trenton, NJ 08625-0420

RE: Sampling Results in Support of Ongoing Remedial Investigations – Area 4 (Former TNT Washout and Munitions Demilitarization Area), Area 18A (Former GSA/US Army Pond Area), and Area 18B (Former Firing Range) dated February 2014
Former Raritan Arsenal; Middlesex County, Edison, New Jersey
SRP PI#: 006021

Dear Mr. Cinque,

The U.S. Army Corps of Engineers, New York District, is pleased to provide the enclosed memorandum describing the analytical results from the sampling activities performed on October 1, 2013. This memo describes the sampling results that were performed at Investigation Area 4 (Former TNT Washout and Munitions Demilitarization Area), Investigation Area 18A (Former GSA/US Army Pond Area), and Investigation Area 18B (Former Firing Range) dated February 2014 for the former Raritan Arsenal, Edison, New Jersey (FUDS project #C02NJ0084) for New Jersey Department of Environmental Protection (NJDEP) review.

Enclosed please find three (3) hard copies of the memo for your review.

Pursuant to the schedule applicable to the site, please submit your comments by March 31, 2014.

If you need additional information or have any questions, please contact me at (917) 790-8487. We look forward to receiving your comments.

Sincerely,

Sandra L. Piettro
Raritan Arsenal Project Manager

Enclosures

CC: Mr. James Kelly / USACE, CENAE (cover letter only)
Mr. Lee DePersia / Avatar (cover letter only)

Sampling Results in Support of Ongoing Remedial Investigations
Former Raritan Arsenal
Area 4 (Former TNT Washout and Munitions Demilitarization Area), Area 18A (Former GSA/US Army Pond Area), and Area 18B (Former Firing Range)

This memorandum describes the analytical results from the sampling activities that were performed at Investigation Area 4 (Former TNT Washout and Munitions Demilitarization Area), Investigation Area 18A (Former GSA/US Army Pond Area), and Investigation Area 18B (Former Firing Range). The approach memorandum dated August 27, 2013 presented the overall sampling plan and incorporated input received from the New Jersey Department of Environmental Protection (NJDEP) during a site visit on August 20, 2013. The sample collection effort was performed by Avatar Environmental on October 1, 2013.

Investigation Area 4 Soil

Soil samples were collected to further define the extent of trinitrotoluene (TNT) and associated residue contamination in Area 4 at sample location 0408. Five locations were sampled with two samples collected from each location. Figure 1 depicts the Area 4 sampling locations. One of the five locations (location ID – 0445) was at former location 0408 where the previous TNT detection of 53,000 mg/kg was observed in 1994. Samples at location 0445 were collected from the surface (0-0.5 feet below ground surface [ft bgs]) and subsurface (3-4 ft bgs), which is the depth interval of the previous TNT detection. The other sample locations (location IDs – 0446, 0447, 0448, and 0449) were located around 0445 and 0408 but closer to sample location 0408 than the delineation samples that were collected by Weston in 1996. A surface and subsurface sample were collected from locations 0446, 0447, 0448, and 0449. All samples were analyzed for explosives using Method SW8330A.

Table 1 presents the analytical results. TNT was not detected in any of the soil samples, including the re-sampling of 0408. Amino-dinitrotoluenes were the only compounds that were detected. Amino-dinitrotoluenes were detected at locations 0448 and 0449 at a depth of 3-4 ft bgs but the concentrations were less than EPA Regional Screening Levels (RSLs) for residential and industrial soil use. NJDEP Soil Remediation Standards (SRSs) are not available for amino-dinitrotoluenes.

Based on the initial delineation sampling at location 0408 performed in 1996 by Weston and the recent sampling performed in 2013 by Avatar, the TNT concentration measured at location 0408 in 1994 appears to be an anomaly as subsequent sampling of the area did not detect TNT above its detection limit. As such, there does not appear to be an existing source of TNT at location 0408. No further investigation of this issue is proposed.

Investigation Area 18A Soil

NJDEP expressed concern that historic polycyclic aromatic hydrocarbon (PAH) contamination associated with Investigation Area 18A could be a continuing source of PAH contamination to the Area 18B Stream through surface runoff during and following precipitation events. Observations made during the site visit and review of area topographic maps indicate that it is unlikely surface runoff from Area 18A would reach the upstream portions of the Area 18B Stream. However, to address this concern, surface (0-0.5 ft bgs) and subsurface (2-3 ft bgs) soil samples were collected at Investigation Area 18A in a previously un-sampled area that appears to be down slope of the areas that were remediated in 1992 and 1998 by USACE. Figure 2 shows the Area 18A soil sampling location. The samples were analyzed for PAHs by Method SW8270C SIM. Table 2 presents the analytical results. PAHs in the surface sample were detected at levels less than NJDEP residential and industrial screening levels. No PAHs were detected in the subsurface sample. These recent sample results, in concert with historic soil sampling results indicating PAHs analyzed from the surrounding area were either not detected or were detected at low levels, indicate that surface migration is likely not a source of PAH contamination to the Area 18B Stream. No further investigation of this issue is proposed.

Investigation Area 18B Stream Sediment

Additional samples were collected from the Area 18B Stream to further define the extent of PAH contamination in stream sediments. Although identified as a stream, it is actually an intermittent storm water drainageway constructed by DOD when the Raritan Arsenal was active. During the recent sediment sampling conducted in October 2013, all of the sediment sampling locations were dry except for location SD1819, the farthest downstream location. Based on field observations, the stream substrate is sand. In fact, sand is present in the top foot and deeper of the substrate throughout much of the drainageway. During the October field effort, pooled water was present at a few locations and had apparently been there for some time; moreover there was no surface water flow in the stream. Groundwater flow in the Area 18B vicinity is generally to the southeast based on the March 2005 Site-Wide Groundwater Contour Map. The upper portion of the stream is likely a losing stream and not hydraulically connected to groundwater. Figure 2 shows the sampling locations.

During the sediment sampling, a sample was collected from the surface (0-0.5 ft bgs) at each location. At the upstream locations, a subsurface sample was also collected at the request of NJDEP. The subsurface depth interval selected for sampling was determined based on photoionization detector (PID) meter readings, odors, or staining. If none of these were present, the first 6 inches of non-sand soil/sediment below the surface sand layer was sampled. All samples were analyzed for PAHs by Method SW8270C SIM.

Tables 3 and 4 presents the analytical results. Table 3 presents comparisons with NJDEP screening levels for human exposure and Table 4 presents comparisons of surface sediment (0 – 0.5 ft samples only) concentrations of PAH with ecological screening levels. On both tables, the PAH results exceeded screening standards in nearly all samples.

The most recent as well as historical results indicate that PAH concentrations tend to decrease with distance downstream of the storm sewer outfall. The Area 18B Stream is fed by two 48-inch diameter storm drains which appear to collect stormwater runoff from upgradient locations including rooftops and paved areas around buildings 245, 246 and possibly 229 (see Figure 3). A review of the Map Annex that accompanies the Dames and Moore (1993) Archival Search Report shows that an aboveground storm drain appears at the general location of the Area 18B Stream in the 1963 site plan. The map presenting the location of the aboveground storm drain shows a network of upgradient, belowground storm drains that discharge to the Area 18B drainage ditch. This map also shows storm drains adjacent to buildings 245 and 246 (the two large buildings located west of Areas 18A and 18B) discharging to the Area 18B drainage ditch. Likewise, a 1958 (revised 1960) storm drain map prepared by the Army (Figure 3) shows the same thing.

Meaningful comparisons of the current results with the previous sample results from the Area 18B Stream are difficult based on the dynamic nature of the stream's sand substrate. Over time, the stream substrate and the associated PAH levels are likely to change and are impacted by major storm events that likely scour older substrate and replaces it with levels from upgradient locations. Any comparisons of the 2013 results with results from 1994 and even 2005 are of limited utility other than to illustrate the changing stream conditions. Nevertheless, Table 5 presents the temporal variability of PAH concentrations at locations that were sampled more than once since 1994. For simplicity, the total PAH concentrations represented by the sum of the individual PAHs were compared.

- Location SD-1820 was sampled in July 2005 (location SD-1812) as part of the sample collection effort for the ecological risk assessment (ERA). The total PAH concentration in 2005 at this location was 120 mg/kg. The 2013 total PAH concentration is 531 mg/kg, an approximately four-fold increase.
- Location SD-1821 was sampled in July 2005 (location SD-1813) and August 1994 (SD-1803). The total PAH concentration in 1994 was 4,934 mg/kg. The 2005 sample results showed a significant decrease to 49 mg/kg. The 2013 total PAH result increased to 2,742 mg/kg.
- Location SD-1822 was sampled in July 2005 (previous location SD-1814 plus a field duplicate) and August 1994 (SD-1804). The 1994 total PAH concentration was 5,436 mg/kg. The 2005 concentration (average of the primary and field duplicate) was 316 mg/kg. The 2013 sample results exhibited a modest increase from 2005 to 902 mg/kg.
- Location SD-1823 was sampled in July 2005 (previous location SD-1815). The 2005 total PAH concentration was 552 mg/kg. The 2013 PAHs results were mostly non-detect, with a total PAH concentration approximately 0.1 mg/kg.
- Location SD-1824 was sampled in August 1994 (previous location SD-1805). The total PAHs detected in 1994 were relatively similar to the 2013 result.
- Location SD-1827 was sampled in July 2005 (location SD-1811) and August 1994 (SD-1806). The total PAH concentrations, less than 50 mg/kg) from this location remained relatively consistent in the 1994, 2005, and 2013 sampling results

As outlined in the previous bullets, there is no temporal trend to report with regards to the total PAH concentrations within the Area 18B Stream. Likewise, there is not a clear trend with depth. The lack of a clear contamination pattern could be related to the sandy substrate and the likely source of the PAHs. These results, especially at the upstream sampling locations, are indicative of an intermittent source of contamination to the Area 18B Stream that is heavily dependent on storm events, such as periodic discharge from the two 48-inch stormwater discharge pipes located at the headwater of the Area 18B Stream. One would expect relative consistency in concentrations if the source was from the previously remediated areas at Investigation Area 18A. In addition, data from historic soil samples collected at the water table between the Area 18B stream and the Area 18A remediation areas did not detect PAHs. The results of the recent sample collection effort indicate that the contamination identified within the Area 18B Stream most likely is the result of storm water discharge from upgradient areas.

TABLE 1
ANALYTICAL RESULTS - OCTOBER 2013
AREA 4 SOIL
Former Raritan Arsenal, Edison, New Jersey
(results in units of milligrams per kilogram, mg/kg)

			SS-0445A		SS-0445B		SS-0445B-DUP		SS-0446A		SS-0446B		SS-0447A		SS-0447B		SS-0448A		SS-0448B		SS-0449A		SS-0449B	
			10/1/2013		10/1/2013		10/1/2013		10/1/2013		10/1/2013		10/1/2013		10/1/2013		10/1/2013		10/1/2013		10/1/2013		10/1/2013	
			L1319641-01		L1319641-02		L1319641-03		L1319641-06		L1319641-07		L1319641-04		L1319641-05		L1319641-08		L1319641-09		L1319641-10		L1319641-11	
			Soil		Soil		Soil		Soil		Soil		Soil		Soil		Soil		Soil		Soil		Soil	
			0 - 0.5		3 - 4		3 - 4		0 - 0.5		3 - 4		0 - 0.5		2.5 - 3		0 - 0.5		3 - 4		0 - 0.5		3 - 4	
	NJDEP																							
Explosive Compound	Residential Direct Contact SRS	Industrial Direct Contact SRS																						
HMX	---	---	0.117	U	0.117	U	0.116	U	0.118	U	0.118	U	0.119	U	0.117	U	0.118	U	0.118	U	0.118	U	0.118	U
RDX	---	---	0.117	U	0.117	U	0.116	U	0.118	U	0.118	U	0.119	U	0.117	U	0.118	U	0.118	U	0.118	U	0.118	U
1,3,5-Trinitrobenzene	---	---	0.117	U	0.117	U	0.116	U	0.118	U	0.118	U	0.119	U	0.117	U	0.118	U	0.118	U	0.118	U	0.118	U
1,3-Dinitrobenzene	---	---	0.117	U	0.117	U	0.116	U	0.118	U	0.118	U	0.119	U	0.117	U	0.118	U	0.118	U	0.118	U	0.118	U
Nitrobenzene	31	340	0.117	U	0.117	U	0.116	U	0.118	U	0.118	U	0.119	U	0.117	U	0.118	U	0.118	U	0.118	U	0.118	U
Tetryl	---	---	0.117	U	0.117	U	0.116	U	0.118	U	0.118	U	0.119	U	0.117	U	0.118	U	0.118	U	0.118	U	0.118	U
2,4,6-Trinitrotoluene	---	---	0.117	U	0.117	U	0.116	U	0.118	U	0.118	U	0.119	U	0.117	U	0.118	U	0.118	U	0.118	U	0.118	U
4-Amino-2,6-dinitrotoluene*	150	1900	0.117	U	0.117	U	0.116	U	0.118	U	0.118	U	0.119	U	0.117	U	0.118	U	0.03	J	0.118	U	0.0425	J
2-Amino-4,6-dinitrotoluene*	150	2000	0.117	U	0.117	U	0.116	U	0.118	U	0.118	U	0.119	U	0.117	U	0.118	U	0.0158	J	0.118	U	0.0158	J
2,6-Dinitrotoluene	0.7	3	0.117	U	0.117	U	0.116	U	0.118	U	0.118	U	0.119	U	0.117	U	0.118	U	0.118	U	0.118	U	0.118	U
2,4-Dinitrotoluene	0.7	3	0.117	U	0.117	U	0.116	U	0.118	U	0.118	U	0.119	U	0.117	U	0.118	U	0.118	U	0.118	U	0.118	U

U - Not detected at the reported detection limit for the sample.

J - Estimated value. The Target analyte concentration is below the quantitation limit (RL), but above the Method Detection Limit (MDL).

* In the absence of NJDEP SRSs, the EPA Regional Screening Levels were used for comparison.

SRS = Soil Remediation Standard

TABLE 2
ANALYTICAL RESULTS - OCTOBER 2013
AREA 18A SOIL
Former Raritan Arsenal, Edison, New Jersey
(results in units of milligrams per kilogram, mg/kg)

			LOCATION:	**SS-18A44A**		**SS-18A44B**
			SAMPLING DATE:	**10/1/2013**		**10/1/2013**
			LAB SAMPLE ID:	**L1319640-01**		**L1319640-02**
			SAMPLE TYPE:	**Soil**		**Soil**
			SAMPLE DEPTH (ft.):	**0 - 0.5**		**2 - 3**
	NJDEP					
PAH Compound	**Residential Direct Contact SRS**	**Industrial Direct Contact SRS**				
Semivolatile Organics by SIM						
Acenaphthene	3400	37000		0.0067	U	0.0068 U
Fluoranthene	2300	24000		0.006	J	0.0068 U
Naphthalene	6	17		0.0067	U	0.0068 U
Benzo(a)anthracene	0.6	2		0.0026	J	0.0068 U
Benzo(a)pyrene	0.2	0.2		0.0026	J	0.0068 U
Benzo(b)fluoranthene	0.6	2		0.0041	J	0.0068 U
Benzo(k)fluoranthene	6	23		0.0018	J	0.0068 U
Chrysene	62	230		0.0034	J	0.0068 U
Acenaphthylene	---	300000		0.0067	U	0.0068 U
Anthracene	17000	30000		0.0067	U	0.0068 U
Benzo(ghi)perylene	380000	30000		0.0024	J	0.0068 U
Fluorene	2300	24000		0.0067	U	0.0068 U
Phenanthrene	---	---		0.0025	J	0.0068 U
Dibenzo(a,h)anthracene	0.2	0.2		0.0067	U	0.0068 U
Indeno(1,2,3-cd)pyrene	0.6	2		0.0023	J	0.0068 U
Pyrene	1700	18000		0.0051	J	0.0068 U
1-Methylnaphthalene	---	---		0.0067	U	0.0068 U
2-Methylnaphthalene	230	2400		0.0067	U	0.0068 U
Total PAHS	---	---		0.0864		Not detected

J - Estimated value. The Target analyte concentration is below the quantitation limit (RL), but above the Method Detection Limit (MDL).

U - Not detected at the reported detection limit for the sample.

RSL = Regional Screening Level

SRS = Soil Remediation Standard

TABLE 3
ANALYTICAL RESULTS - OCTOBER 2013
AREA 18B STREAM SEDIMENT - COMPARISONS WITH HUMAN HEALTH STANDARDS
Former Raritan Arsenal, Edison, New Jersey
(results in units of milligrams per kilogram, mg/kg)

		LOCATION:	**SD-1820**	**SD-1821A**	**SD-1821B**	**SD-1822A**	**SD-1822B**	**SD-1823A**	**SD-1823B**	**SD-1824A**	**SD-1824A-DUP**	**SD-1824B**	**SD-1825**	**SD-1826**	**SD-1827**	**SD-1827-DUP**	**SD-1819**
		SAMPLING DATE:	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**
		LAB SAMPLE ID:	**L1319640-04**	**L1319640-05**	**L1319640-06**	**L1319640-07**	**L1319640-08**	**L1319640-09**	**L1319640-10**	**L1319640-11**	**L1319640-12**	**L1319640-13**	**L1319640-14**	**L1319640-15**	**L1319640-16**	**L1319640-17**	**L1319640-03**
		SAMPLE TYPE:	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**
		SAMPLE DEPTH (ft.):	**0 - 0.5**	**0 - 0.5**	**1 - 1.5**	**0 - 0.5**	**1 - 1.5**	**0 - 0.5**	**2 - 2.5**	**0 - 0.5**	**0 - 0.5**	**3 - 3.5**	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**
		PID READING (ppm):	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.1**	**0.1**	**38**	**0**	**0**	**0**	**0**	**0**
	NJDEP																
PAH Compound	**Residential Direct Contact SRS**	**Industrial Direct Contact SRS**															
Semivolatile Organics by SIM																	
Acenaphthene	3400	37000	12	79	14	15	140	0.0071 U	14	5.4	12	0.088	0.49	1.4	0.21	0.47	0.043 U
Fluoranthene	2300	24000	98	500	79	180	1300	0.0036 J	140	62	110	0.95	14	12	4.2	5.5	0.26
Naphthalene	6	17	6.9	**41**	8.1	10	**84**	0.0071 U	8.4 J	3.5	6.2	0.06	0.24	0.84	0.13	0.36	0.043 U
Benzo(a)anthracene	0.6	2	**36**	**180**	**30**	**63**	**420**	0.0018 J	**51**	**25**	**42**	0.35	**5.4**	**4.8**	1.5	**2.2**	0.11
Benzo(a)pyrene	0.2	0.2	**30**	**150**	**26**	**55**	**380**	0.0017 J	**39**	**19**	**35**	**0.32**	**6**	**4.4**	**1.5**	**2.1**	0.11
Benzo(b)fluoranthene	0.6	2	**36**	**190**	**28**	**62**	**520**	0.0025 J	**50**	**25**	**46**	0.43	**9.1**	**6**	**2.2**	**3**	0.17
Benzo(k)fluoranthene	6	23	**24**	**86**	22	**53**	**230**	0.0071 U	**31**	15	22	0.19	4	2.4	0.99	1.2	0.077
Chrysene	62	230	38	180	31	69	**490**	0.0022 J	54	26	43	0.41	7	5.5	2	2.7	0.15
Acenaphthylene	---	300000	0.45 J	1.7 J	0.37 J	0.84 J	5.3 J	0.0071 U	12 U	3.4 U	3.4 U	0.0064 J	0.19	0.083 J	0.046 J	0.046 J	0.043 U
Anthracene	17000	30000	13	150	13	23	270	0.0071 U	48	14	16	0.14	1.2	2.4	0.43	0.78	0.035 J
Benzo(ghi)perylene	380000	30000	19	93	16	37	240	0.0071 U	29	14	23	0.21	4.9	4	1.1	1.5	0.1
Fluorene	2300	24000	12	77	13	14	120	0.0071 U	15	5.2	10	0.09	0.53	0.99	0.19	0.47	0.043 U
Phenanthrene	---	---	99	470	86	130	1100	0.0071 U	94	43	98	0.78	6.1	9.9	2.5	4.7	0.082
Dibenzo(a,h)anthracene	0.2	0.2	**5.4**	**26**	**4.4**	**10**	**62**	0.0071 U	**7.4** J	**3.7**	**6.2**	0.052	**1.1**	**0.98**	**0.26**	**0.34**	0.024 J
Indeno(1,2,3-cd)pyrene	0.6	2	**17**	**80**	**14**	**32**	**260**	0.0071 U	**25**	**12**	**20**	0.22	**5.2**	**4.2**	1.2	1.6	0.084
Pyrene	1700	18000	77	400	65	140	1000	0.0032 J	110	50	90	0.76	11	10	3.4	4.9	0.22
1-Methylnaphthalene	---	---	3.5	18	3.5	4.3	34 J	0.0071 U	3.7 J	1.1 J	2.6 J	0.022	0.1 J	0.28	0.041 J	0.12	0.043 U
2-Methylnaphthalene	230	2400	3.4	20	3.3	3.4 J	35 J	0.0071 U	3.2 J	1.3 J	2.6 J	0.026	0.11 J	0.33	0.048 J	0.14	0.043 U
Total PAHS	---	---	531	2742	457	902	6690	0.10	735	329	588	5.1	77	71	22	32	1.7

J - Estimated value. The Target analyte concentration is below the quantitation limit (RL), but above the Method Detection Limit (MDL).
U - Not detected at the reported detection limit for the sample.

Exceedances of NJDEP Residential Direct Contact Soil Remediation Standards are indicated by highlighting.
Exceedances of NJDEP Industrial Direct Contact Soil Remediation Standards are indicated by bolding.

RSL = Regional Screening Level
SRS = Soil Remediation Standard

TABLE 4
ANALYTICAL RESULTS - OCTOBER 2013
AREA 18B STREAM SURFACE SEDIMENT - COMPARISONS WITH ECOLOGICAL STANDARDS
Former Raritan Arsenal, Edison, New Jersey
(results in units of milligrams per kilogram, mg/kg)

		LOCATION:	**SD-1820**	**SD-1821A**	**SD-1822A**	**SD-1823A**	**SD-1824A**	**SD-1824A-DUP**	**SD-1825**	**SD-1826**	**SD-1827**	**SD-1827-DUP**	**SD-1819**
		SAMPLING DATE:	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**	**10/1/2013**
		LAB SAMPLE ID:	**L1319640-04**	**L1319640-05**	**L1319640-07**	**L1319640-09**	**L1319640-11**	**L1319640-12**	**L1319640-14**	**L1319640-15**	**L1319640-16**	**L1319640-17**	**L1319640-03**
		SAMPLE TYPE:	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**	**Sediment**
		SAMPLE DEPTH (ft.):	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**
		PID READING (ppm):	**0**	**0**	**0**	**0**	**0.1**	**0.1**	**0**	**0**	**0**	**0**	**0**
	NJDEP												
PAH Compound	**Freshwater Sediment LEL**	**Freshwater Sediment SEL**											
Semivolatile Organics by SIM													
Acenaphthene	0.00671	---	12	79	15	0.0071 U	5.4	12	0.49	1.4	0.21	0.47	0.043 U
Fluoranthene	0.423	1020	98	500	180	0.0036 J	62	110	14	12	4.2	5.5	0.26
Naphthalene	0.176	---	6.9	41	10	0.0071 U	3.5	6.2	0.24	0.84	0.13	0.36	0.043 U
Benzo(a)anthracene	0.108	1480	36	180	63	0.0018 J	25	42	5.4	4.8	1.5	2.2	0.11
Benzo(a)pyrene	0.15	1440	30	150	55	0.0017 J	19	35	6	4.4	1.5	2.1	0.11
Benzo(b)fluoranthene	10.4	---	36	190	62	0.0025 J	25	46	9.1	6	2.2	3	0.17
Benzo(k)fluoranthene	0.24	1340	24	86	53	0.0071 U	15	22	4	2.4	0.99	1.2	0.077
Chrysene	0.166	460	38	180	69	0.0022 J	26	43	7	5.5	2	2.7	0.15
Acenaphthylene	0.00587	---	0.45 J	1.7 J	0.84 J	0.0071 U	3.4 U	3.4 U	0.19	0.083 J	0.046 J	0.046 J	0.043 U
Anthracene	0.0572	370	13	150	23	0.0071 U	14	16	1.2	2.4	0.43	0.78	0.035 J
Benzo(ghi)perylene	0.17	320	19	93	37	0.0071 U	14	23	4.9	4	1.1	1.5	0.1
Fluorene	0.0774	160	12	77	14	0.0071 U	5.2	10	0.53	0.99	0.19	0.47	0.043 U
Phenanthrene	0.204	950	99	470	130	0.0071 U	43	98	6.1	9.9	2.5	4.7	0.082
Dibenzo(a,h)anthracene	0.033	130	5.4	26	10	0.0071 U	3.7	6.2	1.1	0.98	0.26	0.34	0.024 J
Indeno(1,2,3-cd)pyrene	0.2	320	17	80	32	0.0071 U	12	20	5.2	4.2	1.2	1.6	0.084
Pyrene	0.195	850	77	400	140	0.0032 J	50	90	11	10	3.4	4.9	0.22
1-Methylnaphthalene	---	---	3.5	18	4.3	0.0071 U	1.1 J	2.6 J	0.1 J	0.28	0.041 J	0.12	0.043 U
2-Methylnaphthalene	0.0202	---	3.4	20	3.4 J	0.0071 U	1.3 J	2.6 J	0.11 J	0.33	0.048 J	0.14	0.043 U
Total PAHS	4	10000	531	2742	902	0.10	329	588	77	71	22	32	1.7

J - Estimated value. The Target analyte concentration is below the quantitation limit (RL), but above the Method Detection Limit (MDL).

U - Not detected at the reported detection limit for the sample.

Exceedances of Low Effects Level are indicated by highlighting.

SEL = severe effect level

LEL = lowest effect level

TABLE 5
ANALYTICAL RESULTS - OCTOBER 2013
AREA 18B STREAM SEDIMENT - COMPARISONS WITH PREVIOUS SAMPLE RESULTS
Former Raritan Arsenal, Edison, New Jersey
(results in units of milligrams per kilogram, mg/kg)

LOCATION:	SD-1820	SD-1812	SD-1821A	SD-1813	SD-1803	SD-1822A	SD-1814	SD-1816(DUP)	SD-1804	SD-1823A	SD-1815	SD-1824A	SD-1824A-DUP	SD-1805	SD-1827	SD-1827-DUP	SD-1811	SD-1806
SAMPLING DATE:	10/1/2013	7/19/2005	10/1/2013	7/19/2005	8/2/1994	10/1/2013	7/19/2005	7/19/2005	8/2/1994	10/1/2013	7/19/2005	10/1/2013	10/1/2013	8/2/1994	10/1/2013	10/1/2013	7/19/2005	8/2/1994
SAMPLE TYPE:	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
SAMPLE DEPTH (ft.):	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Semivolatile Organics by SIM																		
Acenaphthene	12	2.1	79	1.3	110	15	4.7 JD	9.4 D	110	0.0071 U	13 JD	5.4	12	3	0.21	0.47	0.23 J	0.12 J
Fluoranthene	98	25 D	500	11 D	820	180	57 D	64 D	1100	0.0036 J	110 D	62	110	46	4.2	5.5	8.4	4.5
Naphthalene	6.9	1.8	41	0.92	82	10	3.6 JD	5.5 JD	81	0.0071 U	9.6 JD	3.5	6.2	1.3	0.13	0.36	0.15 J	0.46 U
Benzo(a)anthracene	36	8.8 D	180	3.1	380	63	19 D	21 D	410	0.0018 J	32 D	25	42	22	1.5	2.2	3	2.2
Benzo(a)pyrene	30	5.5	150	2	300	55	15 D	16 D	320	0.0017 J	23 D	19	35	4.9	1.5	2.1	3.2	2.2
Benzo(b)fluoranthene	36	7.8 D	190	2.5	400	62	15 D	15 D	450	0.0025 J	24 D	25	46	23	2.2	3	3.6	4.7
Benzo(k)fluoranthene	24	3.2	86	1.8	49	53	15 D	16 D	150	0.0071 U	22 D	15	22	3.7	0.99	1.2	3.5	0.73
Chrysene	38	11 D	180	3.7	400	69	24 D	26 D	400	0.0022 J	40 D	26	43	23	2	2.7	4.6	2.8
Acenaphthylene	0.45 J	0.07 J	1.7	0.028 J	3.4	0.84 J	6.5 U	7.9 U	47 U	0.0071 U	13 U	3.4 U	3.4 U	0.46 U	0.046 J	0.046 J	0.05 J	0.46 U
Anthracene	13	3.5	150	1.1	280	23	6.9 D	11 D	230	0.0071 U	13 JD	14	16	6.1	0.43	0.78	0.53 J	0.33 J
Benzo(ghi)perylene	19	1.8	93	0.65	240	37	7.3 D	7.6 JD	150	0.0071 U	12 JD	14	23	10	1.1	1.5	1.8	0.81
Fluorene	12	1.8	77	0.76	97	14	3.5 JD	8.2 D	98	0.0071 U	9.7 JD	5.2	10	2.9	0.19	0.47	0.2 J	0.12 J
Phenanthrene	99	23 D	470	11 D	760	130	45 D	77 D	890	0.0071 U	120 D	43	98	30	2.5	4.7	3.7	1.9
Dibenzo(a,h)anthracene	5.4	0.96	26	0.25 J	29	10	2.8 JD	2.9 JD	10 J	0.0071 U	4.8 JD	3.7	6.2	3.4	0.26	0.34	0.62 J	0.17 J
Indeno(1,2,3-cd)pyrene	17	2.3	80	0.41 U	220	32	8.2 D	8.3 D	150	0.0071 U	13 JD	12	20	11	1.2	1.6	2	0.93
Pyrene	77	21 D	400	8.1 D	740	140	45 D	52 D	810	0.0032 J	88 D	50	90	34	3.4	4.9	7.3	3.9
1-Methylnaphthalene	3.5	---	18	---	---	4.3	---	---	---	0.0071 U	---	1.1 J	2.6 J	---	0.041 J	0.12	---	---
2-Methylnaphthalene	3.4	0.71	20	0.40 J	24	3.4 J	1.4 JD	2.8 JD	30 J	0.0071 U	4.6 JD	1.3 J	2.6 J	0.68	0.048 J	0.14	0.94 U	0.46 U
Total PAHS	531	120	2742	49	4934	902	280	351	5436	0.10	552	329	588	225	22	32	44	27

D - The reported value is from a dilution.
J - Estimated value. The Target analyte concentration is below the quantitation limit (RL), but above the Method Detection Limit (MDL).
U - Not detected at the reported detection limit for the sample.



0448		
Depth (ft.)	Analyte	Result (mg/kg)
3 - 4	2-AMINO-4,6-DINITROTOLUENE	0.0158 J
3 - 4	4-Amino-2,6-Dinitrotoluene	0.03 J

0449		
Depth (ft.)	Analyte	Result (mg/kg)
3 - 4	2-AMINO-4,6-DINITROTOLUENE	0.0158 J
3 - 4	4-Amino-2,6-Dinitrotoluene	0.0425 J

Legend
- Sample Locations
- Previous TNT Sample Locations
- Soil Investigation Areas
- Monitoring Wells

N W E S

25 0 25 50
Scale in Feet

Commercial/Industrial Area
Former Raritan Arsenal Site, Edison, NJ

FIGURE 1
SOIL SAMPLE RESULTS IN AREA 4

AVATAR ENVIRONMENTAL

Area 18A

Area 18B

Two 48" Stormwater Discharge Pipes

SD-1820
0 - 0.5 ft. -
530.65 mg/kg

SD-1821A
0 - 0.5 ft. -
2741.7 mg/kg

SD-1821B
1 - 1.5 ft. -
456.67 mg/kg

SD-1822A
0 - 0.5 ft. -
901.54 mg/kg

SD-1822B
1 - 1.5 ft. -
6690.3 mg/kg

SD-1823A
0 - 0.5 ft. -
0.1 mg/kg

SD-1823B
2 - 2.5 ft. -
734.7 mg/kg

SD-1824A
0 - 0.5 ft. -
328.6 mg/kg

SD-1824B
3 - 3.5 ft. -
5.1 mg/kg

SS-18A44A
0 - 0.5 ft. -
0.0864 mg/kg

SD-1824A-DUP
0 - 0.5 ft. -
588 mg/kg

SD-1825
0 - 0.5 ft. -
76.66 mg/kg

SD-1826
0 - 0.5 ft. -
70.5 mg/kg

SD-1827-DUP
0 - 0.5 ft. -
32.13 mg/kg

SD-1827
0 - 0.5 ft. -
21.95 mg/kg

SD-1819
0 - 0.5 ft. -
1.68 mg/kg

1993 Geophysical Survey Area

1993 Geophysical Survey Area

1993 Geophysical Survey Area

2004 Lead Removal Area
Former Firing Range Backstop

Legend

- Stormwater Discharge
- Soil Sample Results
- October 2013 Sediment Results
- Intermitten Stream
- Excavation Areas
- Soil Investigation Areas
- Geophysical Survey

Source:
Topography from CAD drawing supplied by WESTON Solutions, Inc., dated 1992.
Aerial Photos from New Jersey 2007 - 2008 High Resolution Orthophotography, MrSID 5K Tiles - NJ Office of Information Technology (NJOIT), Office of Geographic Information Systems (OGIS) - October 2008.
Stormwater discharge location from Basic Information Maps - General Storm Drainage System Dwg # 18-02-01 Sheet 22 of 25, dated 1958.

N
W E
S

70 0 70 140
Scale in Feet

USEPA/GSA Area
Former Raritan Arsenal Site, Edison, NJ

FIGURE 2
SOIL & SEDIMENT TOTAL PAH RESULTS IN AREAS 18A & 18B

AVATAR ENVIRONMENTAL

Area 18A

N
W E
S

150 0 150 300
Scale in Feet

Source:
Storm drain base map from Basic Information Maps - General Storm Drainage System Dwg.# 18-02-01 Sheet 22 of 25, dated 1958.

USEPA/GSA Area
Former Raritan Arsenal Site, Edison, NJ

FIGURE 3
MAP SHOWING THE LOCATION OF STORM WATER DRAINAGE

State of New Jersey

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

DEPARTMENT OF ENVIRONMENTAL PROTECTION

BOB MARTIN
Commissioner

Bureau of Case Management
401-05F
P.O. Box 420
Trenton, NJ 08625-0420
Phone #: 609-633-1455
Fax #: 609-633-1454

May 23, 2014

Sandra Piettro, Project Manager
Department of the Army
New York District, Corps of Engineers
Jacob K. Javits Federal Building
26 Federal Plaza, Room 1811
New York, NY 10278-0090

Re: Former Raritan Arsenal
Edison Township, Middlesex County, New Jersey
SRP PI# 006021

Dear Ms. Piettro:

The New Jersey Department of Environmental Protection (Department) has completed a review of the document titled "Sampling Results in Support of Ongoing Remedial Investigations – Area 4 (Former TNT Washout and Munitions Demilitarization Area), Area 18A (Former GSA/US Army Pond Area) and Area 18B (Former Firing Range)" dated February 26, 2014, submitted pursuant to the Department of Defense State Memorandum of Agreement (DSMOA) executed on April 3, 1992 and the Technical Requirements for Site Remediation at N.J.A.C. 7:26E.

The Department's comments on the submittal are provided below.

General Comment:

Area 4 is the former TNT Washout and Munitions Demilitarization Area. Ground water at Area 4 is being investigated as part of the AOC-9 plume. Monitored Natural Attenuation (MNA) is the USACE's selected remedy for the explosives contamination. In the latest sampling on September 6, 2012, MW-124 had 44.5 µg/l of 2,4-dinitrotoluene, above the Ground Water Quality Standard (GWQS) of 10 µg/l. It should also be noted that several compounds in AOC 9 were detected at or above the interim generic ground water quality criterion of 100 ppb: nitroglycerin (319 ppb in MW-316), 2-amino-4,6-dinitrotoluene (195 ppb in MW-130 and 198 ppb in MW-124), 4-amino-2,6-dinitrotoluene (198 ppb in MW-124), and PETN (100 ppb in MW-124).

Specific Comments:

Table 4 indicates that 9 of 11 samples contain individual and total PAHs (tPAH) elevated above ecological screening criteria (ESC). For characterization purposes, sediment data from all depths should be compared with ESC. tPAH exceedances from the surface interval range from 5-times the ESC (4 mg/kg) at SD1827 to 685-times the ESC at SD1821A; at SD1822B, the tPAH concentration at the 1-1.5' interval exceeds the ESC by 1670-times (i.e., exceedance is over 3 orders of magnitude). Prior sediment toxicity tests, reported in the *Final Baseline Ecological Risk Assessment Report, March 2008, Table 4-19*, documented adverse effects to the sediment benthic community (*Chironomus tentans* bioassay results, when compared with laboratory control samples). These data confirm the presence of highly elevated tPAHs in the Area 18B stream, and based on the degree of exceedances and prior documented sediment toxicity, sediment remediation is warranted. A risk management approach can be used by the Department and USACE to determine the numeric remediation goals, vertical and horizontal extent of remediation, etc.

The report concludes that the contamination in the Area 18B stream is most likely the result of storm water discharge from upgradient areas. It is the Department's belief that the levels present in surface and subsurface intervals are far higher than would be expected from an upgradient storm water source and may reflect PAH residuals from the Area 18A Pond. USACE should better document their position on offsite source contributions using existing background/reference data or conducting additional confirmation sampling pursuant to N.J.A.C.7:26E from background locations with similar physical/geomorphic characteristics but outside of the influence of the Area 18A Pond. At a minimum, existing sediment tPAH data from similar onsite drainage/stream on the Former Arsenal Site should be examined for comparison purposes. For example, the Department examined tPAH freshwater sediment summary data for the Black Ditch Drainage and County Park Drainage (Tables 3-7A and 3-12A, respectively, dated 3/1/02, from the *Screening-Level Ecological Risk Assessment Report, Final Draft, May 2002*), where the maximum tPAH concentrations were less than 10 mg/kg (i.e., approximate 2.5-times the ESC); mean tPAH concentrations were much lower. The Department also examined sediment data from the two freshwater background/reference locations for the BERA, Farrington Lake and Ireland Brook, which were selected to generally reflect an urban setting (BERA Table 4-5). tPAH data from these locations were also less than 10 mg/kg (6.9 and 4.6 mg/kg, respectively). Taken together, these data support the consideration of a sediment remediation goal for the Area 18B stream of less than 10 mg/kg tPAH.

Based on the recent information supplied by the USACE, the conclusion of no further investigation for the specific areas evaluated associated with the recent sampling for Area 4 and Area 18A is acceptable. However, as described above, further investigation/evaluation of the Area 18B streambed is warranted.

If you require copies of Department Guidance Documents or applications, many of these are available on the internet http://www.state.nj.us/dep/srp. If you have any questions regarding this matter I may be contacted at (609) 633-1416, or at Anthony.Cinque@dep.state.nj.us.

Sincerely,

Anthony Cinque, Case Manager
Bureau of Case Management

cc: John Orozco, Federal Business Centers
Jay Elliot, Edison Health Department
Anne Hayton, NJDEP/BEERA
Dave Van Eck, NJDEP/BGWPA

Additional Information – NJDEP Comments
Sampling Results in Support of Ongoing Remedial Investigations
Former Raritan Arsenal
Area 4 (Former TNT Washout and Munitions Demilitarization Area), Area 18A (Former GSA/US Army Pond Area), and Area 18B (Former Firing Range)

Elevated PAHs in the Area 18B stream are mostly likely from up-gradient sources and not from either the overland flow of eroded sediments or from residual PAH's in soil leaching into groundwater and subsequently discharging into the Area 18B stream. Evidence to support this position is based on the surface topography, the groundwater flow direction, analytical results, and the lack of mobility of PAHs in the subsurface. Based on the following evidence, it is highly unlikely that the former Area 18A pond is the source of elevated PAH contamination in the Area 18B stream.

Based on topography, as shown on Figure 1, direct overland flow from the former Area 18A pond to the Area 18B stream is blocked by a rise in topography that runs along the eastern side of the stream. Surface water or run-off originating at the former Area 18A pond would be diverted along this rise to the lower portion of the stream.

The overall groundwater flow direction for the site is in a southeasterly direction (Weston, 2008). The most recent site-wide groundwater elevation data was collected in 2005. The groundwater flow direction in the vicinity of Area 18A is toward the southeast as shown on Figure 2. Therefore, groundwater flow is away from the upper portion of the stream where the highest concentrations of PAHs were found.

PAHs in general are not very mobile in the subsurface. Except for the more soluble PAH compounds (e.g., naphthalene, methylnaphthalenes) they have very low aqueous solubility and are strongly sorbed to organic material and fine-grained sediment and therefore, do not migrate any appreciable distance and definitely would not migrate at high concentrations. PAH mobility generally decreases with the number of benzene rings. As shown on Figure 1, a portion of the area where elevated PID readings were measured is in fine-grained silty sand and clay. A portion of the area of elevated PID readings is in a sand unit. However, PAHs would still have to migrate through silty sand to reach the stream.

A review of background/reference data showed that boreholes 18A05 and 18A15 were advanced between the former Area 18A pond and Area 18B stream, as shown in Figure 3. Soil samples were collected from borehole 18A05 at depths of 0 to 0.5 ft bgs, 2.5 to 3.0 ft bgs, and 9.5 to 10.0 ft bgs. The analytical results for these samples indicated PAH concentrations of 0.20 J mg/kg, non-detect, and non-detect. Soil samples were also collected from borehole 18A15 (Figure 1) at depths of 0 to 0.5 ft bgs, 6.5 to 7.0 ft bgs, and 8.7 to 9.2 ft bgs. The analytical results for these samples were all non-detect for PAHs. The deepest interval sampled in each borehole was collected directly above groundwater and PAHs were not detected in these samples. The borehole logs for these two locations do not make any note of elevated readings, odors or staining for the entire depth of the borehole. Therefore, it does not appear that this was a

migration pathway. Borehole logs and analytical results are found in *Final Report of Investigation Former Raritan Arsenal Area 18A Investigation* (Weston, 1996).

A possible upgradient source is the buildings in the 18D area of concern, which were constructed between 1951 and 1961. The roofs of the buildings (245 and 246) are thought to be coal tar or asphalt. Aerial images of both buildings indicate that both roofs are severely deteriorated. The first signs of wear in a coal tar pitch roof include blisters, splits, and cracks which allow for leaks and ponding.

Current research shows that significant PAH contamination can be attributed to the breakdown of surfaces treated with coal-tar pitch. When compared to unsealed and asphalt sealed surfaces, coal-tar pitch sealed surfaces have been shown to release 100-1000 times more PAHs into the environment (Selbig, 2009).

References

Selbig, W.R., 2009. Concentrations of polycyclic aromatic hydrocarbons (PAHs) in urban stormwater, Madison, Wisconsin, 2005-08. U.S. Department of the Interior, U.S. Geological Survey. Retrieved from: http://pubs.usgs.gov/of/2009/1077/pdf/ofr20091077.pdf

Weston. 1996. Final Report of Investigation Former Raritan Arsenal Area 18A Investigation Prepared for the U.S. Army Corps of Engineers, Waltham, Massachusetts. March 1996.

Weston. 2008. Draft Groundwater Remedial Action Work Plan for the Former Raritan Arsenal, Edison, New Jersey. Prepared for the U.S. Army Corps of Engineers. February 2008.

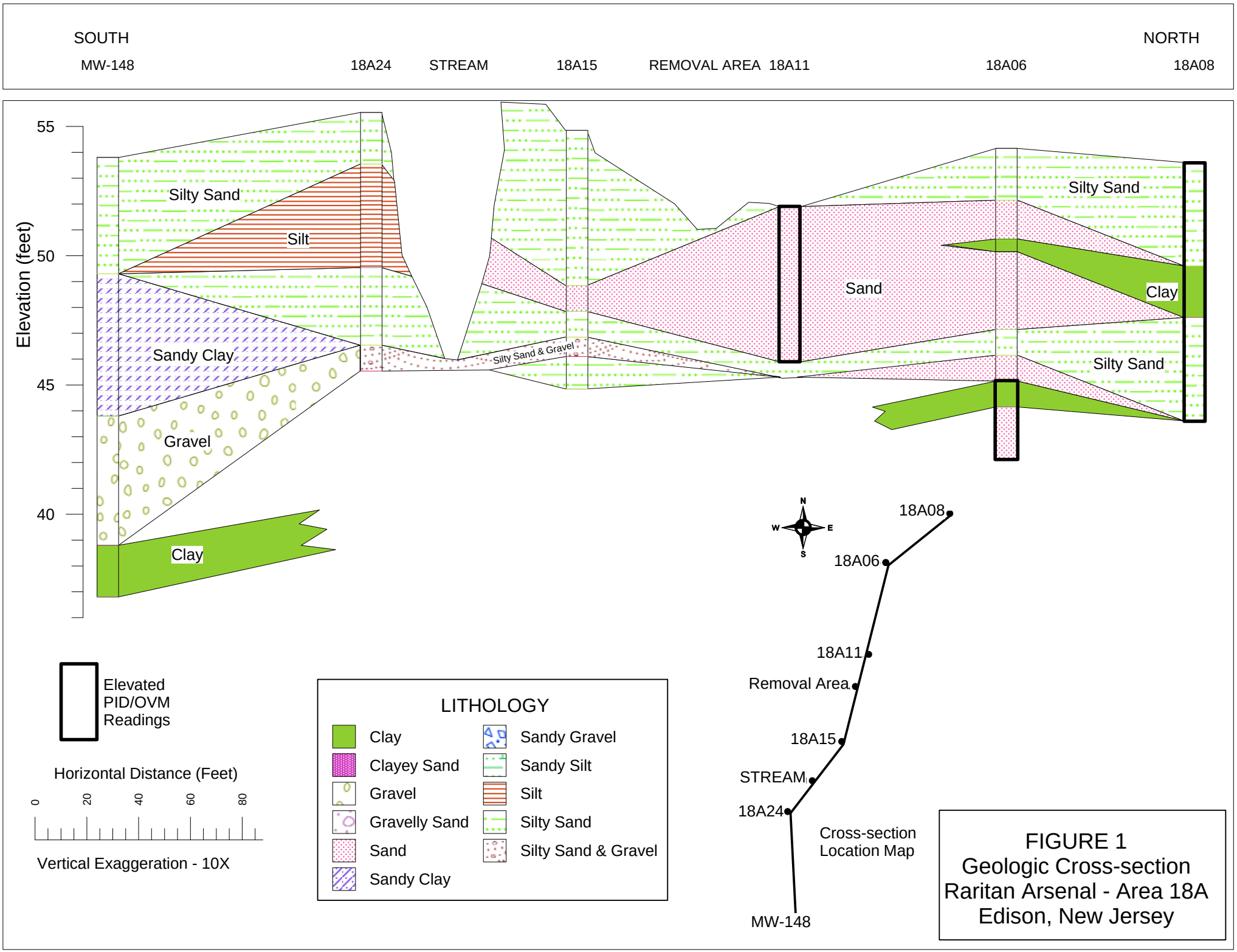


FIGURE 1
Geologic Cross-section
Raritan Arsenal - Area 18A
Edison, New Jersey

AVATAR ENVIRONMENTAL

229
245
246
410
422
423

Area 18D
Area 18G
Area 18A
Area 18B
Area 18C
Area 10
Area 19
Area 1

MW-64 50.72
MW-87A
MW-87C 51.34
MW-138 53.13
MW-125 37.49
MW-EPA-1A 44.91
MW-EPA-2A
MW-71C 42.49
MW-148 45.0
MW-106A
MW-57 39.28
MW-8 27.55
MW-31
MW-9
MW-7 24.30
MW-89A
MW-89C 20.87
MW-46A 28.06
OB-6A OB-6A

50
45
40
35
30
25

PARSHING AVE

Legend
- Monitoring Wells
- Groundwater Contours
- Soil Investigation Areas

N W E S

100 0 100 200
Scale in Feet

Source:
Aerial Photos from New Jersey 2007 - 2008 High Resolution Orthophotography. MrSID 5K Tiles - NJ Office of Information Technology (NJOIT), Office of Geographic Information Systems (OGIS) - October 2008.

USEPA/GSA Area
Former Raritan Arsenal Site, Edison, NJ

FIGURE 2
AREAS 18A AND 18B
GROUNDWATER CONTOUR MAP

AVATAR ENVIRONMENTAL

Legend
- Soil Boring Locations
- Monitoring Wells
- Excavation Areas
- Soil Investigation Areas

18A25, 18A34, 18A04, 18A43, 18A32, 18A03, 18A31, 18A09, 18A14, 18A08, 18A13, 18A02, 18A18, 18A30, 18A06, MW-EPA-2A, 18A12, 18A22, 18A01, 18A17, 18A33, SA-18A-01, SA-18A-02, 18A21, 18A07, 18A20, 18A11, MW-71C, 18A16, 18B29, 18B28, 18B26, 18B27, 18A05, 18A19, 18A23, 18A42, 18A15, Area 18A, SW1820, 18A10, SW1803, SW1821, SW1822, SW1826, SW1804, SW1823, 18A44, SW1805, SW1824, 18B81, 18A24, 18A26, SW1825, 18A41, Area 18B, MW-148, MW-EPA-1A

N, W, E, S

70 0 70 140
Scale in Feet

Source:
Topography from CAD drawing supplied by WESTON Solutions, Inc. dated 1992.
Aerial Photos from New Jersey 2007 - 2008 High Resolution Orthophotography, MrSID 5K Tiles - NJ Office of Information Technology (NJOIT), Office of Geographic Information Systems (OGIS) - October 2008.

USEPA/GSA Area
Former Raritan Arsenal Site, Edison, NJ

FIGURE 3
AREAS 18A & 18B
BOREHOLE LOCATIONS

Appendix C

Asbestos Landfill Focus Informational Paper

State of New Jersey

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

DEPARTMENT OF ENVIRONMENTAL PROTECTION

BOB MARTIN
Commissioner

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401-05F
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Trenton, NJ 08625-0420
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July 17, 2014

Sandra Piettro, Project Manager
Department of the Army
New York District, Corps of Engineers
Jacob K. Javits Federal Building
26 Federal Plaza, Room 1811
New York, NY 10278-0090

Re: Former Raritan Arsenal
Edison Township, Middlesex County, New Jersey
SRP PI# 006021

Dear Ms. Piettro:

The New Jersey Department of Environmental Protection (Department) has completed a review of the "Final – Focus Informational Paper Asbestos Landfill – Investigation Area 18C" dated February 27, 2014, submitted pursuant to the Department of Defense State Memorandum of Agreement (DSMOA) executed on April 3, 1992 and the Technical Requirements for Site Remediation at N.J.A.C. 7:26E.

The Department's comments on the submittal are provided below.

General Comments:

The purpose of this document was to present the site history and prior environmental investigation findings for a portion of Area 18C; an area comprised of 19 acres of undeveloped, forested land impacted by landfilling. This 19-acre section of 18C has historically been referred to as the "asbestos landfill", AOC 1, within Area 18C.

This area is known to contain building demolition debris and asbestos-containing waste associated with the debris. The USACE states, that prior to Arsenal operations on site, this area was used for both borrow and fill work, dating to pre-1940's. In addition, historic aerial photos indicate that this area continued to be used for fill and borrow activities until the Raritan Arsenal closed in 1964. After a period of dormancy, new disturbance to this area began in the late 1970's, to the late 1980's when building demolition debris some of which may have contained asbestos was placed in this area.

In the early 1990's, to address the asbestos hazards posed by these piles, the USACE voluntarily applied a spray-on polymer to stabilize/encapsulate this material to reduce exposures.

The USACE concludes that contamination associated with the asbestos landfill (asbestos and chemical contamination) is not the result of activities managed or conducted by the DoD on the former Raritan Arsenal.

Specific Comments:

Section 2, Former Raritan Arsenal History, contains some information that conflicts with Section 3, Asbestos Landfill History. The fourth paragraph in Section 2 states that "another section of the GSA property bordering Woodbridge Avenue was sold to the Environmental Protection Agency (EPA), which maintains office, warehouse, and laboratory space on site. It is within this area that the Asbestos Landfill is located." However, the third paragraph of Section 3 states that "the asbestos landfill is located on property currently owned by GSA." This issue must be clarified as it is unclear whether the Asbestos Landfill is within EPA property or GSA property.

The former Raritan Arsenal operated from 1917 to 1963. Based on review of the information presented in this report, it appears that much of the physical disturbance involving landfilling this 19-acre portion of Area 18C appears to be from post-1963, however, the historical aerial records indicate that significant disturbance also occurred in this area during the 1940's to 1963. Although most of the building demolition debris disposal may be from the post 1963 timeframe, there were approximately 20+ years beforehand where possible borrow/fill and related land disturbances occurred in this area. In addition, the demolition debris (and potentially the asbestos) comes from Former Arsenal buildings. In particular, in 1954, a large disturbance is visible and it appears that significant changes to the area occurred in the 1947–1957 timeframe.

Soil samples collected from within the fill material revealed the presence of elevated levels of total PAHs (approximating 1,000–2,000 ppm). In addition, to a lesser extent, other contaminants detected in this area include: PCBs (maximum of 23 ppm versus NJDEP Residential Soil Remediation Standard (RSRS) of 0.2 ppm), DDT (maximum of 23 ppm versus NJDEP RSRS of 2 ppm), Lead (up to 1,670 ppm versus NJDEP RSRS of 400 ppm) and Arsenic (24.7 ppm, versus NJDEP RSRS of 19 ppm). The source(s) of these contaminants remains unclear.

The existing soil and groundwater data do not indicate a significant or continuing source of mobile contamination to areas surrounding this landfill. However, two concerns remain: Lack of surface water or sediment testing immediately down gradient of this fill area in the wetlands to the southeast and the presence of demolition debris, asbestos and contaminated soil in an uncontrolled and inappropriate disposal site.

Both the aerial photography records and environmental testing suggest that environmental impacts in this area could potentially be partially due to both Former Raritan Arsenal operations and subsequent land owners. It is recommended that the current site owners and USACE work together to properly remediate (either remove illegally dumped materials or officially close this are per NJDEP Landfill regulations) or otherwise mitigate the environmental damage posed by this landfill. In either scenario, it appears that downgradient surface water and sediment testing should be performed immediately downstream of this landfill, in the wetland areas to the southeast.

The USACE should note that the Asbestos Landfill is near ground water plume AOC 8, about 300 feet upgradient of monitoring well MW-106A. While not currently positioned within the

AOC 8 plume, well MW-106A had been considered a fringe well for previous configurations of AOC 8. This well has shown the presence of trichloroethylene (TCE) in eight of the ten ground water samples collected between 1998 and 2012 at levels at or below 7.4 µg/l. However, analyses of the soil samples collected within the asbestos landfill area did not show the presence of VOCs above screening levels. From the description of the debris and results of soil samples is does not appear that the asbestos landfill is contributing to ground water contamination.

Although ground water from MW-106A was not analyzed for asbestos, asbestos is not generally considered a major problem in ground water. Both the Drinking Water Standard and Ground Water Quality Standard for asbestos is $7x10^6$ fibers/liter >10µm.

If you require copies of Department Guidance Documents or applications, many of these are available on the internet http://www.state.nj.us/dep/srp. If you have any questions regarding this matter I may be contacted at (609) 633-1416, or at Anthony.Cinque@dep.state.nj.us.

Sincerely,

Anthony Cinque, Case Manager
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cc: Kwong Cho, USEPA
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FINAL

FOCUS INFORMATIONAL PAPER
ASBESTOS LANDFILL – INVESTIGATION AREA 18C
Former Raritan Arsenal
Edison, New Jersey

FUDS Project Number CO2NJ0084-15

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AVATAR ENVIRONMENTAL

A Service-Disabled Veteran Owned Small Business

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ACRONYMS

ACM	asbestos containing building materials
ASR	Archive Search Report
bgs	below ground surface
bgw	below groundwater
DOD	Department of Defense
EPA	United States Environmental Protection Agency
FUDS	Formerly Used Defense Site
GSA	General Services Administration
MCC	Middlesex County College
mg/kg	milligram per kilogram
NJDEP	New Jersey Department of Environmental Protection
PAH	polyaromatic hydrocarbons
PCB	polychlorinated biphenyls
ppm	parts per million
QC	quality control
RI	remedial investigation
TCL VOCs	target compound list volatile organic compounds
TCL SVOCs	target compound list semi-volatile organic compounds
TEP	Thomas Edison Park
USACE	United States Army Corps of Engineers
Weston	Weston Solutions, Inc.

1. INTRODUCTION

The goal of the Focus Informational Paper is to develop a clear understanding of the party responsible for the Asbestos Landfill Area and the contamination present therein.

To place the contaminant issues associated with the Asbestos Landfill in context, this Paper presents the information and data related to the Asbestos Landfill, which is located within Investigation Area 18C of the former Raritan Arsenal in Edison, New Jersey. This Paper includes the following information:

- A brief history of the former Raritan Arsenal;
- A history of the Asbestos Landfill;
- A description of previous environmental investigations performed by the United States Army Corps of Engineers (USACE) at the Asbestos Landfill; and
- Historic aerial photographs.

2. FORMER RARITAN ARSENAL HISTORY

The former Raritan Arsenal encompasses approximately 3,316 acres in Edison and Woodbridge Townships, Middlesex County, New Jersey (see Figure 2-1). It is bordered to the north and northwest by Woodbridge Avenue, to the southwest by Mill Road and the Industrial Land Reclamation Landfill, and to the south and east by the Raritan River (Figure 2-2).

Prior to the construction of the Arsenal, the area consisted of tidal marsh, clay and sand pit quarries, and farmland with several residences. The former Raritan Arsenal was used by the U.S. Army from 1917 to 1963. Operations at the site included the receipt, storage, shipment, and decommissioning of ordnance, arms, and machinery. During this period, waste material, including ordnance and chemical agents, was reportedly buried on site. It has also been reported that explosive materials were routinely destroyed by surface burning or burning in chambers or pits. Accidental explosions in magazine buildings and outdoor storage areas reportedly scattered materials over large areas and drove ordnance fragments into the ground.

Site operations were phased out between 1961 and 1963 with custody and care of the former Raritan Arsenal area being conveyed to the General Services Administration (GSA). In 1964, GSA sold 2,000 acres of the former Raritan Arsenal to the Visceglia family which formed the Federal Storage Warehouses Company. In 1975, Federal Storage Warehouses split into two companies (Federal Business Centers and Summit Associates, Inc.) and built the Raritan Center, a major commercial and industrial complex.

GSA also sold a parcel of land, located in the western part of the site, to Middlesex County. The county developed this area into Thomas Edison Park (TEP) and Middlesex County College (MCC). GSA sold another section of the property bordering Woodbridge Avenue to the Environmental Protection Agency (EPA), which maintains office, warehouse, and laboratory space on site.

Area 18C is a 58-acre area consisting of two former Arsenal buildings (Buildings 255 and 256) that were demolished in August 2014, blacktop and railroad areas, and undeveloped forested

land. Currently, GSA still owns a 19-acre plot (undeveloped forested land) southeast of the area owned by the EPA Region 2 and still unoccupied.

3. ASBESTOS LANDFILL HISTORY

Although it has voluntarily conducted investigations and other actions at this location, it is the opinion of the USACE that the Department of Defense (DOD) is not responsible for the creation of the Asbestos Landfill.

Figure 3-1 shows the approximate location of the Asbestos Landfill, which falls within the boundary of Investigation Area 18C. It is located on a parcel that is owned by GSA. The extent of the Asbestos Landfill shown on Figure 3-1 was obtained from a Geophysical Investigation Report for Area 18C conducted by Weston Solutions, Inc. (Weston) in June 1996 (Weston, 1996). It is likely that the Asbestos Landfill boundary was, in part, based on results from soil borings and test pits completed during a Remedial Investigation performed by Weston (see Section 4), and may represent the area treated (encapsulated) with a polymer in 1992 and surrounded by orange construction fencing. The actual extent of the entire debris pile which consists of building debris is larger than the extent of the encapsulated area depicted on Figure 3-1. The 1996 Geophysical Survey Report identified an area where debris (mostly construction debris) was evident in a soil bank extending north and south of the Asbestos Landfill (Figure 3-1). Test pits were excavated in 1996 to investigate geophysical survey identified anomalies (Figure 3-1). Test pits T-22, T-24 and T-26 encountered construction debris described as sections of brick walls, brick and mortar fragments, cement beams, steel piping, wood, tin roofing, telephone pole, railroad ties, etc. Construction debris was encountered from the ground surface to depths of 5 to 12 feet below ground surface. TP-21 did not encounter construction debris.

The Asbestos Landfill is located on property currently owned by GSA. The 1993 Archive Search Report (ASR) (Dames and Moore, 1993) identified this area as being an historical fill and borrow area. Area AS-43 identified in the ASR (located in the general area of Asbestos Landfill) represents a portion of the old borrow pit that predated the original Arsenal construction and which was filled beginning in the mid-1940s. Historic aerial photos indicate this area was used for fill and borrow activities until the Arsenal closed in 1964 (Aerial photos are provided in Attachment A). Re-vegetation of the area appears to have occurred until at least the late 1970s after which soil disturbance is again evident through the mid- to late 1980s (EPA, 1985).

According to EPA personnel who were on site at the time, GSA demolished 32 to 34 buildings, some of which contained asbestos, between 1981 and 1982. GSA consolidated this building debris in the area known as the Debris Pile, part of which is the current Asbestos Landfill. Office furniture and equipment were consolidated south of Building 205 and the helipad and subsequently disposed of by EPA in 1990. A discussion of the EPA understanding of historical events is contained in a letter from Mr. Kwong Cho to Ms. Sandra Piettro dated 12 December 2013 (see Attachment B).

Attachment C contains two memoranda related to past activities at the Asbestos Landfill. The first, dated 12 February 1992, describes the initial site inspection along with the results of asbestos samples collected from suspect material. The second, a 2 March 1992 letter from Mr. Paul Barber to Mr. Roger Hager, identifies the source of the asbestos containing building materials (ACM) as several old barracks demolished in the late 1970s. This letter (see Attachment C) specifies that the asbestos was not removed from the barracks before demolition and the resulting debris was partly covered by soil. It appears as though suspected ACM was segregated from the rest of the building debris and placed in the area called the Asbestos Landfill.

Figures 3-2 and 3-3 provide aerial photos of the area just before and just after the building demolition dates (1978 and 1983 respectively).

4. PREVIOUS ENVIRONMENTAL INVESTIGATIONS

A Rapid Response Action was carried out in 1992 by the USACE-Huntsville District at the Asbestos Landfill to stabilize/encapsulate suspected asbestos material found at the site. This was accomplished by spraying the material with a copolymer. The exact location of the spraying could not be determined other than a general description that it was at an area to the south of historic soil sample location S-9. Orange construction fencing was placed around the treatment area to restrict access. Some of the fencing can still be observed on site.

A surface geophysical survey was conducted for Investigation Area 18C (Weston, 1996). However, the survey was not performed for the Asbestos Landfill area. Weston Solutions, Inc. (Weston) prepared a Remedial Investigation report (RI) based on field investigations performed from April to July 1996 (Weston, 1999). Ten soil borings were planned to be advanced within or just outside of the Asbestos Landfill as part of the RI activities. Table 4-1 presents a summary of the Asbestos Landfill sampling program. Figure 3-1 presents the soil boring/test pits locations where soil samples were collected. The majority of the soil borings were not completed to the planned depth or location due to the presence of numerous magnetic anomalies and/or auger refusal. Test pits were excavated at (or nearby) eight of the 10 soil boring locations in an attempt to attain the proposed boring depths, and better observe the contents within the landfill and collect the proposed samples. Potable water was sprayed on the soil boring and excavation cuttings to reduce the potential for asbestos distribution. An encapsulant was sprayed on the ground surface to seal soil disturbed during the excavations and soil borings.

Soil borings 18C01 through 18C04 were installed at the perimeter of the Landfill area. Samples were proposed at 0 to 0.5 feet below ground surface (bgs) and the 6-inch interval above groundwater. At three of the locations (18C01, 18C02, and 18C03), groundwater was encountered at less than 2 feet bgs and the samples from the second interval (lower surface soil) were collected approximately 1.0 to 1.5 feet below groundwater (bgw). The two samples at soil boring 18C04 were both collected above groundwater, since groundwater was encountered at 5.8 feet bgs.

The six remaining borings (18C05 through 18C10) within the landfill area were begun using a drill rig, but were completed as test pits (excluding 18C08) due to anomalies and/or refusal at shallow depths (2 to 4 feet bgs). Several of the test pits were moved slightly from the original boring locations so that better coverage of the area could be accomplished. Attachment D presents the boring logs for soil borings 18C01 through 18C10. Attachment E presents the test pit logs.

All of the samples collected were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), metals, pH, and TNT (screening). Two samples were submitted for confirmatory explosives analysis, and all but the deeper sample intervals collected from the perimeter of the landfill (18C01 through 18C04) were submitted for asbestos analysis.

Four soil borings were drilled at the perimeter of the landfill. The six remaining soil borings within the landfill area were completed as test pits. All soil samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and TNT screening. Two samples were submitted for confirmatory explosives analysis. All but the deeper sample intervals collected from the perimeter of the landfill were submitted for asbestos analysis.

Table 4-2 presents the analytical results for the samples collected as part of the Asbestos Landfill sampling program that exceeded a screening level from EPA and New Jersey Department of Environmental Protection (NJDEP). VOCs and explosive compounds were not detected at levels exceeding any screening levels and are therefore not presented on Table 4-2. Polycyclic aromatic hydrocarbons (PAHs) were detected at levels exceeding the EPA and NJDEP screening levels for the majority of samples collected from the Asbestos Landfill. The pesticides DDE and heptachlor epoxide exceeded the residential screening levels in one sample. DDT exceeded at least one screening level in five samples. Aroclor 1254 was detected at concentrations exceeding the screening levels in two samples. Arsenic exceeded the NJDEP background level of 19 mg/kg in one sample. Chromium, assumed to be in the hexavalent form, exceeded its EPA screening levels in every sample. Lead results exceeded the residential screening level of 400 mg/kg in eight samples and exceeded the industrial screening level (800 mg/kg) in two samples.

The asbestos analyses for samples collected from the Asbestos Landfill indicated that the soil samples submitted for analysis contained an abundant amount of construction-type debris within the soil matrix. Consequently, the different materials were analyzed separately where possible. The results of the analyses are reported as a volumetric percent representing the amount of asbestos detected in the sample aliquot analyzed. In most instances, the asbestos detected was a result of the analysis of the debris, and not fibers within the soil matrix. A total of 24 soil samples (including two QC duplicate samples) including 14 soil boring samples and 10 test pit samples were submitted for analysis of asbestos. Thirteen samples contained detectable concentrations of asbestos, which in every case was identified as being chrysotile. The concentrations ranged from less than 1% up to 8% (TP-18C07B). The remaining 11 samples did not exhibit detectable levels of asbestos. Table 4-3 presents the asbestos results.

Fill consisting of construction debris noted in the asbestos landfill included wood, bricks, scrap metal, large sections of brick wall, metal piping, building columns, concrete, black roofing material, concrete slabs, rebar, and chain link fence. Drums or other indications of buried chemical wastes were not noted in the test pits and soil borings advanced within the Asbestos Landfill.

5. SUMMARY AND CONCLUSIONS

Based on the historical documents and aerial photographs, testimony from EPA personnel, memoranda from USACE, geophysical surveys, and Remedial Investigation reports, the contamination (asbestos and chemical contamination) associated with the Asbestos Landfill is not the result of activities managed or conducted by the DOD on the former Raritan Arsenal. This landfill is believed to be a result of GSA-directed demolition conducted in the late 1970s and early 1980s.

6. REFERENCES

Dames and Moore, Inc., 1993. Draft Archive Search Report, Former Raritan Arsenal, Edison, New Jersey. Volume 1, Sections 1-13, Volume 2, Appendices A-K.

EPA [U.S. Environmental Protection Agency], 1985. Site Analysis, Raritan Arsenal, Edison, New Jersey. May 1985.

Weston [Weston Solutions, Inc.], 1996. Geophysical Investigation Report, Area 18C Investigation. Contract No. DACA-41-92-D-8002. Delivery Order 0012. June 1996.

Weston, 1999. Final Supplemental Report of Investigation, Areas 18B, 18C, 18D, 18F, and 18G Investigations. Contract No. DACA-41-92-D-8002. Delivery Order 0012. July 1999.

Tables

Table 4-1
Summary of Asbestos Landfill Sampling Program
Asbestos Landfill Focus Informational Paper
Former Raritan Arsenal

Soil Boring/ Test Pit ID	Location	Sample Date	Sample Interval (ft)	Notes
SS-18C01A	Outside of Landfill	5/10/1996	0-0.5	Upper surface soil/0-0.5 ft AGW
TP-18C01B		6/18/1996	1.5-2	Lower surface soil/1-1.5 ft BGW
SS-18C02A		5/10/1996	0-0.5	Upper surface soil/0-0.5 ft AGW
TP-18C02B		6/18/1996	1.5-2	Lower surface soil/1-1.5 ft BGW
SS-18C03A		5/10/1996	0-0.5	Upper surface soil/0-0.5 ft AGW
TP-18C03B		6/18/1996	1.5-2	Lower surface soil/1-1.5 ft BGW
SS-18C04A		5/10/1996	0-0.5	Upper surface soil
SS-18C04B		5/10/1996	5.3-5.8	0-0.5 ft AGW
SS-18C05A	Inside of Landfill	5/13/1996	0-0.5	Upper surface soil
TP-18C05-1B		6/17/1996	6-6.5	Within fill material
TP-18C05-1C[a]		6/17/1996	7.5-8	Approximately 0-0.5 ft AGW
SS-18C06A		5/10/1996	0-0.5	Upper surface soil
TP-18C06B		6/17/1996	4-4.5	Within fill material
TP-18C06C		6/17/1996	8.5-9	0-0.5 ft AGW
SS-18C07A		5/13/1996	0-0.5	Upper surface soil
TP-18C07B		6/17/1996	5-5.5	Within fill material
TP-18C07C		6/17/1996	8-8.5	0-0.5 ft AGW
SS-18C08A		5/13/1996	0-0.5	Upper surface soil
SS-18C08B		5/13/1996	3-3.5	Within fill material
SS-18C08C		5/13/1996	4.2-4.7	0-0.5 ft AGW
SS-18C09A		5/13/1996	0-0.5	Upper surface soil
SS-18C09B		5/13/1996	2.9-3.4	Within fill material
TP-18C09-1C		6/18/1996	9.5-10	0-0.5 ft AGW
SS-18C10A[b]		5/13/1996	0-0.5	Upper surface soil
TP-18C10B		6/17/1996	5-5.5	Within fill material
TP-18C10C		6/17/1996	8-8.5	1-1.5 ft below fill material

AGW = above groundwater
BGW = below groundwater
[a] Field duplicate collected - TP-18C150-1C
[b] Field duplicate collected - SS-18C45A

Table 4-2
Asbestos Landfill - Point-by-Point Comparison to Human Health Standards
Asbestos Landfill Focus Informational Paper
Former Raritan Arsenal

Analyte = Benzo(a)anthracene						EPA RSL	EPA RSL	NJDEP SRS	NJDEP SRS
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier	Industrial 2.1	Residential 0.15	Industrial 2	Residential 0.6
Soil Sample	TP-18C01B	6/18/1996	1.5-2	0.4	U	-	-	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	0.32	J	-	X	-	-
Soil Sample	TP-18C03B	6/18/1996	1.5-2	0.41	U	-	-	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	0.18	J	-	X	-	-
Test Pit	TP-18C05-1B	6/17/1996	6-6.5	140	V	X	X	X	X
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Soil Sample	TP-18C06B	6/17/1996	4-4.5	260	V	X	X	X	X
Soil Sample	TP-18C06C	6/17/1996	8.5-9	0.98	V	-	X	-	X
Soil Sample	TP-18C07B	6/17/1996	5-5.5	310	J	X	X	X	X
Soil Sample	TP-18C07C	6/17/1996	8-8.5	0.78	V	-	X	-	X
Soil Sample	TP-18C10B	6/17/1996	5-5.5	260	V	X	X	X	X
Soil Sample	TP-18C10C	6/17/1996	8-8.5	0.047	J	-	-	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	210	V	X	X	X	X
Soil Sample	SS-18C07A	5/13/1996	0-0.5	120	V	X	X	X	X
Soil Sample	SS-18C08A	5/13/1996	0-0.5	160	V	X	X	X	X
Soil Sample	SS-18C08B	5/13/1996	3-3.5	170	V	X	X	X	X
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	160	V	X	X	X	X
Soil Sample	SS-18C09A	5/13/1996	0-0.5	130	V	X	X	X	X
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	200	V	X	X	X	X
Soil Sample	SS-18C10A	5/13/1996	0-0.5	230	V	X	X	X	X
Soil Sample	SS-18C01A	5/10/1996	0-0.5	0.21	J	-	X	-	-
Soil Sample	SS-18C02A	5/10/1996	0-0.5	0.41	V	-	X	-	-
Soil Sample	SS-18C03A	5/10/1996	0-0.5	0.35	J	-	X	-	-
Soil Sample	SS-18C04A	5/10/1996	0-0.5	370	V	X	X	X	X
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	40	V	X	X	X	X
Soil Sample	SS-18C06A	5/10/1996	0-0.5	440	V	X	X	X	X
Analyte = Benzo(a)anthracene						EPA RSL	EPA RSL	NJDEP SRS	NJDEP SRS
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier	Industrial 2.1	Residential 0.15	Industrial 2	Residential 0.6
Soil Sample	TP-18C01B	6/18/1996	1.5-2	0.4	U	-	-	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	0.33	J	X	X	X	X
Soil Sample	TP-18C03B	6/18/1996	1.5-2	0.41	U	-	-	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	0.16	J	-	X	-	-
Test Pit	TP-18C05-1B	6/17/1996	6-6.5	110	V	X	X	X	X
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Soil Sample	TP-18C06B	6/17/1996	4-4.5	220	V	X	X	X	X
Soil Sample	TP-18C06C	6/17/1996	8.5-9	0.89	V	X	X	X	X
Soil Sample	TP-18C07B	6/17/1996	5-5.5	260	J	X	X	X	X
Soil Sample	TP-18C07C	6/17/1996	8-8.5	0.71	V	X	X	X	X
Soil Sample	TP-18C10B	6/17/1996	5-5.5	230	V	X	X	X	X
Soil Sample	TP-18C10C	6/17/1996	8-8.5	0.39	U	-	-	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	190	V	X	X	X	X
Soil Sample	SS-18C07A	5/13/1996	0-0.5	100	V	X	X	X	X
Soil Sample	SS-18C08A	5/13/1996	0-0.5	140	V	X	X	X	X
Soil Sample	SS-18C08B	5/13/1996	3-3.5	150	V	X	X	X	X
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	130	V	X	X	X	X
Soil Sample	SS-18C09A	5/13/1996	0-0.5	110	V	X	X	X	X
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	180	V	X	X	X	X
Soil Sample	SS-18C10A	5/13/1996	0-0.5	180	V	X	X	X	X
Soil Sample	SS-18C01A	5/10/1996	0-0.5	0.21	J	-	X	X	X
Soil Sample	SS-18C02A	5/10/1996	0-0.5	0.39	J	X	X	X	X
Soil Sample	SS-18C03A	5/10/1996	0-0.5	0.36	J	X	X	X	X
Soil Sample	SS-18C04A	5/10/1996	0-0.5	340	V	X	X	X	X
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	36	V	X	X	X	X
Soil Sample	SS-18C06A	5/10/1996	0-0.5	370	V	X	X	X	X

RSL = Regional Screening Level
SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value
U = not detected
mg/kg = milligrams per kilogroam

Table 4-2
Asbestos Landfill - Point-by-Point Comparison to Human Health Standards
Asbestos Landfill Focus Informational Paper
Former Raritan Arsenal

Analyte = Benzo(b)fluoranthene						EPA RSL	EPA RSL	NJDEP SRS	NJDEP SRS
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier	Industrial 2.1	Residential 0.15	Industrial 2	Residential 0.6
Soil Sample	TP-18C01B	6/18/1996	1.5-2	0.4	U	-	-	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	0.29	J	-	X	-	-
Soil Sample	TP-18C03B	6/18/1996	1.5-2	0.41	U	-	-	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	0.12	J	-	-	-	-
Test Pit	TP-18C05-1B	6/17/1996	6-6.5	86	V	X	X	X	X
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Soil Sample	TP-18C06B	6/17/1996	4-4.5	180	V	X	X	X	X
Soil Sample	TP-18C06C	6/17/1996	8.5-9	0.76	V	-	X	-	X
Soil Sample	TP-18C07B	6/17/1996	5-5.5	230	J	X	X	X	X
Soil Sample	TP-18C07C	6/17/1996	8-8.5	0.55	V	-	X	-	-
Soil Sample	TP-18C10B	6/17/1996	5-5.5	160	J	X	X	X	X
Soil Sample	TP-18C10C	6/17/1996	8-8.5	0.39	U	-	-	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	160	V	X	X	X	X
Soil Sample	SS-18C07A	5/13/1996	0-0.5	81	V	X	X	X	X
Soil Sample	SS-18C08A	5/13/1996	0-0.5	120	V	X	X	X	X
Soil Sample	SS-18C08B	5/13/1996	3-3.5	110	V	X	X	X	X
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	100	V	X	X	X	X
Soil Sample	SS-18C09A	5/13/1996	0-0.5	88	V	X	X	X	X
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	150	V	X	X	X	X
Soil Sample	SS-18C10A	5/13/1996	0-0.5	150	V	X	X	X	X
Soil Sample	SS-18C01A	5/10/1996	0-0.5	0.18	J	-	X	-	-
Soil Sample	SS-18C02A	5/10/1996	0-0.5	0.38	J	-	X	-	-
Soil Sample	SS-18C03A	5/10/1996	0-0.5	0.31	J	-	X	-	-
Soil Sample	SS-18C04A	5/10/1996	0-0.5	280	V	X	X	X	X
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	32	V	X	X	X	X
Soil Sample	SS-18C06A	5/10/1996	0-0.5	300	V	X	X	X	X
Analyte = Benzo(k)fluoranthene						EPA RSL	EPA RSL	NJDEP SRS	NJDEP SRS
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier	Industrial 21	Residential 1.5	Industrial 23	Residential 6
Soil Sample	TP-18C01B	6/18/1996	1.5-2	0.4	U	-	-	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	0.27	J	-	-	-	-
Soil Sample	TP-18C03B	6/18/1996	1.5-2	0.41	U	-	-	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	0.15	J	-	-	-	-
Test Pit	TP-18C05-1B	6/17/1996	6-6.5	95	V	X	X	X	X
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Soil Sample	TP-18C06B	6/17/1996	4-4.5	190	V	X	X	X	X
Soil Sample	TP-18C06C	6/17/1996	8.5-9	0.81	V	-	-	-	-
Soil Sample	TP-18C07B	6/17/1996	5-5.5	240	J	X	X	X	X
Soil Sample	TP-18C07C	6/17/1996	8-8.5	0.7	V	-	-	-	-
Soil Sample	TP-18C10B	6/17/1996	5-5.5	210	J	X	X	X	X
Soil Sample	TP-18C10C	6/17/1996	8-8.5	0.39	U	-	-	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	160	V	X	X	X	X
Soil Sample	SS-18C07A	5/13/1996	0-0.5	99	V	X	X	X	X
Soil Sample	SS-18C08A	5/13/1996	0-0.5	140	V	X	X	X	X
Soil Sample	SS-18C08B	5/13/1996	3-3.5	130	V	X	X	X	X
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	110	V	X	X	X	X
Soil Sample	SS-18C09A	5/13/1996	0-0.5	98	V	X	X	X	X
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	160	V	X	X	X	X
Soil Sample	SS-18C10A	5/13/1996	0-0.5	180	V	X	X	X	X
Soil Sample	SS-18C01A	5/10/1996	0-0.5	0.18	J	-	-	-	-
Soil Sample	SS-18C02A	5/10/1996	0-0.5	0.35	J	-	-	-	-
Soil Sample	SS-18C03A	5/10/1996	0-0.5	0.35	J	-	-	-	-
Soil Sample	SS-18C04A	5/10/1996	0-0.5	330	V	X	X	X	X
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	30	V	X	X	X	X
Soil Sample	SS-18C06A	5/10/1996	0-0.5	360	V	X	X	X	X

RSL = Regional Screening Level
SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value
U = not detected
mg/kg = milligrams per kilogroam

Table 4-2
Asbestos Landfill - Point-by-Point Comparison to Human Health Standards
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Analyte = Carbazole								NJDEP SRS	NJDEP SRS
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier			Industrial 96	Residential 24
Soil Sample	TP-18C01B	6/18/1996	1.5-2	0.4	U	-	-	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	0.38	U	-	-	-	-
Soil Sample	TP-18C03B	6/18/1996	1.5-2	0.41	U	-	-	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	0.37	U	-	-	-	-
Test Pit	TP-18C05-1B	6/17/1996	6-6.5	31	V	-	-	-	X
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Soil Sample	TP-18C06B	6/17/1996	4-4.5	58	V	-	-	-	X
Soil Sample	TP-18C06C	6/17/1996	8.5-9	0.21	J	-	-	-	-
Soil Sample	TP-18C07B	6/17/1996	5-5.5	66	J	-	-	-	X
Soil Sample	TP-18C07C	6/17/1996	8-8.5	0.088	J	-	-	-	-
Soil Sample	TP-18C10B	6/17/1996	5-5.5	71	V	-	-	-	X
Soil Sample	TP-18C10C	6/17/1996	8-8.5	0.39	U	-	-	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	42	V	-	-	-	X
Soil Sample	SS-18C07A	5/13/1996	0-0.5	24	V	-	-	-	-
Soil Sample	SS-18C08A	5/13/1996	0-0.5	37	V	-	-	-	X
Soil Sample	SS-18C08B	5/13/1996	3-3.5	34	V	-	-	-	X
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	34	V	-	-	-	X
Soil Sample	SS-18C09A	5/13/1996	0-0.5	28	V	-	-	-	X
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	40	V	-	-	-	X
Soil Sample	SS-18C10A	5/13/1996	0-0.5	51	V	-	-	-	X
Soil Sample	SS-18C01A	5/10/1996	0-0.5	0.41	U	-	-	-	-
Soil Sample	SS-18C02A	5/10/1996	0-0.5	0.094	J	-	-	-	-
Soil Sample	SS-18C03A	5/10/1996	0-0.5	0.085	J	-	-	-	-
Soil Sample	SS-18C04A	5/10/1996	0-0.5	48	V	-	-	-	X
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	7.6	V	-	-	-	-
Soil Sample	SS-18C06A	5/10/1996	0-0.5	74	V	-	-	-	X

Analyte = Chrysene						EPA RSL	EPA RSL	NJDEP SRS	NJDEP SRS
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier	Industrial 210	Residential 15	Industrial 230	Residential 62
Soil Sample	TP-18C01B	6/18/1996	1.5-2	0.4	U	-	-	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	0.38	V	-	-	-	-
Soil Sample	TP-18C03B	6/18/1996	1.5-2	0.41	U	-	-	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	0.18	J	-	-	-	-
Test Pit	TP-18C05-1B	6/17/1996	6-6.5	130	V	-	X	-	X
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Soil Sample	TP-18C06B	6/17/1996	4-4.5	250	V	X	X	X	X
Soil Sample	TP-18C06C	6/17/1996	8.5-9	1.1	V	-	-	-	-
Soil Sample	TP-18C07B	6/17/1996	5-5.5	280	J	X	X	X	X
Soil Sample	TP-18C07C	6/17/1996	8-8.5	0.78	V	-	-	-	-
Soil Sample	TP-18C10B	6/17/1996	5-5.5	250	V	X	X	X	X
Soil Sample	TP-18C10C	6/17/1996	8-8.5	0.042	J	-	-	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	210	V	-	X	-	X
Soil Sample	SS-18C07A	5/13/1996	0-0.5	120	V	-	X	-	X
Soil Sample	SS-18C08A	5/13/1996	0-0.5	160	V	-	X	-	X
Soil Sample	SS-18C08B	5/13/1996	3-3.5	150	V	-	X	-	X
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	140	V	-	X	-	X
Soil Sample	SS-18C09A	5/13/1996	0-0.5	120	V	-	X	-	X
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	190	V	-	X	-	X
Soil Sample	SS-18C10A	5/13/1996	0-0.5	220	V	X	X	-	X
Soil Sample	SS-18C01A	5/10/1996	0-0.5	0.22	J	-	-	-	-
Soil Sample	SS-18C02A	5/10/1996	0-0.5	0.46	V	-	-	-	-
Soil Sample	SS-18C03A	5/10/1996	0-0.5	0.39	J	-	-	-	-
Soil Sample	SS-18C04A	5/10/1996	0-0.5	350	V	X	X	X	X
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	38	V	-	X	-	-
Soil Sample	SS-18C06A	5/10/1996	0-0.5	420	V	X	X	X	X

RSL = Regional Screening Level
SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value
U = not detected
mg/kg = milligrams per kilogroam

Table 4-2
Asbestos Landfill - Point-by-Point Comparison to Human Health Standards
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Analyte = Dibenz(a,h)anthracene						EPA RSL	EPA RSL	NJDEP SRS	NJDEP SRS
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier	Industrial 0.21	Residential 0.015	Industrial 0.2	Residential 0.2
Soil Sample	TP-18C01B	6/18/1996	1.5-2	0.4	U	-	-	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	0.38	U	-	-	-	-
Soil Sample	TP-18C03B	6/18/1996	1.5-2	0.41	U	-	-	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	0.37	U	-	-	-	-
Test Pit	TP-18C05-1B	6/17/1996	6-6.5	24	V	X	X	X	X
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Soil Sample	TP-18C06B	6/17/1996	4-4.5	41	V	X	X	X	X
Soil Sample	TP-18C06C	6/17/1996	8.5-9	0.16	J	-	X	-	-
Soil Sample	TP-18C07B	6/17/1996	5-5.5	49	J	X	X	X	X
Soil Sample	TP-18C07C	6/17/1996	8-8.5	0.17	J	-	X	-	-
Soil Sample	TP-18C10B	6/17/1996	5-5.5	44	V	X	X	X	X
Soil Sample	TP-18C10C	6/17/1996	8-8.5	0.39	U	-	-	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	42	V	X	X	X	X
Soil Sample	SS-18C07A	5/13/1996	0-0.5	20	V	X	X	X	X
Soil Sample	SS-18C08A	5/13/1996	0-0.5	28	J	X	X	X	X
Soil Sample	SS-18C08B	5/13/1996	3-3.5	29	V	X	X	X	X
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	23	V	X	X	X	X
Soil Sample	SS-18C09A	5/13/1996	0-0.5	20	J	X	X	X	X
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	38	V	X	X	X	X
Soil Sample	SS-18C10A	5/13/1996	0-0.5	38	J	X	X	X	X
Soil Sample	SS-18C01A	5/10/1996	0-0.5	0.41	U	-	-	-	-
Soil Sample	SS-18C02A	5/10/1996	0-0.5	0.079	J	-	X	-	-
Soil Sample	SS-18C03A	5/10/1996	0-0.5	0.11	J	-	X	-	-
Soil Sample	SS-18C04A	5/10/1996	0-0.5	69	V	X	X	X	X
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	7.7	V	X	X	X	X
Soil Sample	SS-18C06A	5/10/1996	0-0.5	87	V	X	X	X	X
Analyte = Indeno(1,2,3-c,d)pyrene						EPA RSL	EPA RSL	NJDEP SRS	NJDEP SRS
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier	Industrial 2.1	Residential 0.15	Industrial 2	Residential 0.6
Soil Sample	TP-18C01B	6/18/1996	1.5-2	0.4	U	-	-	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	0.19	J	-	X	-	-
Soil Sample	TP-18C03B	6/18/1996	1.5-2	0.41	U	-	-	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	0.069	J	-	-	-	-
Test Pit	TP-18C05-1B	6/17/1996	6-6.5	58	V	X	X	X	X
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Soil Sample	TP-18C06B	6/17/1996	4-4.5	110	V	X	X	X	X
Soil Sample	TP-18C06C	6/17/1996	8.5-9	0.41	V	-	X	-	-
Soil Sample	TP-18C07B	6/17/1996	5-5.5	130	J	X	X	X	X
Soil Sample	TP-18C07C	6/17/1996	8-8.5	0.38	J	-	X	-	-
Soil Sample	TP-18C10B	6/17/1996	5-5.5	120	V	X	X	X	X
Soil Sample	TP-18C10C	6/17/1996	8-8.5	0.39	U	-	-	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	100	V	X	X	X	X
Soil Sample	SS-18C07A	5/13/1996	0-0.5	49	V	X	X	X	X
Soil Sample	SS-18C08A	5/13/1996	0-0.5	70	V	X	X	X	X
Soil Sample	SS-18C08B	5/13/1996	3-3.5	71	V	X	X	X	X
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	62	V	X	X	X	X
Soil Sample	SS-18C09A	5/13/1996	0-0.5	49	V	X	X	X	X
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	91	V	X	X	X	X
Soil Sample	SS-18C10A	5/13/1996	0-0.5	92	V	X	X	X	X
Soil Sample	SS-18C01A	5/10/1996	0-0.5	0.13	J	-	-	-	-
Soil Sample	SS-18C02A	5/10/1996	0-0.5	0.23	J	-	X	-	-
Soil Sample	SS-18C03A	5/10/1996	0-0.5	0.2	J	-	X	-	-
Soil Sample	SS-18C04A	5/10/1996	0-0.5	160	V	X	X	X	X
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	19	V	X	X	X	X
Soil Sample	SS-18C06A	5/10/1996	0-0.5	180	V	X	X	X	X

RSL = Regional Screening Level
SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value
U = not detected
mg/kg = milligrams per kilogroam

Table 4-2
Asbestos Landfill - Point-by-Point Comparison to Human Health Standards
Asbestos Landfill Focus Informational Paper
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Analyte = Naphthalene						EPA RSL	EPA RSL	NJDEP SRS	NJDEP SRS
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier	Industrial 18	Residential 3.6	Industrial 17	Residential 6
Soil Sample	TP-18C01B	6/18/1996	1.5-2	0.4	U	-	-	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	0.38	U	-	-	-	-
Soil Sample	TP-18C03B	6/18/1996	1.5-2	0.41	U	-	-	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	0.37	U	-	-	-	-
Test Pit	TP-18C05-1B	6/17/1996	6-6.5	17	V	-	X	-	X
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	0.37	U	-	-	-	-
Soil Sample	TP-18C06B	6/17/1996	4-4.5	31	V	X	X	X	X
Soil Sample	TP-18C06C	6/17/1996	8.5-9	0.059	J	-	-	-	-
Soil Sample	TP-18C07B	6/17/1996	5-5.5	51	J	X	X	X	X
Soil Sample	TP-18C07C	6/17/1996	8-8.5	0.39	U	-	-	-	-
Soil Sample	TP-18C10B	6/17/1996	5-5.5	62	V	X	X	X	X
Soil Sample	TP-18C10C	6/17/1996	8-8.5	0.39	U	-	-	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	28	V	X	X	X	X
Soil Sample	SS-18C07A	5/13/1996	0-0.5	17	J	-	X	-	X
Soil Sample	SS-18C08A	5/13/1996	0-0.5	20	J	X	X	X	X
Soil Sample	SS-18C08B	5/13/1996	3-3.5	22	J	X	X	X	X
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	26	V	X	X	X	X
Soil Sample	SS-18C09A	5/13/1996	0-0.5	17	J	-	X	-	X
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	20	J	X	X	X	X
Soil Sample	SS-18C10A	5/13/1996	0-0.5	19	J	X	X	X	X
Soil Sample	SS-18C01A	5/10/1996	0-0.5	0.41	U	-	-	-	-
Soil Sample	SS-18C02A	5/10/1996	0-0.5	0.078	J	-	-	-	-
Soil Sample	SS-18C03A	5/10/1996	0-0.5	0.47	U	-	-	-	-
Soil Sample	SS-18C04A	5/10/1996	0-0.5	41	V	X	X	X	X
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	4.6	V	-	X	-	-
Soil Sample	SS-18C06A	5/10/1996	0-0.5	64	V	X	X	X	X
Analyte = 4,4-DDE						EPA RSL	EPA RSL	NJDEP SRS	NJDEP SRS
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier	Industrial 5.1	Residential 1.4	Industrial 9	Residential 2
Soil Sample	TP-18C01B	6/18/1996	1.5-2	0.004	U	-	-	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	0.0076	U	-	-	-	-
Soil Sample	TP-18C03B	6/18/1996	1.5-2	0.0041	U	-	-	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	0.0075	U	-	-	-	-
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	0.0037	U	-	-	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	0.0037	U	-	-	-	-
Soil Sample	TP-18C06C	6/17/1996	8.5-9	0.0038	U	-	-	-	-
Soil Sample	TP-18C07B	6/17/1996	5-5.5	0.38	J	-	-	-	-
Soil Sample	TP-18C07C	6/17/1996	8-8.5	0.019	U	-	-	-	-
Soil Sample	TP-18C10B	6/17/1996	5-5.5	4.3	V	-	X	-	X
Soil Sample	TP-18C10C	6/17/1996	8-8.5	0.0039	U	-	-	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	0.76	I	-	-	-	-
Soil Sample	SS-18C07A	5/13/1996	0-0.5	0.39	U	-	-	-	-
Soil Sample	SS-18C08A	5/13/1996	0-0.5	1.3	I	-	-	-	-
Soil Sample	SS-18C08B	5/13/1996	3-3.5	0.71	I	-	-	-	-
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	0.56	I	-	-	-	-
Soil Sample	SS-18C09A	5/13/1996	0-0.5	0.57	I	-	-	-	-
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	0.42	U	-	-	-	-
Soil Sample	SS-18C10A	5/13/1996	0-0.5	0.64	I	-	-	-	-
Soil Sample	SS-18C01A	5/10/1996	0-0.5	0.0041	U	-	-	-	-
Soil Sample	SS-18C02A	5/10/1996	0-0.5	0.005	V	-	-	-	-
Soil Sample	SS-18C03A	5/10/1996	0-0.5	0.0066	V	-	-	-	-
Soil Sample	SS-18C04A	5/10/1996	0-0.5	1	V	-	-	-	-
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	0.25	V	-	-	-	-
Soil Sample	SS-18C06A	5/10/1996	0-0.5	0.33	V	-	-	-	-

RSL = Regional Screening Level
SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value
U = not detected
mg/kg = milligrams per kilogroam

Table 4-2
Asbestos Landfill - Point-by-Point Comparison to Human Health Standards
Asbestos Landfill Focus Informational Paper
Former Raritan Arsenal

Analyte = 4,4-DDT						EPA RSL	EPA RSL	NJDEP SRS	NJDEP SRS
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier	Industrial 7	Residential 1.7	Industrial 8	Residential 2
Soil Sample	TP-18C01B	6/18/1996	1.5-2	0.004	U	-	-	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	0.013	V	-	-	-	-
Soil Sample	TP-18C03B	6/18/1996	1.5-2	0.0041	U	-	-	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	0.019	V	-	-	-	-
Test Pit	TP-18C05-1B	6/17/1996	6-6.5	3.5	V	-	X	-	X
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	0.0037	U	-	-	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	0.0037	U	-	-	-	-
Soil Sample	TP-18C06B	6/17/1996	4-4.5	0.73	V	-	-	-	-
Soil Sample	TP-18C06C	6/17/1996	8.5-9	0.0038	U	-	-	-	-
Soil Sample	TP-18C07B	6/17/1996	5-5.5	0.73	J	-	-	-	-
Soil Sample	TP-18C07C	6/17/1996	8-8.5	0.019	U	-	-	-	-
Soil Sample	TP-18C10B	6/17/1996	5-5.5	23	V	X	X	X	X
Soil Sample	TP-18C10C	6/17/1996	8-8.5	0.0067	V	-	-	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	2.6	V	-	X	-	X
Soil Sample	SS-18C07A	5/13/1996	0-0.5	0.69	V	-	-	-	-
Soil Sample	SS-18C08A	5/13/1996	0-0.5	4.9	V	-	X	-	X
Soil Sample	SS-18C08B	5/13/1996	3-3.5	1.5	V	-	-	-	-
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	2	V	-	X	-	-
Soil Sample	SS-18C09A	5/13/1996	0-0.5	1.3	V	-	-	-	-
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	0.9	V	-	-	-	-
Soil Sample	SS-18C10A	5/13/1996	0-0.5	1.7	J	-	-	-	-
Soil Sample	SS-18C01A	5/10/1996	0-0.5	0.0054	V	-	-	-	-
Soil Sample	SS-18C02A	5/10/1996	0-0.5	0.014	V	-	-	-	-
Soil Sample	SS-18C03A	5/10/1996	0-0.5	0.014	V	-	-	-	-
Soil Sample	SS-18C04A	5/10/1996	0-0.5	1.6	V	-	-	-	-
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	0.45	V	-	-	-	-
Soil Sample	SS-18C06A	5/10/1996	0-0.5	0.67	V	-	-	-	-
Analyte = Heptachlor epoxide						EPA RSL	EPA RSL	NJDEP SRS	NJDEP SRS
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier	Industrial 0.19	Residential 0.053	Industrial 0.3	Residential 0.07
Soil Sample	TP-18C01B	6/18/1996	1.5-2	0.002	U	-	-	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	0.0038	U	-	-	-	-
Soil Sample	TP-18C03B	6/18/1996	1.5-2	0.0021	U	-	-	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	0.0037	U	-	-	-	-
Test Pit	TP-18C05-1B	6/17/1996	6-6.5	0.3	U	-	-	-	-
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	0.0018	U	-	-	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	0.0018	U	-	-	-	-
Soil Sample	TP-18C06B	6/17/1996	4-4.5	0.061	U	-	-	-	-
Soil Sample	TP-18C06C	6/17/1996	8.5-9	0.0019	U	-	-	-	-
Soil Sample	TP-18C07B	6/17/1996	5-5.5	0.18	UJ	-	-	-	-
Soil Sample	TP-18C07C	6/17/1996	8-8.5	0.0097	U	-	-	-	-
Soil Sample	TP-18C10B	6/17/1996	5-5.5	1.4	U	-	-	-	-
Soil Sample	TP-18C10C	6/17/1996	8-8.5	0.002	U	-	-	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	0.21	U	-	-	-	-
Soil Sample	SS-18C07A	5/13/1996	0-0.5	0.19	U	-	-	-	-
Soil Sample	SS-18C08A	5/13/1996	0-0.5	0.29	U	-	-	-	-
Soil Sample	SS-18C08B	5/13/1996	3-3.5	0.23	U	-	-	-	-
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	0.21	U	-	-	-	-
Soil Sample	SS-18C09A	5/13/1996	0-0.5	0.22	U	-	-	-	-
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	0.21	U	-	-	-	-
Soil Sample	SS-18C10A	5/13/1996	0-0.5	0.22	U	-	-	-	-
Soil Sample	SS-18C01A	5/10/1996	0-0.5	0.0021	U	-	-	-	-
Soil Sample	SS-18C02A	5/10/1996	0-0.5	0.0021	U	-	-	-	-
Soil Sample	SS-18C03A	5/10/1996	0-0.5	0.0024	U	-	-	-	-
Soil Sample	SS-18C04A	5/10/1996	0-0.5	0.11	U	-	-	-	-
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	0.041	U	-	-	-	-
Soil Sample	SS-18C06A	5/10/1996	0-0.5	0.18	V	-	X	-	X

RSL = Regional Screening Level
SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value
U = not detected
mg/kg = milligrams per kilogroam

Table 4-2
Asbestos Landfill - Point-by-Point Comparison to Human Health Standards
Asbestos Landfill Focus Informational Paper
Former Raritan Arsenal

Analyte = Aroclor-1254						EPA RSL	EPA RSL	NJDEP SRS	NJDEP SRS
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier	Industrial 0.74	Residential 0.22	Industrial 1	Residential 0.2
Soil Sample	TP-18C01B	6/18/1996	1.5-2	0.04	U	-	-	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	0.076	U	-	-	-	-
Soil Sample	TP-18C03B	6/18/1996	1.5-2	0.041	U	-	-	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	0.075	U	-	-	-	-
Test Pit	TP-18C05-1B	6/17/1996	6-6.5	23	V	X	X	X	X
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	0.037	U	-	-	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	0.037	U	-	-	-	-
Soil Sample	TP-18C06B	6/17/1996	4-4.5	3.3	V	X	X	X	X
Soil Sample	TP-18C06C	6/17/1996	8.5-9	0.038	U	-	-	-	-
Soil Sample	TP-18C07B	6/17/1996	5-5.5	3.6	UJ	-	-	-	-
Soil Sample	TP-18C07C	6/17/1996	8-8.5	0.19	U	-	-	-	-
Soil Sample	TP-18C10B	6/17/1996	5-5.5	27	U	-	-	-	-
Soil Sample	TP-18C10C	6/17/1996	8-8.5	0.039	U	-	-	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	4.1	U	-	-	-	-
Soil Sample	SS-18C07A	5/13/1996	0-0.5	3.9	U	-	-	-	-
Soil Sample	SS-18C08A	5/13/1996	0-0.5	5.9	U	-	-	-	-
Soil Sample	SS-18C08B	5/13/1996	3-3.5	4.6	U	-	-	-	-
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	4.3	U	-	-	-	-
Soil Sample	SS-18C09A	5/13/1996	0-0.5	4.4	U	-	-	-	-
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	4.2	U	-	-	-	-
Soil Sample	SS-18C10A	5/13/1996	0-0.5	4.4	U	-	-	-	-
Soil Sample	SS-18C01A	5/10/1996	0-0.5	0.041	U	-	-	-	-
Soil Sample	SS-18C02A	5/10/1996	0-0.5	0.041	U	-	-	-	-
Soil Sample	SS-18C03A	5/10/1996	0-0.5	0.047	U	-	-	-	-
Soil Sample	SS-18C04A	5/10/1996	0-0.5	2.2	U	-	-	-	-
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	0.82	U	-	-	-	-
Soil Sample	SS-18C06A	5/10/1996	0-0.5	2.7	U	-	-	-	-
Analyte = Arsenic								NJDEP SRS	NJDEP SRS
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier			Industrial 19	Residential 19
Soil Sample	TP-18C01B	6/18/1996	1.5-2	7.2	V	-	-	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	25	V	-	-	X	X
Soil Sample	TP-18C03B	6/18/1996	1.5-2	1.2	V	-	-	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	3.1	V	-	-	-	-
Test Pit	TP-18C05-1B	6/17/1996	6-6.5	5.3	V	-	-	-	-
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	3.3	V	-	-	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	3.8	V	-	-	-	-
Soil Sample	TP-18C06B	6/17/1996	4-4.5	3.9	V	-	-	-	-
Soil Sample	TP-18C06C	6/17/1996	8.5-9	3.6	V	-	-	-	-
Soil Sample	TP-18C07B	6/17/1996	5-5.5	6.3	J	-	-	-	-
Soil Sample	TP-18C07C	6/17/1996	8-8.5	7.2	V	-	-	-	-
Soil Sample	TP-18C10B	6/17/1996	5-5.5	9.9	V	-	-	-	-
Soil Sample	TP-18C10C	6/17/1996	8-8.5	1.7	V	-	-	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	7	V	-	-	-	-
Soil Sample	SS-18C07A	5/13/1996	0-0.5	6.2	V	-	-	-	-
Soil Sample	SS-18C08A	5/13/1996	0-0.5	6.9	V	-	-	-	-
Soil Sample	SS-18C08B	5/13/1996	3-3.5	3.7	V	-	-	-	-
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	5.1	V	-	-	-	-
Soil Sample	SS-18C09A	5/13/1996	0-0.5	5.1	V	-	-	-	-
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	4.5	V	-	-	-	-
Soil Sample	SS-18C10A	5/13/1996	0-0.5	3.9	V	-	-	-	-
Soil Sample	SS-18C01A	5/10/1996	0-0.5	2.8	V	-	-	-	-
Soil Sample	SS-18C02A	5/10/1996	0-0.5	6.4	V	-	-	-	-
Soil Sample	SS-18C03A	5/10/1996	0-0.5	2.1	V	-	-	-	-
Soil Sample	SS-18C04A	5/10/1996	0-0.5	6	V	-	-	-	-
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	3.7	V	-	-	-	-
Soil Sample	SS-18C06A	5/10/1996	0-0.5	5.9	V	-	-	-	-

RSL = Regional Screening Level
SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value
U = not detected
mg/kg = milligrams per kilogroam

Table 4-2
Asbestos Landfill - Point-by-Point Comparison to Human Health Standards
Asbestos Landfill Focus Informational Paper
Former Raritan Arsenal

Analyte = Chromium						EPA RSL	EPA RSL		
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier	Industrial 5.6	Residential 0.29		
Soil Sample	TP-18C01B	6/18/1996	1.5-2	16	V	X	X	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	18	V	X	X	-	-
Soil Sample	TP-18C03B	6/18/1996	1.5-2	7.1	V	X	X	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	15	V	X	X	-	-
Test Pit	TP-18C05-1B	6/17/1996	6-6.5	19	V	X	X	-	-
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	16	V	X	X	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	15	V	X	X	-	-
Soil Sample	TP-18C06B	6/17/1996	4-4.5	17	V	X	X	-	-
Soil Sample	TP-18C06C	6/17/1996	8.5-9	16	V	X	X	-	-
Soil Sample	TP-18C07B	6/17/1996	5-5.5	12	J	X	X	-	-
Soil Sample	TP-18C07C	6/17/1996	8-8.5	22	V	X	X	-	-
Soil Sample	TP-18C10B	6/17/1996	5-5.5	18	V	X	X	-	-
Soil Sample	TP-18C10C	6/17/1996	8-8.5	6.9	V	X	X	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	20	V	X	X	-	-
Soil Sample	SS-18C07A	5/13/1996	0-0.5	12	V	X	X	-	-
Soil Sample	SS-18C08A	5/13/1996	0-0.5	20	V	X	X	-	-
Soil Sample	SS-18C08B	5/13/1996	3-3.5	14	V	X	X	-	-
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	17	V	X	X	-	-
Soil Sample	SS-18C09A	5/13/1996	0-0.5	17	V	X	X	-	-
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	14	V	X	X	-	-
Soil Sample	SS-18C10A	5/13/1996	0-0.5	23	V	X	X	-	-
Soil Sample	SS-18C01A	5/10/1996	0-0.5	6.1	V	X	X	-	-
Soil Sample	SS-18C02A	5/10/1996	0-0.5	17	V	X	X	-	-
Soil Sample	SS-18C03A	5/10/1996	0-0.5	6.6	V	X	X	-	-
Soil Sample	SS-18C04A	5/10/1996	0-0.5	19	V	X	X	-	-
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	17	V	X	X	-	-
Soil Sample	SS-18C06A	5/10/1996	0-0.5	29	V	X	X	-	-
Analyte = Lead						EPA RSL	EPA RSL	NJDEP SRS	NJDEP SRS
Sample Type	Sample ID	Sample Date	Sample Interval (ft)	Result (mg/kg)	Qualifier	Industrial 800	Residential 400	Industrial 800	Residential 400
Soil Sample	TP-18C01B	6/18/1996	1.5-2	16	V	-	-	-	-
Soil Sample	TP-18C02B	6/18/1996	1.5-2	17	V	-	-	-	-
Soil Sample	TP-18C03B	6/18/1996	1.5-2	2.6	V	-	-	-	-
Test Pit	TP-18C09-1C	6/18/1996	9.5-10	11	V	-	-	-	-
Test Pit	TP-18C05-1B	6/17/1996	6-6.5	421	V	-	X	-	X
Test Pit	TP-18C05-1C	6/17/1996	7.5-8	8.6	V	-	-	-	-
Test Pit	TP-18C150-1C	6/17/1996	7.5-8	7.6	V	-	-	-	-
Soil Sample	TP-18C06B	6/17/1996	4-4.5	326	V	-	-	-	-
Soil Sample	TP-18C06C	6/17/1996	8.5-9	11	V	-	-	-	-
Soil Sample	TP-18C07B	6/17/1996	5-5.5	212	J	-	-	-	-
Soil Sample	TP-18C07C	6/17/1996	8-8.5	16	V	-	-	-	-
Soil Sample	TP-18C10B	6/17/1996	5-5.5	301	V	-	-	-	-
Soil Sample	TP-18C10C	6/17/1996	8-8.5	77	V	-	-	-	-
Soil Sample	SS-18C05A	5/13/1996	0-0.5	712	V	-	X	-	X
Soil Sample	SS-18C07A	5/13/1996	0-0.5	229	V	-	-	-	-
Soil Sample	SS-18C08A	5/13/1996	0-0.5	529	V	-	X	-	X
Soil Sample	SS-18C08B	5/13/1996	3-3.5	471	V	-	X	-	X
Soil Sample	SS-18C08C	5/13/1996	4.2-4.7	372	V	-	-	-	-
Soil Sample	SS-18C09A	5/13/1996	0-0.5	1270	V	X	X	X	X
Soil Sample	SS-18C09B	5/13/1996	2.9-3.4	421	V	-	X	-	X
Soil Sample	SS-18C10A	5/13/1996	0-0.5	492	V	-	X	-	X
Soil Sample	SS-18C01A	5/10/1996	0-0.5	23	V	-	-	-	-
Soil Sample	SS-18C02A	5/10/1996	0-0.5	42	V	-	-	-	-
Soil Sample	SS-18C03A	5/10/1996	0-0.5	39	V	-	-	-	-
Soil Sample	SS-18C04A	5/10/1996	0-0.5	361	V	-	-	-	-
Soil Sample	SS-18C04B	5/10/1996	5.3-5.8	257	V	-	-	-	-
Soil Sample	SS-18C06A	5/10/1996	0-0.5	1060	V	X	X	X	X

RSL = Regional Screening Level
SRS = Soil Remediation Standard
X = indicates the concentration is greater than the screening level
J = estimated value
U = not detected
mg/kg = milligrams per kilogroam

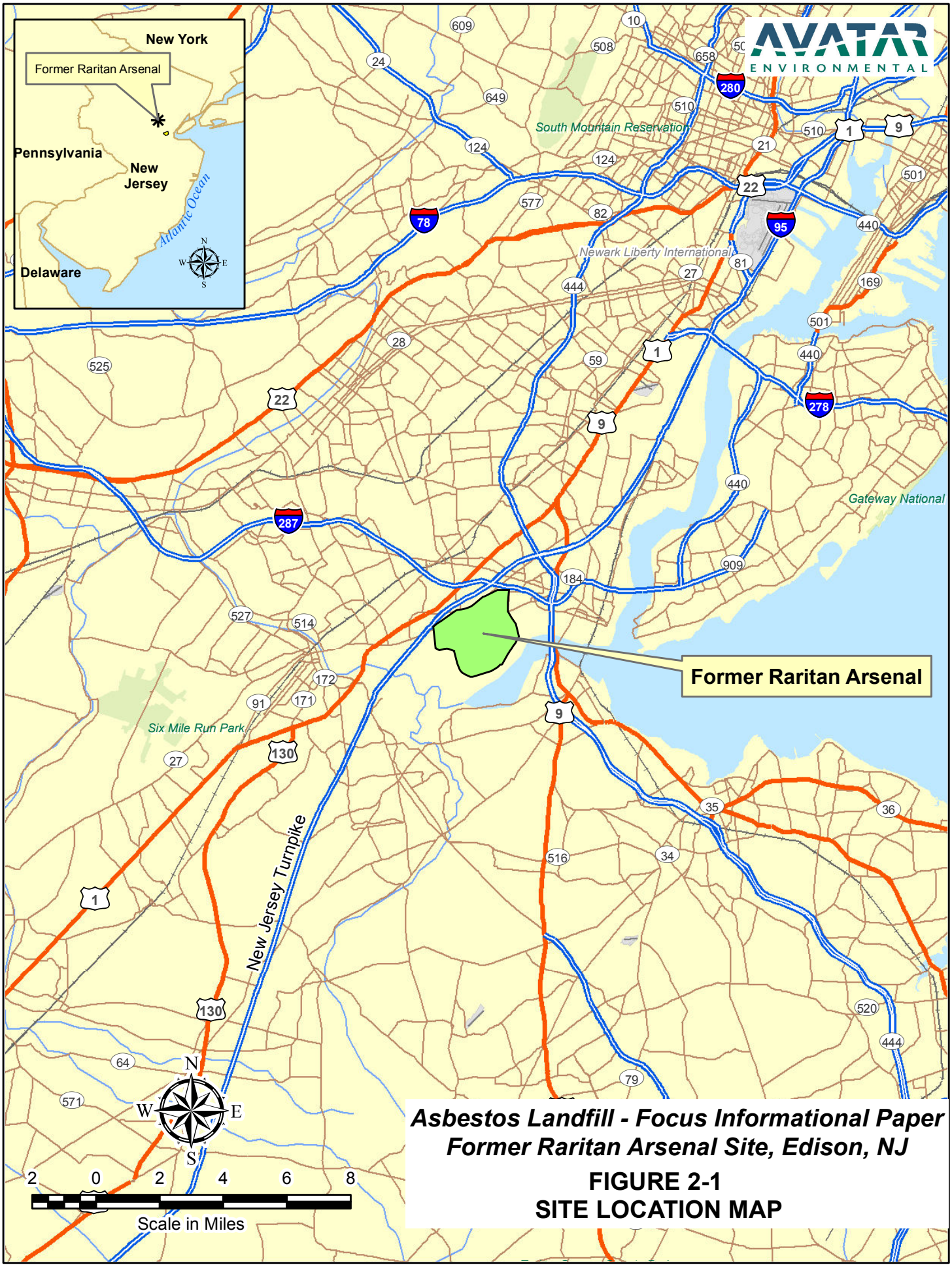
Table 4-3
Summary of Asbestos Laboratory Results
Asbestos Landfill Focus Informational Paper
Former Raritan Arsenal

Soil Boring/ Test Pit ID	Location	Sample Date	Sample Interval (ft)	Results (%)					Notes
				Chrysotile	Amosite	Crocidolite	Other	Total	
SS-18C01A	Outside of Landfill	5/10/1996	0-0.5	ND	ND	ND	ND	ND	Upper surface soil/0-0.5 ft AGW
TP-18C01B		6/18/1996	1.5-2	not analyzed					Lower surface soil/1-1.5 ft BGW
SS-18C02A		5/10/1996	0-0.5	ND	ND	ND	ND	ND	Upper surface soil/0-0.5 ft AGW
TP-18C02B		6/18/1996	1.5-2	not analyzed					Lower surface soil/1-1.5 ft BGW
SS-18C03A		5/10/1996	0-0.5	ND	ND	ND	ND	ND	Upper surface soil/0-0.5 ft AGW
TP-18C03B		6/18/1996	1.5-2	not analyzed					Lower surface soil/1-1.5 ft BGW
SS-18C04A		5/10/1996	0-0.5	2	ND	ND	ND	2	Upper surface soil
SS-18C04B		5/10/1996	5.3-5.8	not analyzed					0-0.5 ft AGW
SS-18C05A	Inside of Landfill	5/13/1996	0-0.5	2	ND	ND	ND	2	Upper surface soil
TP-18C05-1B		6/17/1996	6-6.5	2	ND	ND	ND	2	Within fill material
TP-18C05-1C		6/17/1996	7.5-8	ND	ND	ND	ND	ND	Approximately 0-0.5 ft AGW
TP-18C150-1C		6/17/1996	7.5-8	ND	ND	ND	ND	ND	Approximately 0-0.5 ft AGW
SS-18C06A		5/10/1996	0-0.5	<1	ND	ND	ND	<1	Upper surface soil
TP-18C06B		6/17/1996	4-4.5	<1	ND	ND	ND	<1	Within fill material
TP-18C06C		6/17/1996	8.5-9	ND	ND	ND	ND	ND	0-0.5 ft AGW
SS-18C07A		5/13/1996	0-0.5	ND	ND	ND	ND	ND	Upper surface soil
TP-18C07B		6/17/1996	5-5.5	8	ND	ND	ND	8	Within fill material
TP-18C07C		6/17/1996	8-8.5	ND	ND	ND	ND	ND	0-0.5 ft AGW
SS-18C08A		5/13/1996	0-0.5	ND	ND	ND	ND	ND	Upper surface soil
SS-18C08B		5/13/1996	3-3.5	2	ND	ND	ND	2	Within fill material
SS-18C08C		5/13/1996	4.2-4.7	2	ND	ND	ND	2	0-0.5 ft AGW
SS-18C09A		5/13/1996	0-0.5	2	ND	ND	ND	2	Upper surface soil
SS-18C09B		5/13/1996	2.9-3.4	2	ND	ND	ND	2	Within fill material
TP-18C09-1C		6/18/1996	9.5-10	not analyzed					0-0.5 ft AGW
SS-18C10A		5/13/1996	0-0.5	2	ND	ND	ND	2	Upper surface soil
SS-18C45A (DUP)		5/13/1996	0-0.5	<1	ND	ND	ND	<1	Upper surface soil
TP-18C10B		6/17/1996	5-5.5	3	ND	ND	ND	3	Within fill material
TP-18C10C		6/17/1996	8-8.5	ND	ND	ND	ND	ND	1-1.5 ft below fill material

AGW = above groundwater
BGW = below groundwater
ND = not detected

* The results of the analyses are reported as a volumetric percent representing the amount of asbestos detected in the sample aliquot analyzed. In most instances, the asbestos detected was a result of the analysis of the debris, not fibers within the soil matrix.

Figures


New York
Former Raritan Arsenal
Pennsylvania
New Jersey
Atlantic Ocean
Delaware
AVATAR ENVIRONMENTAL
South Mountain Reservation
Newark Liberty International
Gateway National
Six Mile Run Park
New Jersey Turnpike
Former Raritan Arsenal
Asbestos Landfill - Focus Informational Paper
Former Raritan Arsenal Site, Edison, NJ
FIGURE 2-1
SITE LOCATION MAP
2 0 2 4 6 8
Scale in Miles

AVATAR ENVIRONMENTAL

Woodbridge Army Reserve Center

700

MIP

Beechwood Development

Middlesex County College

U.S.EPA and GSA Property

Exclusion Area

Mill

Seneca

Fieldcrest

Megaw

King Georges Post

Clearview

Amboy

440

Approx. Location of Asbestos Landfill

Parkway

Thomas Edison Park

Commercial / Industrial

Meadow

Capped Area 14

Undeveloped / Wetlands

RARITAN RIVER

flow

444

9

Legend

- Boundary from FUDSMIS GIS
- Exclusion Area
- Army Reserve Center

Operable Units (OUs)

- Middlesex Interfaith Partners
- Beechwood Development
- U.S.EPA/GSA Property
- Commercial / Industrial
- Capped Area 14
- Undeveloped / Wetlands
- TEP/Areas 9,10, and 19
- Middlesex County College
- Area18D
- Area 5

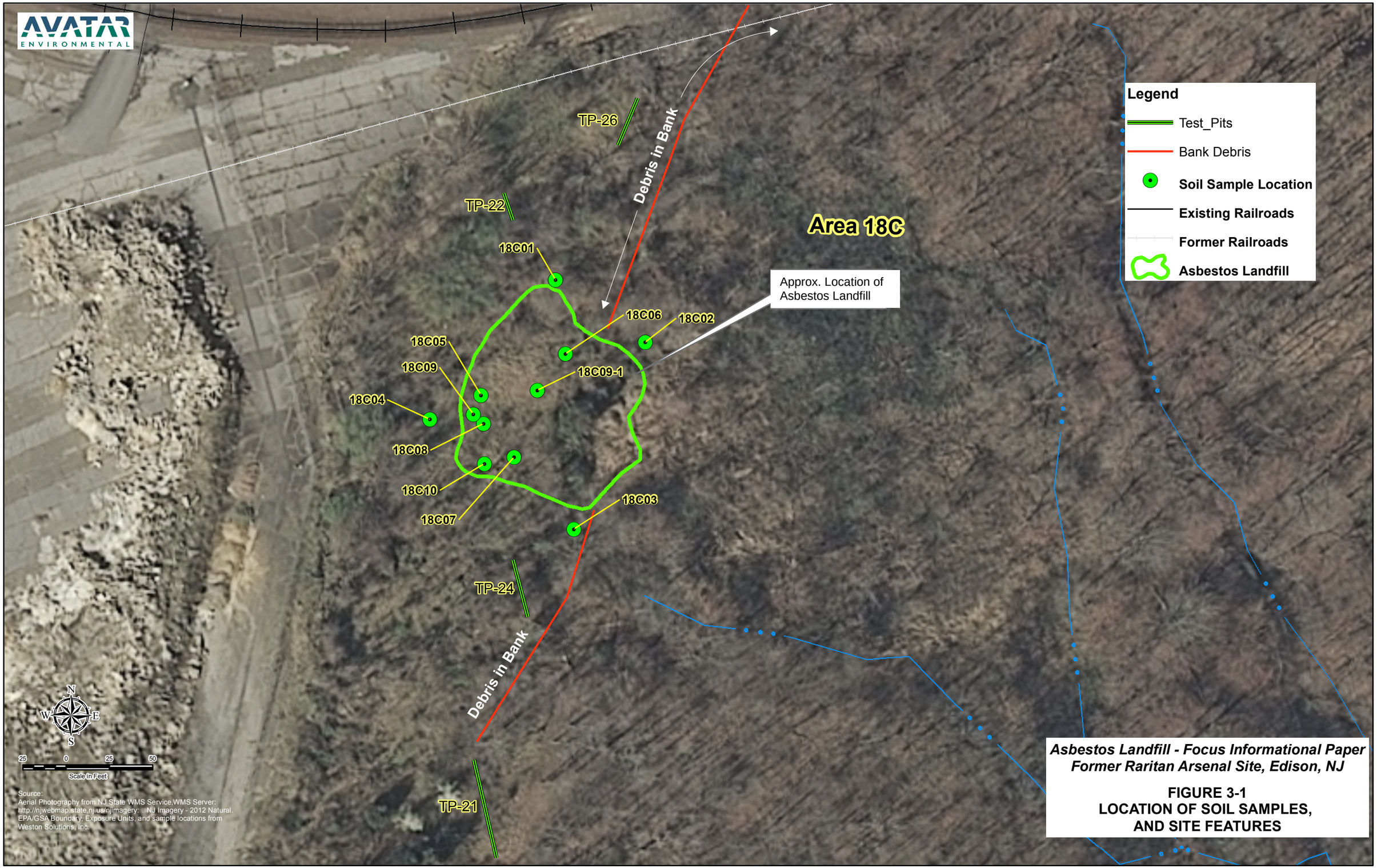
1,000 0 1,000 2,000

Scale in Feet

Source:
Aerial Photos from New Jersey 2002 High Resolution Orthophotography, State of New Jersey, Office of Information Technology.

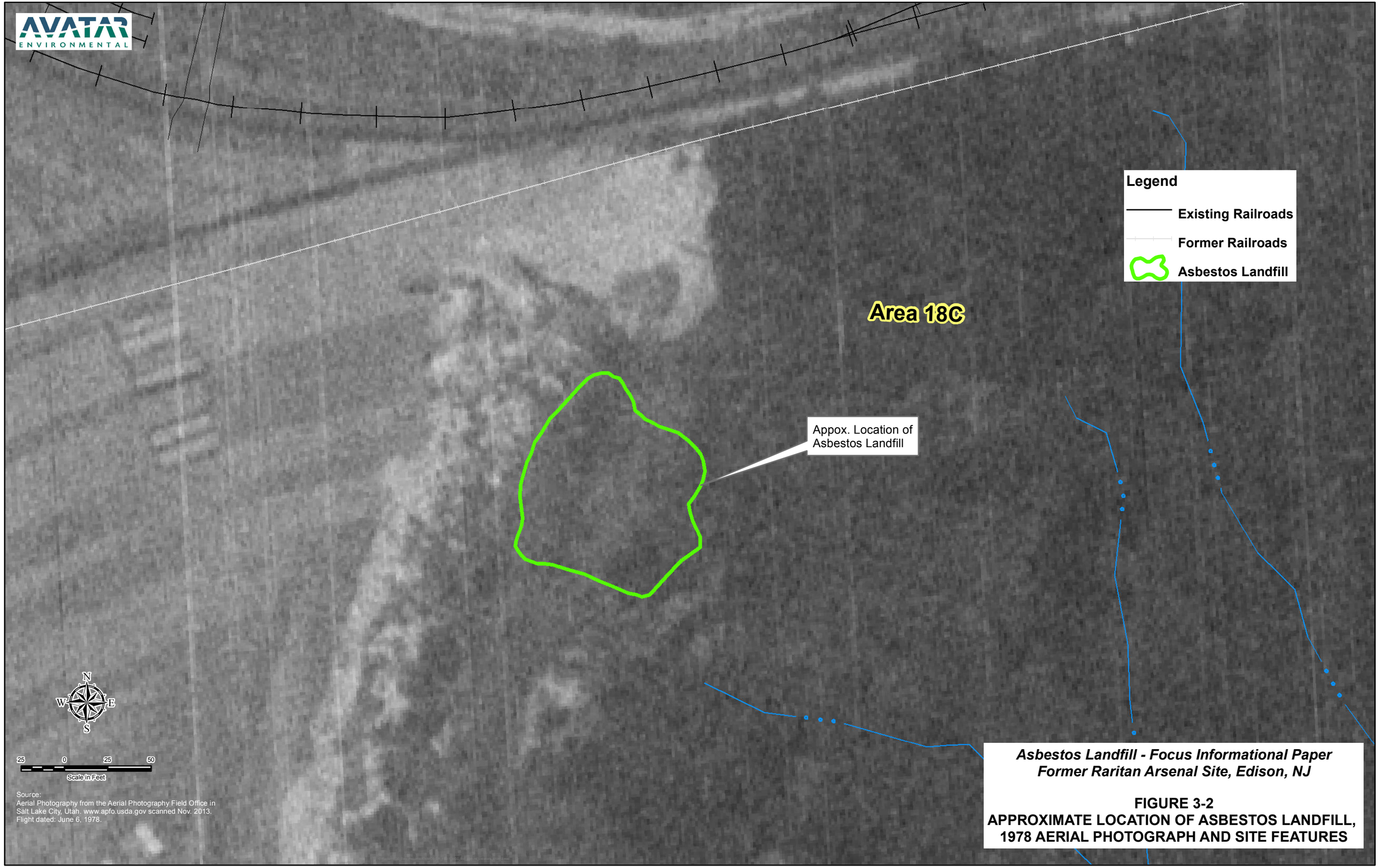
Asbestos Landfill - Focus Informational Paper
Former Raritan Arsenal Site, Edison, NJ
FIGURE 2-2
SITE LAYOUT

Raritan\Area18C\MXDs\Area18C_Fig2-2_Site-Layout_011415.mxd



Asbestos Landfill - Focus Informational Paper
Former Raritan Arsenal Site, Edison, NJ

FIGURE 3-1
LOCATION OF SOIL SAMPLES, AND SITE FEATURES


AVATAR
ENVIRONMENTAL
Area 18C
Appox. Location of
Asbestos Landfill
Legend
Existing Railroads
Former Railroads
Asbestos Landfill
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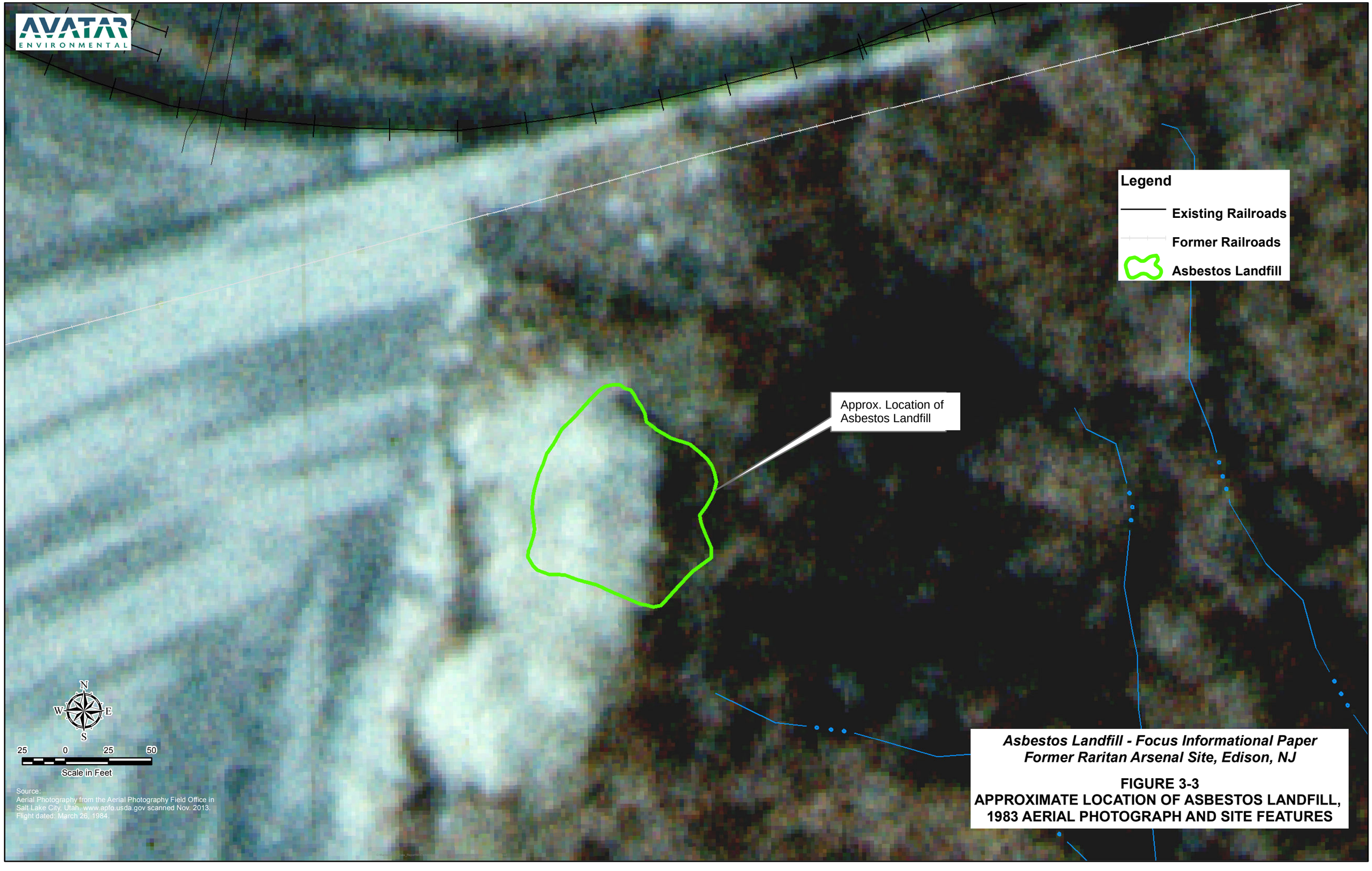
50
Scale in Feet
Source:
Aerial Photography from the Aerial Photography Field Office in
Salt Lake City, Utah. www.apfo.usda.gov scanned Nov. 2013.
Flight dated: June 6, 1978.
Asbestos Landfill - Focus Informational Paper
Former Raritan Arsenal Site, Edison, NJ
FIGURE 3-2
APPROXIMATE LOCATION OF ASBESTOS LANDFILL,
1978 AERIAL PHOTOGRAPH AND SITE FEATURES

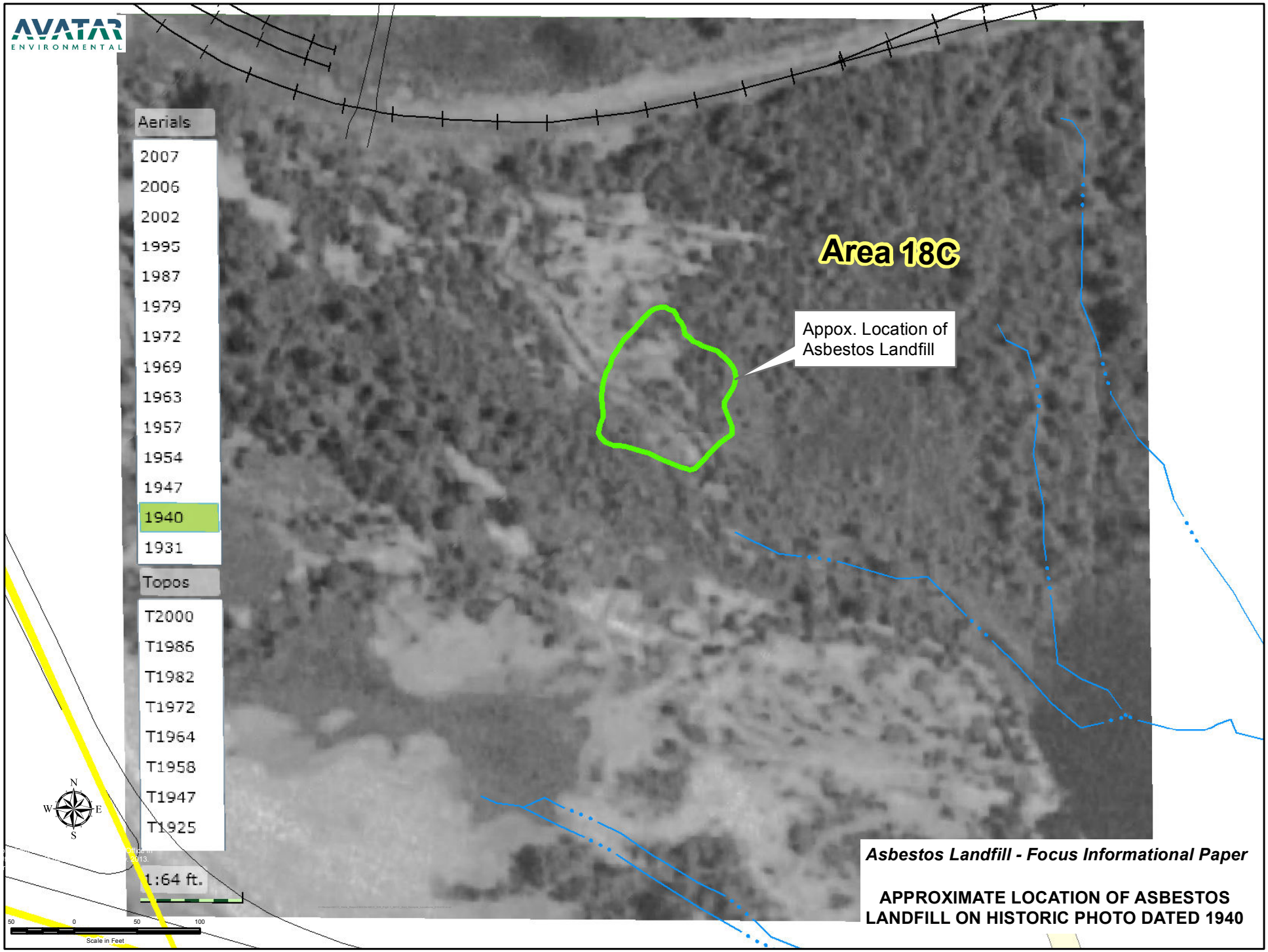


Asbestos Landfill - Focus Informational Paper
Former Raritan Arsenal Site, Edison, NJ

FIGURE 3-3
APPROXIMATE LOCATION OF ASBESTOS LANDFILL,
1983 AERIAL PHOTOGRAPH AND SITE FEATURES

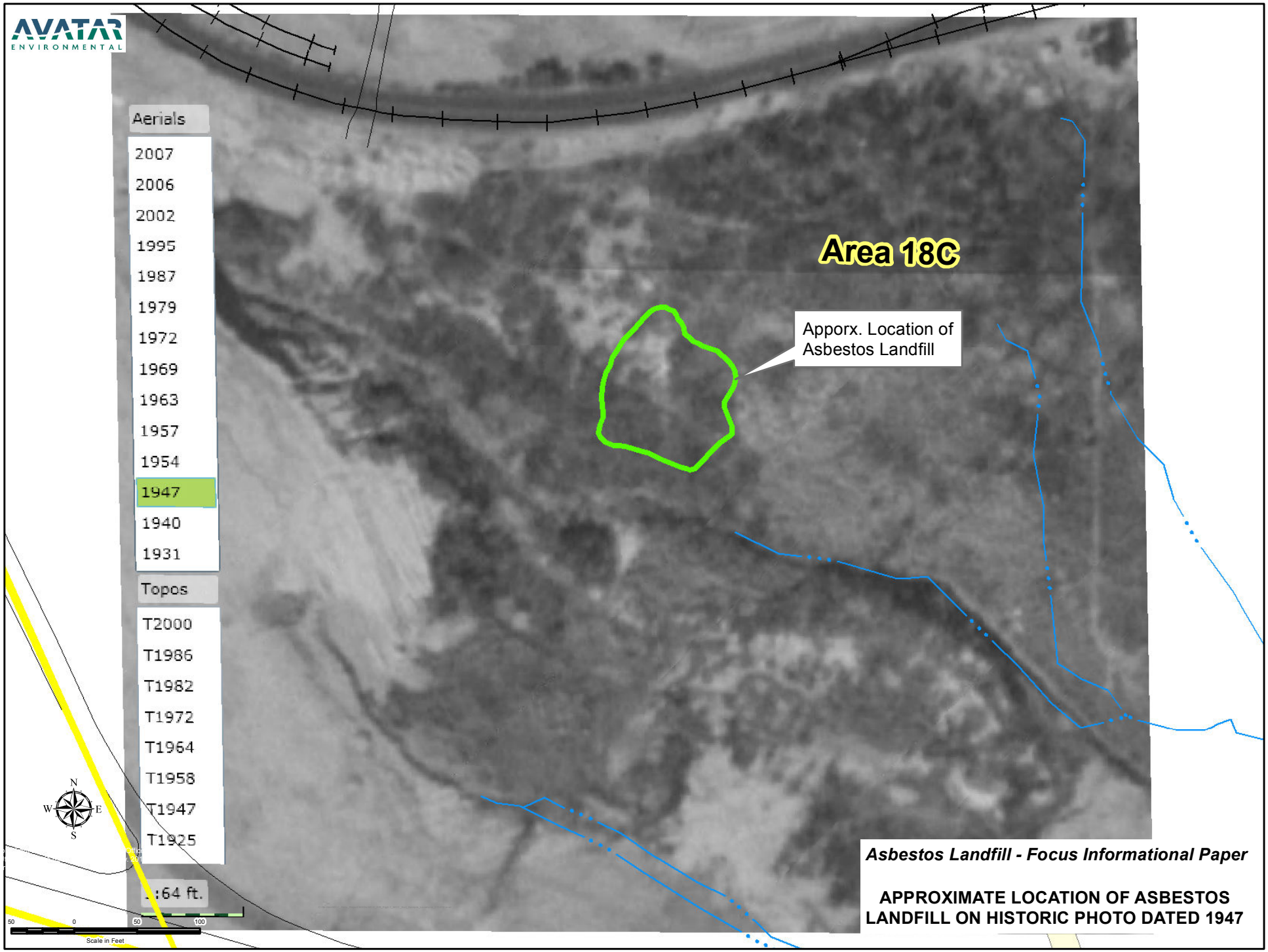
Attachments

Attachment A
Historic Aerial Photographs



Asbestos Landfill - Focus Informational Paper

APPROXIMATE LOCATION OF ASBESTOS LANDFILL ON HISTORIC PHOTO DATED 1940


AVATAR
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T1925
Area 18C
Apporx. Location of
Asbestos Landfill
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Scale in Feet
Asbestos Landfill - Focus Informational Paper
APPROXIMATE LOCATION OF ASBESTOS
LANDFILL ON HISTORIC PHOTO DATED 1947


AVATAR
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T1925
Area 18C
Approx. Location of Asbestos Landfill
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Scale in Feet
Asbestos Landfill - Focus Informational Paper
APPROXIMATE LOCATION OF ASBESTOS LANDFILL ON HISTORIC PHOTO DATED 1954


AVATAR
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1:64 ft.
Area 18C
Approx. Location of Asbestos Landfill
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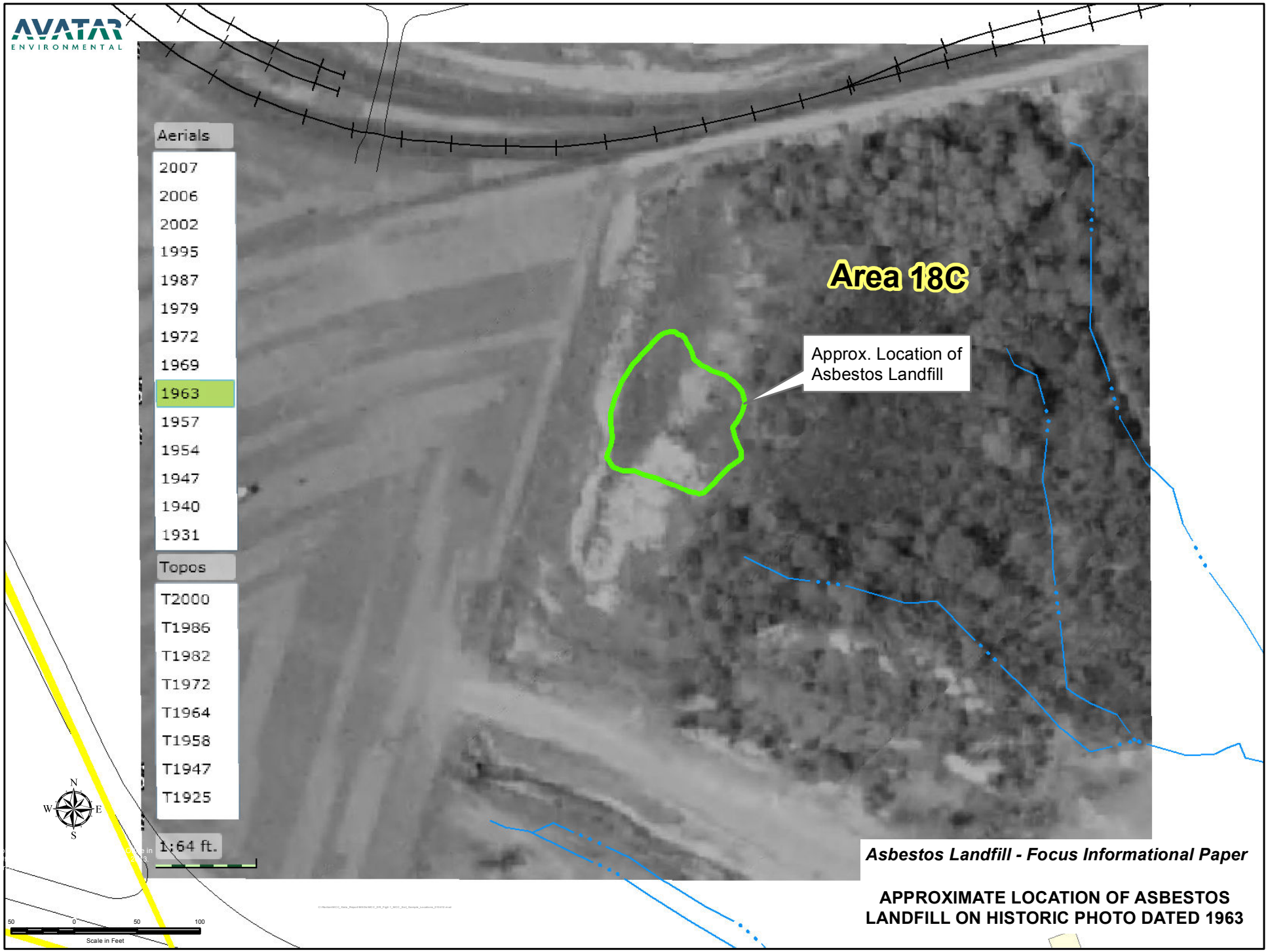
Scale in Feet
Asbestos Landfill - Focus Informational Paper
APPROXIMATE LOCATION OF ASBESTOS LANDFILL ON HISTORIC PHOTO DATED 1957


AVATAR
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1:64 ft.
Area 18C
Approx. Location of Asbestos Landfill
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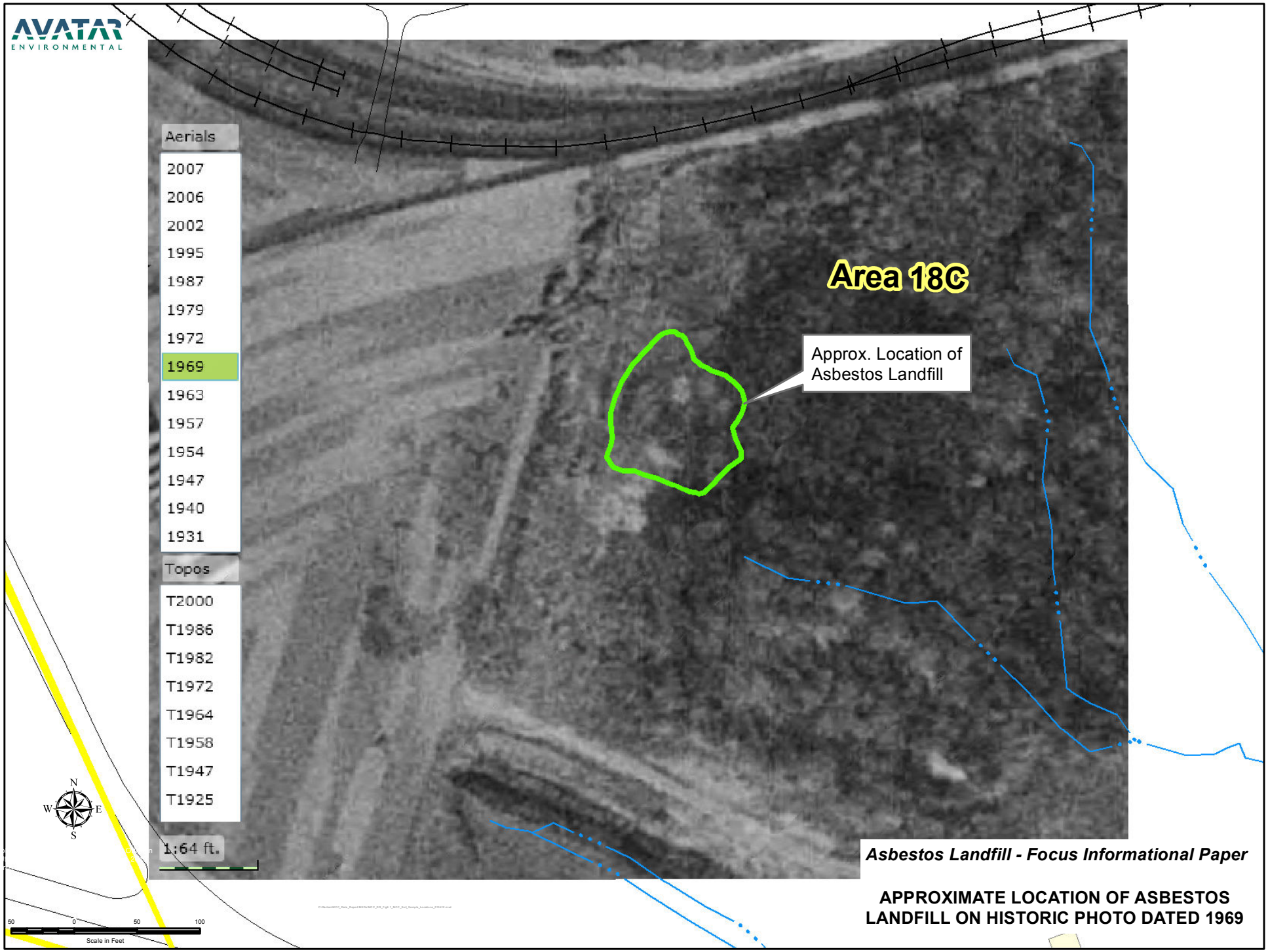
Scale in Feet
Asbestos Landfill - Focus Informational Paper
APPROXIMATE LOCATION OF ASBESTOS LANDFILL ON HISTORIC PHOTO DATED 1963


AVATAR
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Aerials
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1:64 ft.
Area 18C
Approx. Location of Asbestos Landfill
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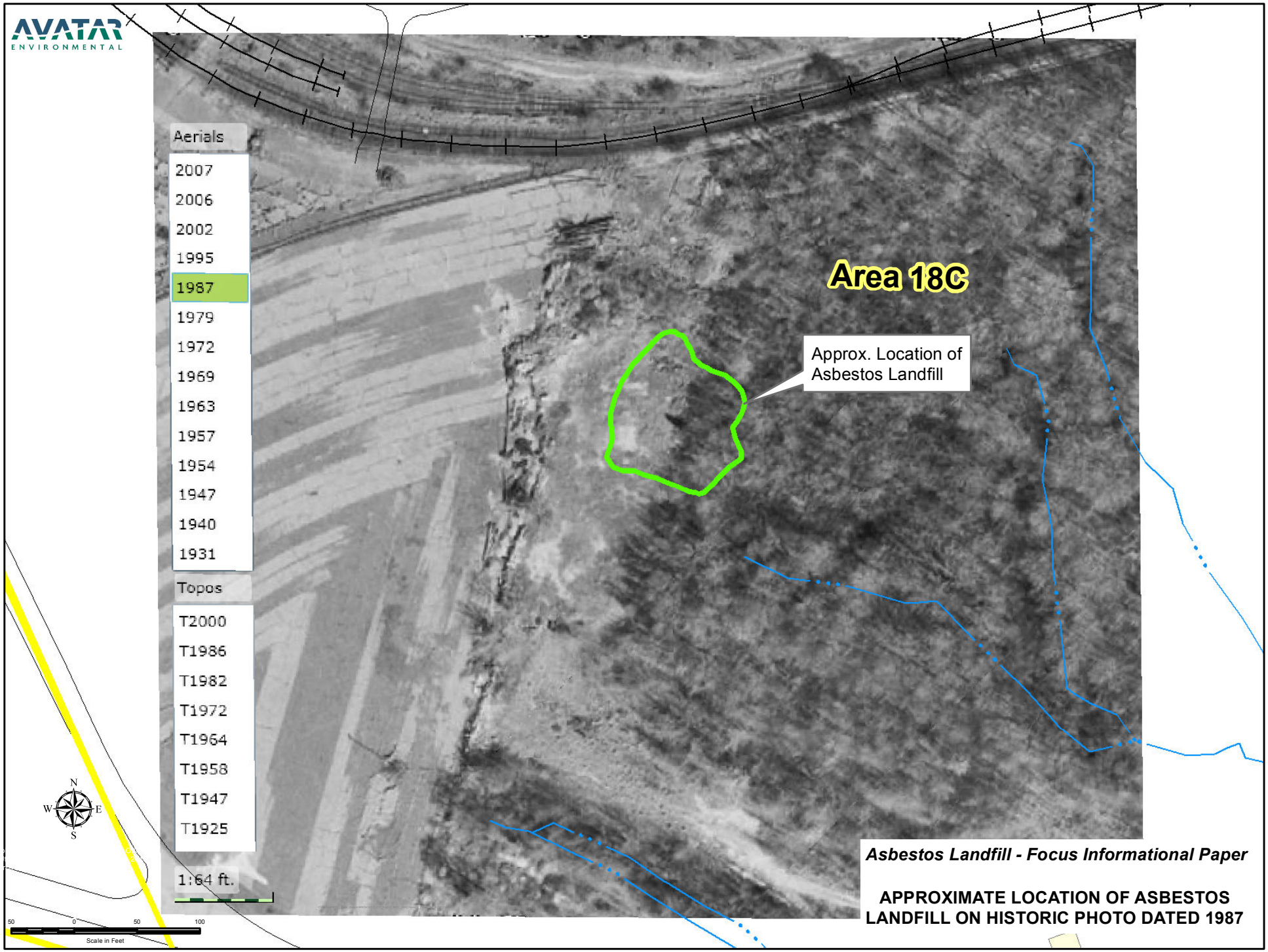
Scale in Feet
Asbestos Landfill - Focus Informational Paper
APPROXIMATE LOCATION OF ASBESTOS LANDFILL ON HISTORIC PHOTO DATED 1969


AVATAR
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1:64 ft.
Area 18C
Approx. Location of Asbestos Landfill
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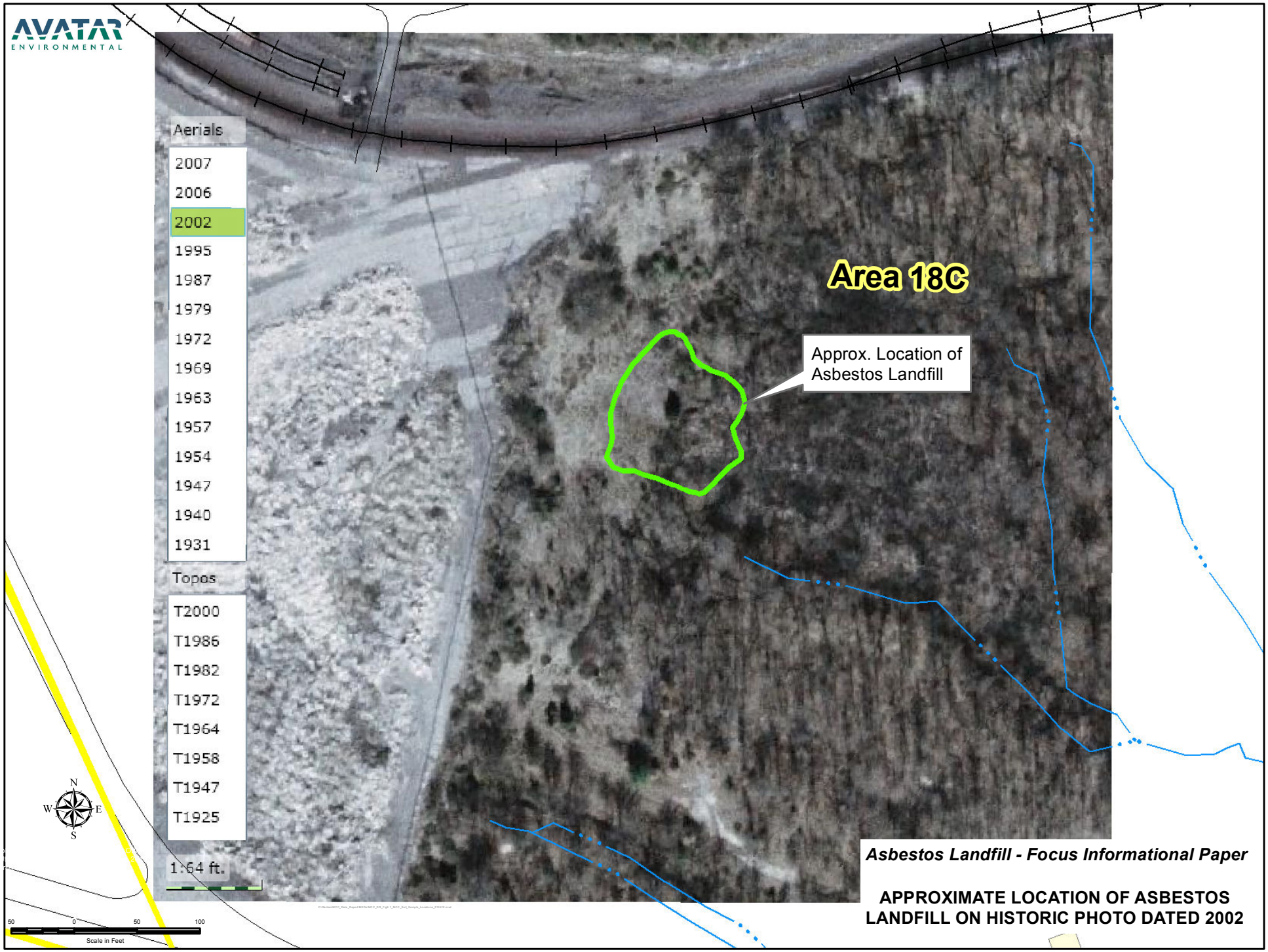
Scale in Feet
Asbestos Landfill - Focus Informational Paper
APPROXIMATE LOCATION OF ASBESTOS LANDFILL ON HISTORIC PHOTO DATED 1987


AVATAR
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Aerials
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T1925
1:64 ft.
Area 18C
Approx. Location of Asbestos Landfill
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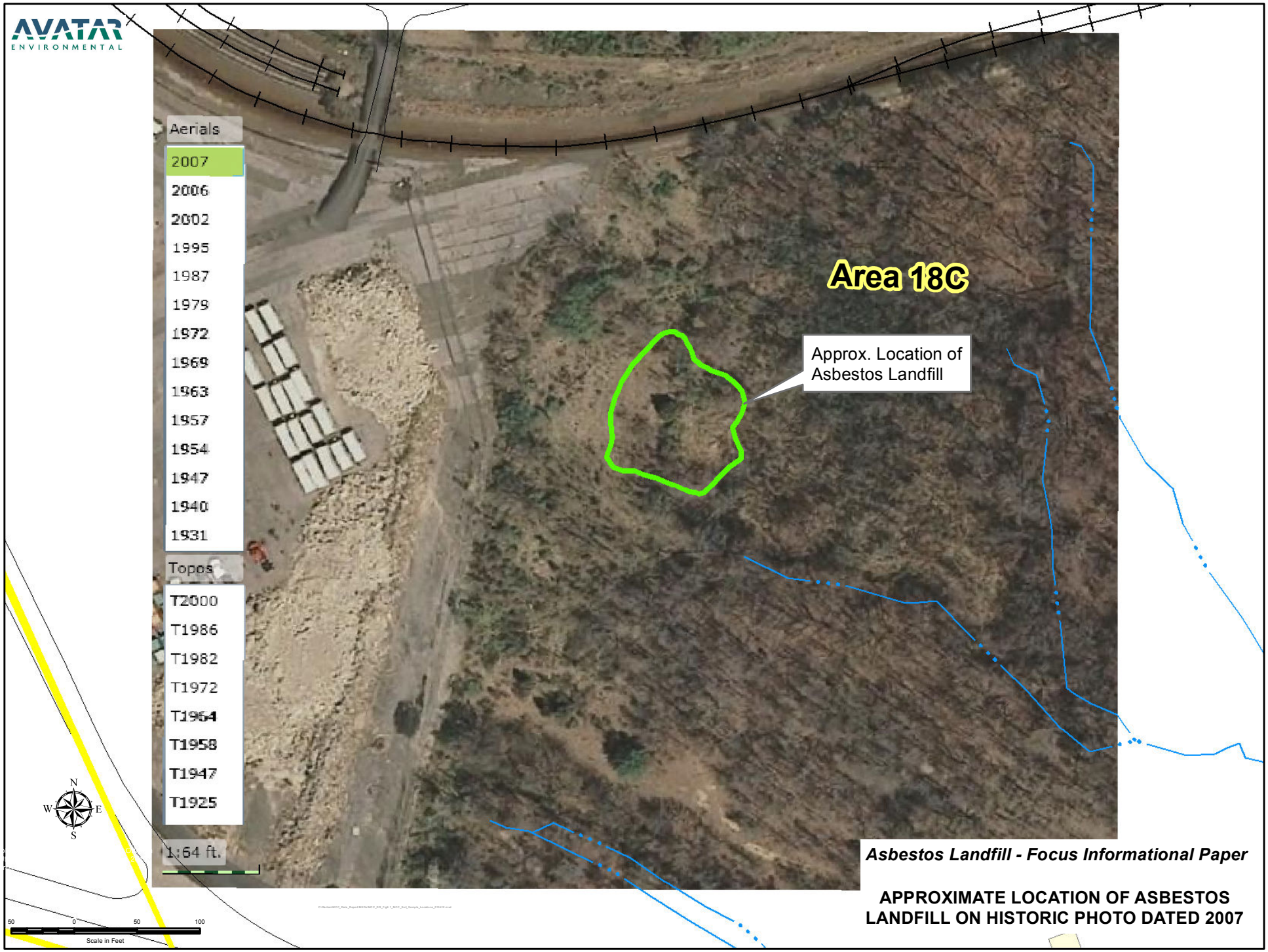
Scale in Feet
Asbestos Landfill - Focus Informational Paper
APPROXIMATE LOCATION OF ASBESTOS LANDFILL ON HISTORIC PHOTO DATED 2002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ENVIRONMENTAL
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1:64 ft.
Area 18C
Approx. Location of Asbestos Landfill
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Scale in Feet
Asbestos Landfill - Focus Informational Paper
APPROXIMATE LOCATION OF ASBESTOS LANDFILL ON HISTORIC PHOTO DATED 2007

Attachment B
U.S. EPA Testimonial

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION II
EDISON, NEW JERSEY 08837

December 12, 2013

Sandra Piettro:

As per discussions with Joseph A. Pernice, the following points were established:

1. 1963 - US Army closes Raritan Arsenal and turns property over to GSA.

2. GSA utilizes former Raritan Arsenal as warehousing complex.

3. 1981-1982 – GSA demolishes 32-34 buildings.

    a. Building materials from demolition consolidated in area presently referred to as the debris pile.
    b. Office furniture and equipment consolidated into a separate debris pile located to the south of Building 205 and the heliport. The abandoned equipment and furniture was cleaned up by EPA in 1990.

4. 1988 – GSA relinquishes ownership of 205 acres of former Raritan Arsenal to EPA.

Kwong Cho
USEPA Region 2
2PM-FAMB-EECFS
Edison, New Jersey
Office: 732-906-6901

Attachment C
Historic Memoranda

DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT, CORPS OF ENGINEERS
700 FEDERAL BUILDING
KANSAS CITY, MISSOURI 64106-2896

Area 18C file

REPLY TO ATTENTION OF:

CEMRK-ED-TD (200)

200.1f
C02NJ008405_02.01_0007

02 Mar 92

MEMORANDUM FOR Commander, Missouri River Division,
ATTN: CEMRD-ED-CP, (Mr. Roger Hager)

SUBJECT: Removal of Asbestos-Containing Debris and Fuel Oil at the Former Raritan Arsenal, Edison, New Jersey

1. Reference:

a. Inspection Report: Raritan Depot, Asbestos Section, EPA Region II, dated 12 Feb 92.

b. Meeting between Major Ben Bauman, CENAN-PP-PM-R, Mr. Pradip Dalal, CEMRK-ED-TD, and Ms. Kathy Older, CEMRK-ED-GH, 20 Feb 92.

c. Memorandum, CENAN-PP-R, dated 27 Feb 92, Subject: Asbestos Encapsulation (Area 18C & 18D), Removal of No. 6 Oil (Area 18D).

2. Reference 1a. was provided to us during the reference 1b. meeting. During the meeting, Major Bauman requested a Rapid Response Action to remove asbestos-containing debris from a site which is currently owned by the General Services Administration (GSA). According to the memo, several old Army barracks were demolished in the late 70's. The asbestos was not removed from the barracks before demolition. According to Major Bauman, the resulting debris was partly covered by soil. The analytical results of nine samples taken by the EPA staff indicate that the friability of five samples was high, three samples were of moderate friability, and one sample was low. We have enclosed the referenced 1a. document and analytical results of the samples for your records. As per paragraph 1a. of the reference 1c., we expect to receive an official request from EPA in the near future.

3. According to DERP policy, asbestos is not eligible for DERP funds except incidentally with clean-up of other hazardous waste or demolition of unsafe structures. However, asbestos-containing debris is an exceptional case which we believe should be considered under DERP in light of the current political environment and public concern which surrounds this project.

4. Reference 1c. also requests removal of unspecified amounts of fuel oil No. 6 from the 420,000 gallon above ground storage tank. The tank is rusting and could leak oil on the ground. The tank

CEMRK-ED-TD
SUBJECT: Removal of Asbestos-Containing Debris and Fuel Oil at the Former Raritan Arsenal, Edison, New Jersey

and piping system which contains asbestos is accessible to the public.

5. We request that you approve a Rapid Response Action for removal of fuel oil and piping with asbestos material from the tank and the asbestos-containing debris from this site. No funds have been budgeted for these Rapid Response Actions in FY 92. We anticipate being able to provide budget requirements for these project by mid April 1992.

6. If you need any more information, please contact Mr. Pradip Dalal, of my staff, at 816-426-2608, extension 3004.

FOR THE COMMANDER:

SIGNED

2 Encls

PAUL D. BARBER
Chief, Engineering Division

CF: (w/o encls)
CENAN-PP-PM-R (Major Ben Bauman)

UNITED STA S ENVIRONMENTAL PROTECTION ENCY
REGION II

Maj. Bauman

Area 18C file

DATE: FEB 12 1992

SUBJECT: Inspection Report - Raritan Depot

FROM: Robert Fitzpatrick, Chief RF
Asbestos Section, ACB

TO: Kenneth Eng, Chief
Air Compliance Branch

I. BACKGROUND

On January 16, 1992, you and I attended a meeting with George Pavlou, Vince Pitruzzello, Walter Shep and Helen Shannon of ERRD, and Jim Foley of Facilities Administration Branch to discuss the handling of approximately one acre of alleged asbestos-containing building debris buried at the Raritan Depot. The debris pile resulted from the demolition of several old army barracks in the late 70's, which were demolished without removing the asbestos first. It was proposed that AWMD (ACB) and ERRD perform a multi-media site survey after which ERRD would have a contractor to perform sampling analysis to determine if asbestos is present. However, it was later determined that ERRD could not use Superfund monies for site investigations at federal facilities. Therefore, it was agreed that ACB and FAB will perform a presampling survey to target suspect material for sampling.

II. LOCATION AND OBJECTIVE

On February 6, 1992, I conducted an inspection of the demolition debris pile located at an area east of Bonhampton Road and south of the former helicopter landing pad. The purpose of the inspection was to determine if the surface and sides of the debris pile were contaminated with asbestos.

III. INSPECTION PARTICIPANTS

Helen Shannon EPA-ERRD
Kwong Cho EPA-OPM
Major Benjamin Bauman - U.S. Army Corp. of Engineers
Robert Fitzpatrick - EPA-AWM

IV. SYNOPSIS OF INSPECTION

With the above inspection participants we walked around the perimeter and over the top of the debris pile. The pile consisted of brick, concrete, wood and asphalt roofing product. During the walk-thru I observed debris which might be asbestos-containing material. I then took eight(8) samples of suspect material.

200.1f
C02NJ008402_02.19_0001



V. SAMPLE RESULTS

On February 6, 1992 the samples were sent to JACA Corp. for analysis. On February 7, 1992 I received the following results via telephone.

Sample No.:

1) 70%-80% Chrysotile
2) 65%-70% Chrysotile
3) 0
4) 0
5) 0
6) 0
7)* < 1% Chrysotile - *Sample needs to be point counted
8)** a - 10% - 15% Chrysotile
b - 80% - 90% Chrysotile - **Composite Sample

VI. CONCLUSIONS AND RECOMMENDATIONS

Four of the eight samples tested positive for asbestos indicating that the surface of the debris pile is contaminated with asbestos. The exact extent of contamination of the whole debris pile cannot be determined at this time because we are unable to sample the inner layers of the debris pile.

It is recommended that a meeting be set up with ERRD, OPM and AWM to determine our next course of action.

Attachments

JACA® CORP.

Environmental Engineers • Consultants

February 11, 1992

Ms. Avia Eyllon
U.S. EPA, Region II
Air Compliance Branch
Room 500
26 Federal Plaza
New York, NY 10278

Dear Ms. Eyllon:

Enclosed are the laboratory reports for eight suspect bulk asbestos samples received by our laboratory on February 7, 1992. One sample, RD02069208, was slit at our laboratory into two samples for analysis as per instructions on the chain of custody form. The samples were analyzed using EPA Method 600/M4-82-020 following JACA's approved QA/QC Manual for identification of asbestos fibers using polarized light microscopy (PLM). As indicated on the reports, four of the nine samples analyzed were determined to be asbestos-containing. Sample RD02069207 was initially determined to contain <1 percent asbestos. This sample was then analyzed using the point counting technique, as mandated by current protocol, and no asbestos fibers were counted. This sample can be considered to have had a trace amount of asbestos present, which is as indicated as <1 percent on the laboratory report.

If you have any questions regarding these results, please contact me.

Sincerely,

Scott W. DeChant

SCOTT W. DECHANT
Senior Industrial Hygienist

SWD:kad
cc: Robert Fitzpatrick, EPA - Region II

550 Pinetown Road, Fort Washington, PA 19034 • (215) 643-5466 • Fax (215) 643-2772

JACA Corp.
550 Pinetown Road
Ft. Washington, PA 19034
(215) 643-5466 ◆ FAX: (215) 643-2772

Bulk Sample Analysis Report

JACA ID#	Client ID	Color, Texture	Friability	Chrysotile	Amosite	Crocidolite	Actinolite	Tremolite	Anthophyllite	TOTAL ASBESTOS
920112	RD02069201	Gray fibrous	High	80%	ND	ND	ND	ND	ND	80%
				Mineral Wool	Fibrous Glass	Cellulose	Synthetic	Other		TOTAL NON-ASB.
				ND	ND	ND	ND	ND		ND

JACA ID#	Client ID	Color, Texture	Friability	Chrysotile	Amosite	Crocidolite	Actinolite	Tremolite	Anthophyllite	TOTAL ASBEST
920113	RD02069202	Gray fibrous	High	70%	ND	ND	ND	ND	ND	70%
				Mineral Wool	Fibrous Glass	Cellulose	Synthetic	Other		TOTAL NON-ASB.
				5%	ND	ND	ND	ND		5%

JACA ID#	Client ID	Color, Texture	Friability	Chrysotile	Amosite	Crocidolite	Actinolite	Tremolite	Anthophyllite	TOTAL ASBESTOS
920114	RD02069203	Gray fibrous	High	ND	ND	ND	ND	ND	ND	ND
				Mineral Wool	Fibrous Glass	Cellulose	Synthetic	Other		TOTAL NON-ASB.
				80%	ND	10%	ND	ND		90%

JACA ID#	Client ID	Color, Texture	Friability	Chrysotile	Amosite	Crocidolite	Actinolite	Tremolite	Anthophyllite	TOTAL ASBESTOS
920115	RD02069204	Off white cloth	High	ND	ND	ND	ND	ND	ND	ND
				Mineral Wool	Fibrous Glass	Cellulose	Synthetic	Other		TOTAL NON-ASB.
				ND	ND	95%	ND	ND		95%

Analytical Method: Polarized light microscopy
EPA Method 600 / M4-82-020

Date of Analysis: February 7, 1992

Comments: Totals represent fibrous material only
ND = none detected

Scott W. [illegible]
Stephen Forostiak — Analyst

Paul A. [illegible]
Chief Bureau [illegible]

JACA Corp.
550 Pinetown Road
Ft. Washington, PA 19034
(215) 643-5466 ◆ FAX: (215) 643-2772

Bulk Sample Analysis Report

JACA ID#	Client ID	Color, Texture	Friability	Chrysotile	Amosite	Crocidolite	Actinolite	Tremolite	Anthophyllite	TOTAL ASBESTOS
920116	RD02069205	Black tar	Moderate	ND	ND	ND	ND	ND	ND	ND
				Mineral Wool	Fibrous Glass	Cellulose	Synthetic	Other		TOTAL NON-ASB.
				ND	ND	40%	ND	ND		40%

JACA ID#	Client ID	Color, Texture	Friability	Chrysotile	Amosite	Crocidolite	Actinolite	Tremolite	Anthophyllite	TOTAL ASBESTOS
920117	RD02069206	White chalk	Moderate	ND	ND	ND	ND	ND	ND	ND
				Mineral Wool	Fibrous Glass	Cellulose	Synthetic	Other		TOTAL NON-ASB.
				15%	ND	ND	ND	ND		15%

JACA ID#	Client ID	Color, Texture	Friability	Chrysotile	Amosite	Crocidolite	Actinolite	Tremolite	Anthophyllite	TOTAL ASBESTOS
920118	RD02069207	Brown fibrous hard	Low-Moderate	<1%	ND	ND	ND	ND	ND	<1%
				Mineral Wool	Fibrous Glass	Cellulose	Synthetic	Other		TOTAL NON-ASB.
				ND	ND	95%	ND	ND		95%

JACA ID#	Client ID	Color, Texture	Friability	Chrysotile	Amosite	Crocidolite	Actinolite	Tremolite	Anthophyllite	TOTAL ASBESTOS
920119	RD02069208	Black tar	Low	15%	ND	ND	ND	ND	ND	15%
				Mineral Wool	Fibrous Glass	Cellulose	Synthetic	Other		TOTAL NON-ASB.
				ND	ND	5%	ND	ND		5%

Analytical Method: Polarized light microscopy
EPA Method 600 / M4-82-020

Date of Analysis: February 7, 1992

Comments: Totals represent fibrous material only
ND = none detected

Stephen Forestiak
Analyst

Paul Butrymowicz

JACA Corp.
550 Pinetown Road
Ft. Washington, PA 19034
(215) 643-5466 ◆ FAX: (215) 643-2772

Bulk Sample Analysis Report

JACA ID#	Client ID	Color, Texture	Friability	Chrysotile	Amosite	Crocidolite	Actinolite	Tremolite	Anthophyllite	TOTAL ASBESTOS
920120	RD02069208	White fibrous	High	90%	ND	ND	ND	ND	ND	90%
				Mineral Wool	Fibrous Glass	Cellulose	Synthetic	Other_____		TOTAL NON-ASB.
				5%	ND	ND	ND	ND		5%

JACA ID#	Client ID	Color, Texture	Friability	Chrysotile	Amosite	Crocidolite	Actinolite	Tremolite	Anthophyllite	TOTAL ASBESTOS
XXXX										XXX
				Mineral Wool	Fibrous Glass	Cellulose	Synthetic	Other_____		TOTAL NON-ASB.
										XXX

JACA ID#	Client ID	Color, Texture	Friability	Chrysotile	Amosite	Crocidolite	Actinolite	Tremolite	Anthophyllite	TOTAL ASBESTOS
XXXX										XXX
				Mineral Wool	Fibrous Glass	Cellulose	Synthetic	Other_____		TOTAL NON-ASB.
										XXX

JACA ID#	Client ID	Color, Texture	Friability	Chrysotile	Amosite	Crocidolite	Actinolite	Tremolite	Anthophyllite	TOTAL ASBESTOS
XXXX										XXX
				Mineral Wool	Fibrous Glass	Cellulose	Synthetic	Other_____		TOTAL NON-ASB.
										XXX

Analytical Method: Polarized light microscopy
EPA Method 600 / M4-82-020

Date of Analysis: February 7, 1992

Comments: Totals represent fibrous material only
ND = none detected

Stephen Forostiak
Analyst

Paul Bulsavage

Attachment D
Soil Boring Logs

BOREHOLE ID : 18C01 PROJECT NAME: USACOE-RARITAN-18C
BEGIN DATE : 05/10/96 END DATE : 05/10/96

LOGGER/COMPANY : C. CADALSO

BOREHOLE COMPLETED IN (<O>verburden <B>edrock) : O

TOTAL DEPTH : 4.00 DEPTH TO BEDROCK : 0.00

BOREHOLE DIAMETER #1: 3.00
INTERVAL: 0.00 ft. to 4.00 ft. BGS
METHOD : SLEDGE HAMMER FLUID : NONE
BOREHOLE DIAMETER #2:
INTERVAL:
METHOD : FLUID :
BOREHOLE DIAMETER #3:
INTERVAL:
METHOD : FLUID :

DRILLING COMPANY : JC ANDERSON
DRILLER : S. BURGER
DRILL RIG TYPE : MANUAL

	ESTIMATED	SURVEYED
SURFACE ELEVATION :	0.000	41.333
N. COORDINATE :	0.0000	611045.8180
E. COORDINATE :	0.0000	533411.8640

WELL PERMIT.....(Y)es (N)o: N PERMIT # :

HOLE ABANDONED...(Y)es (N)o: Y
WELL INSTALLED...(Y)es (N)o: N
WELL CLUSTER.....(Y)es (N)o: N No. OF WELLS : 0
WELL NEST.....(Y)es (N)o: N No. OF WELLS : 0
PUMPS INSTALLED..(Y)es (N)o: N

	TYPE	DEPTH
PURGE :		0.00
SAMPLE :		0.00

BOREHOLE TESTING
BOREHOLE GEOPHYSICS.....(Y)es (N)o: N
SLUG TESTS.....(Y)es (N)o: N
PACKER TESTS.....(Y)es (N)o: N
PUMPING TESTS.....(Y)es (N)o: N

COMMENTS :
BOREHOLE MOVED 12' EAST DUE TO MAGNETIC ANOMALIES.
SLEDGE HAMMER WAS USED TO DRIVE SPLIT SPOON. REMAINING SAMPLE INTERVAL COLLECTED DURING TEST PIT PROGRAM.

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BOREHOLE /WELL ID	SMP NUM	LTH NUM	LITHOLOGY INT. (FT BGS)		SAMPLING METHOD	SIZE GRAVEL	GRAVEL PCT.	SIZE SAND	SAND PCT	SILT PCT	CLAY PCT	ORGANIC PCT	ROCK TYPE	PLAST	SORT	STRENGTH	MOISTURE	STRAT UNIT
18C01	1	1	0.00	2.00	SPS	CM	10	F	65	15	10	0		NON	POR	NOC	WET	US
18C01	2	1	2.00	4.00	SPS	C	15	FM	50	15	10	10		NON	POR	NOC	WET	US

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	:	USACOE-RARITAN-18C	TOTAL DEPTH	:	4.00
SITE NAME	:	RARITAN ARSENAL-AREA 18C	LOGGER	:	C. CADALSO
BORING ID	:	18C01	DRILLING COMPANY	:	JC ANDERSON
NORTHING	:	611045.8180 surveyed	DRILLING RIG	:	MANUAL
EASTING	:	533411.8640 surveyed	DATE STARTED	:	05/10/96
ELEVATION	:	41.333 surveyed	DATE COMPLETED	:	05/10/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
40	1		100	Silty sand, SM	DARK BROWN/YELL	NOC	WET		OVM 0.0	FILL. SS-18C01A(0-0.5')& VOC 1.5'-2' COLLECTED. GW AT 0.5' BGS.
39	2		100	Silty sand with gravel, SM	BROWN	NOC	WET		OVM 0.0	NATURAL SOIL NOT ENCOUNTERED. TD AT 4' BGS.
38	3									
37	4									
36	5									
35	6									
34	7									
33	8									
32	9									
31	10									

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BOREHOLE ID : 18C02 *PROJECT NAME:* USACOE-RARITAN-18C
BEGIN DATE : 05/10/96 *END DATE :* 05/10/96

LOGGER/COMPANY : C. CADALSO

BOREHOLE COMPLETED IN (<O>verburden <B>edrock) : O

TOTAL DEPTH : 2.00 *DEPTH TO BEDROCK :* 0.00

BOREHOLE DIAMETER #1: 3.00
INTERVAL: 0.00 ft. to 2.00 ft. BGS
METHOD : SLEDGE HAMMER *FLUID :* NONE
BOREHOLE DIAMETER #2:
INTERVAL:
METHOD : *FLUID :*
BOREHOLE DIAMETER #3:
INTERVAL:
METHOD : *FLUID :*

DRILLING COMPANY : JC ANDERSON
DRILLER : S. BURGER
DRILL RIG TYPE : MANUAL

	ESTIMATED	*SURVEYED*
SURFACE ELEVATION :	0.000	37.473
N. COORDINATE :	0.0000	611009.9540
E. COORDINATE :	0.0000	533463.6190

WELL PERMIT.....(Y)es (N)o: N *PERMIT # :*

HOLE ABANDONED...(Y)es (N)o: Y
WELL INSTALLED...(Y)es (N)o: N
WELL CLUSTER.....(Y)es (N)o: N *No. OF WELLS :* 0
WELL NEST.....(Y)es (N)o: N *No. OF WELLS :* 0
PUMPS INSTALLED..(Y)es (N)o: N

	TYPE	*DEPTH*
PURGE :		0.00
SAMPLE :		0.00

BOREHOLE TESTING
BOREHOLE GEOPHYSICS.....(Y)es (N)o: N
SLUG TESTS.....(Y)es (N)o: N
PACKER TESTS.....(Y)es (N)o: N
PUMPING TESTS.....(Y)es (N)o: N

COMMENTS :
BORING RELOCATED 14' NORTHEAST DUE TO SURFACE WATER AT PROPOSED LOCATION. SLEDGE HAMMER USED TO DRIVE SPLIT SPOON. REMAINING SAMPLE COLLECTED DURING TEST PIT PROGRAM.

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DATE: 09/25/96 **** Roy F. WESTON, Inc. LITHOLOGICAL DATA FOR - CLIENT ID: 18C *** PAGE: 1

BOREHOLE /WELL ID	SMP NUM	LTH NUM	LITHOLOGY INT. (FT BGS)		SAMPLING METHOD	SIZE GRAVEL	GRAVEL PCT.	SIZE SAND	SAND PCT	SILT PCT	CLAY PCT	ORGANIC PCT	ROCK TYPE	PLAST	SORT	STRENGTH	MOISTURE	STRAT UNIT
18C02	1	1	0.00	2.00	SPS	MC	20	F	50	10	10	10		NON	POR	NOC	WET	US

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Borehole Log

Roy F. WESTON, Inc.

PROJECT :	USACOE-RARITAN-18C	TOTAL DEPTH :	2.00
SITE NAME :	RARITAN ARSENAL-AREA 18C	LOGGER :	C. CADALSO
BORING ID :	18C02	DRILLING COMPANY :	JC ANDERSON
NORTHING :	611009.9540 surveyed	DRILLING RIG :	MANUAL
EASTING :	533463.6190 surveyed	DATE STARTED :	05/10/96
ELEVATION :	37.473-surveyed	DATE COMPLETED :	05/10/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
36	1		100	Silty sand with gravel, SM	DARK BROWN	NOC	WET		OVM 0.0	FILL. SS18C02A(0-0.5') COLLECTED. NATURAL SOIL NOT OBSERVED. GW AT 0.5'. TD AT 2' BGS.
35	2									
34	3									
33	4									
32	5									
31	6									
30	7									
29	8									
28	9									
27	10									

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Borehole Location Data

Roy F. WESTON, Inc.

BOREHOLE ID : 18C03 PROJECT NAME: USACOE-RARITAN-18C
BEGIN DATE : 05/10/96 END DATE : 05/10/96

LOGGER/COMPANY : C. CADALSO

BOREHOLE COMPLETED IN (<O>verburden <B>edrock) : O

TOTAL DEPTH : 4.00 DEPTH TO BEDROCK : 0.00

BOREHOLE DIAMETER #1: 3.00
INTERVAL: 0.00 ft. to 4.00 ft. BGS
METHOD : SLEDGE HAMMER FLUID : NONE
BOREHOLE DIAMETER #2:
INTERVAL:
METHOD : FLUID :
BOREHOLE DIAMETER #3:
INTERVAL:
METHOD : FLUID :

DRILLING COMPANY : JC ANDERSON
DRILLER : S. BURGER
DRILL RIG TYPE : MANUAL

	ESTIMATED	SURVEYED
SURFACE ELEVATION :	0.000	33.190
N. COORDINATE :	0.0000	610902.0900
E. COORDINATE :	0.0000	533422.4900

WELL PERMIT.....(Y)es (N)o: N PERMIT # :

HOLE ABANDONED...(Y)es (N)o: Y
WELL INSTALLED...(Y)es (N)o: N
WELL CLUSTER.....(Y)es (N)o: N No. OF WELLS : 0
WELL NEST.....(Y)es (N)o: N No. OF WELLS : 0
PUMPS INSTALLED..(Y)es (N)o: N

	TYPE	DEPTH
PURGE :		0.00
SAMPLE :		0.00

BOREHOLE TESTING
BOREHOLE GEOPHYSICS.....(Y)es (N)o: N
SLUG TESTS.....(Y)es (N)o: N
PACKER TESTS.....(Y)es (N)o: N
PUMPING TESTS.....(Y)es (N)o: N

COMMENTS :
SLEDGE HAMMER WAS USED TO DRIVE SPLIT SPOON. DUE TO SHALLOW GW, "B" INTERVAL NOT COLLECTED. "B" INTERVAL SAMPLE COLLECTED BELOW GW DURING TEST PIT PROGRAM.

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DATE: 09/25/96 **** Roy F. WESTON, Inc. LITHOLOGICAL DATA FOR - CLIENT ID: 18C *** PAGE: 1

BOREHOLE /WELL ID	SMP NUM	LTH NUM	LITHOLOGY INT. (FT BGS)		SAMPLING METHOD	SIZE GRAVEL	GRAVEL PCT.	SIZE SAND	SAND PCT	SILT PCT	CLAY PCT	ORGANIC PCT	ROCK TYPE	PLAST	SORT	STRENGTH	MOISTURE	STRAT UNIT
18C03	1	1	0.00	2.00	SPS	F	10	FM	80	0	0	10		NON	MOD	NOC	WET	LS
18C03	2	1	2.00	4.00	SPS		0	FM	75	10	10	5		NON	MOD	NOC	SAT	LS

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	:	USACOE-RARITAN-18C	TOTAL DEPTH	:	4.00
SITE NAME	:	RARITAN ARSENAL-AREA 18C	LOGGER	:	C. CADALSO
BORING ID	:	18C03	DRILLING COMPANY	:	JC ANDERSON
NORTHING	:	610902.0900 surveyed	DRILLING RIG	:	MANUAL
EASTING	:	533422.4900 surveyed	DATE STARTED	:	05/10/96
ELEVATION	:	33.190 surveyed	DATE COMPLETED	:	05/10/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
32	1		100	Poorly graded sand with silt, SP-SM	YELLOW/BROWN	NOC	WET		OVM 31.2	NATURAL SOIL AT SURFACE. SS-18C03A(0-0.5') COLLECTED. GW AT 0.5' BGS
31	2		100	Silty sand, SM	YELLOW/BROWN	NOC	SAT		OVM 10.2	TD AT 4'.
30	3									
29	4									
28	5									
27	6									
26	7									
25	8									
24	9									
23	10									

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Borehole Location Data — **Roy F. WESTON, Inc.**

BOREHOLE ID : 18C04 PROJECT NAME: USACOE-RARITAN-18C
BEGIN DATE : 05/10/96 END DATE : 05/10/96

LOGGER/COMPANY : C. CADALSO

BOREHOLE COMPLETED IN (<O>verburden <B>edrock) : O

TOTAL DEPTH : 8.00 DEPTH TO BEDROCK : 0.00

BOREHOLE DIAMETER #1: 6.25
INTERVAL: 0.00 ft. to 6.00 ft. BGS
METHOD : HSA FLUID : NONE
BOREHOLE DIAMETER #2: 3.00
INTERVAL: 6.00 ft. to 8.00 ft. BGS
METHOD : SPLLIT SPOON FLUID : NONE
BOREHOLE DIAMETER #3:
INTERVAL:
METHOD : FLUID :

DRILLING COMPANY : JC ANDERSON
DRILLER : S. BURGER
DRILL RIG TYPE : CME-550 ATV

	ESTIMATED	SURVEYED
SURFACE ELEVATION :	0.000	49.040
N. COORDINATE :	0.0000	610965.3500
E. COORDINATE :	0.0000	533339.2400

WELL PERMIT.....(Y)es (N)o: N PERMIT # :

HOLE ABANDONED...(Y)es (N)o: Y
WELL INSTALLED...(Y)es (N)o: N
WELL CLUSTER.....(Y)es (N)o: N No. OF WELLS : 0
WELL NEST.....(Y)es (N)o: N No. OF WELLS : 0
PUMPS INSTALLED..(Y)es (N)o: N TYPE DEPTH
PURGE : 0.00
SAMPLE : 0.00

BOREHOLE TESTING
BOREHOLE GEOPHYSICS.....(Y)es (N)o: N
SLUG TESTS.....(Y)es (N)o: N
PACKER TESTS.....(Y)es (N)o: N
PUMPING TESTS.....(Y)es (N)o: N

COMMENTS :
BOREHOLE MOVED 12 FT NORTH FROM PROPOSED LOCATION DUE TO LARGE MAGNETIC ANOMALY.

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DATE: 09/25/96 **** Roy F. WESTON, Inc. LITHOLOGICAL DATA FOR - CLIENT ID: 18C *** PAGE: 1

BOREHOLE /WELL ID	SMP NUM	LTH NUM	LITHOLOGY INT. (FT BGS)		SAMPLING METHOD	SIZE GRAVEL	GRAVEL PCT.	SIZE SAND	SAND PCT	SILT PCT	CLAY PCT	ORGANIC PCT	ROCK TYPE	PLAST	SORT	STRENGTH	MOISTURE	STRAT UNIT
18C04	1	1	0.00	2.00	SPS		0	FM	60	25	0	15		NON	POR	NOC	DRY	US
18C04	2	1	2.00	4.00	SPS		0		0	0	0	0						
18C04	3	1	4.00	6.00	SPS		0	FM	60	25	0	15		NON	POR	NOC	MST	US
18C04	4	1	6.00	8.00	SPS	F	10	MC	78	5	7	0		NON	MOD	NOC	SAT	LS

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: USACOE-RARITAN-18C	TOTAL DEPTH	: 8.00
SITE NAME	: RARITAN ARSENAL-AREA 18C	LOGGER	: C. CADALSO
BORING ID	: 18C04	DRILLING COMPANY	: JC ANDERSON
NORTHING	: 610965.3500 surveyed	DRILLING RIG	: CME-550 ATV
EASTING	: 533339.2400 surveyed	DATE STARTED	: 05/10/96
ELEVATION	: 49.040 surveyed	DATE COMPLETED	: 05/10/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
			75	Silty sand, SM	DARK BROWN	NOC	DRY	3 6 8 7	OVM 0.0	FILL, SS-18B04A(0-0.5'), VOC 1.5'-2' COLLECTED.
48	1									
47	2			No Sample Recovered				3 5 4 6		FILL, NO RECOVERY DUE TO LARGE BRICK FRAGMENT.
46	3									
45	4		100	Silty sand, SM	DARK BROWN	NOC	MST	3 6 7 8	OVM 37.2	NATURAL SOIL & GW AT 5.8' BGS, SS-18B04B (5.3'-5.8')COLLECTED.
44	5									
43	6		100	Clayey sand, SC	YELLOW BROWN	NOC	SAT	7 6 3 3	OVM 0.0	TD AT 8'.
42	7									
41	8									
40	9									
39	10									

Borehole Location Data

Roy F. WESTON, Inc.

BOREHOLE ID : 18C05 PROJECT NAME: USACOE-RARITAN-18C
BEGIN DATE : 05/13/96 END DATE : 05/13/96

LOGGER/COMPANY : C. CADALSO

BOREHOLE COMPLETED IN (<O>verburden <B>edrock) : O

TOTAL DEPTH : 4.00 DEPTH TO BEDROCK : 0.00

BOREHOLE DIAMETER #1: 6.25
INTERVAL: 0.00 ft. to 2.00 ft. BGS
METHOD : HSA FLUID : NONE
BOREHOLE DIAMETER #2: 3.00
INTERVAL: 2.00 ft. to 4.00 ft. BGS
METHOD : SPLIT SPOON FLUID : NONE
BOREHOLE DIAMETER #3:
INTERVAL:
METHOD : FLUID :

DRILLING COMPANY : JC ANDERSON
DRILLER : S. BURGER
DRILL RIG TYPE : CME-550 ATV

	ESTIMATED	SURVEYED
SURFACE ELEVATION :	0.000	47.760
N. COORDINATE :	0.0000	610979.3100
E. COORDINATE :	0.0000	533368.8000

WELL PERMIT.....(Y)es (N)o: N PERMIT # :

HOLE ABANDONED...(Y)es (N)o: Y
WELL INSTALLED...(Y)es (N)o: N
WELL CLUSTER.....(Y)es (N)o: N No. OF WELLS : 0
WELL NEST.....(Y)es (N)o: N No. OF WELLS : 0
PUMPS INSTALLED..(Y)es (N)o: N

	TYPE	DEPTH
PURGE :		0.00
SAMPLE :		0.00

BOREHOLE TESTING
BOREHOLE GEOPHYSICS.....(Y)es (N)o: N
SLUG TESTS.....(Y)es (N)o: N
PACKER TESTS.....(Y)es (N)o: N
PUMPING TESTS.....(Y)es (N)o: N

COMMENTS :
BOREHOLE MOVED FROM PROPOSED LOCATION DUE TO MAGNETIC ANOMALIES. THEREFORE, DEEPER SAMPLE COULD NOT BE OBTAINED. REMAINING SAMPLES COLLECTED DURING TEST PIT PROGRAM.

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BOREHOLE /WELL ID	SMP NUM	LTH NUM	LITHOLOGY INT. (FT BGS)		SAMPLING METHOD	SIZE GRAVEL	GRAVEL PCT.	SIZE SAND	SAND PCT	SILT PCT	CLAY PCT	ORGANIC PCT	ROCK TYPE	PLAST	SORT	STRENGTH	MOISTURE	STRAT UNIT
18C05	1	1	0.00	0.50	SPS		0	F	20	60	0	20		NON	MOD	NOC	MST	US
18C05	1	2	0.50	2.00	SPS		0		0	0	0	0						
18C05	2	1	2.00	4.00			0		0	0	0	0						

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	:	USACOE-RARITAN-18C	TOTAL DEPTH	:	4.00
SITE NAME	:	RARITAN ARSENAL-AREA 18C	LOGGER	:	C. CADALSO
BORING ID	:	18C05	DRILLING COMPANY	:	JC ANDERSON
NORTHING	:	610979.3100 surveyed	DRILLING RIG	:	CME-550 ATV
EASTING	:	533368.8000 surveyed	DATE STARTED	:	05/13/96
ELEVATION	:	47.760 surveyed	DATE COMPLETED	:	05/13/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
47	0			Silt with sand, ML	DARK BROWN	NOC	MST	WOH/4	OVM 0.0	FILL. SS-18C05A(0-0.5') COLLECTED. BRICK, WOOD & GLASS NOTED.
				No Sample Recovered						
46	1									
45	2			No Sample Recovered				4 15 18 7		FILL. BRICK FRAGMENTS NOTED. GW/NATURAL SOIL NOT OBSERVED. TD AT 4' BGS.
44	3									
43	4									
42	5									
41	6									
40	7									
39	8									
38	9									
37	10									

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Borehole Location Data

Roy F. WESTON, Inc.

BOREHOLE ID : 18C06 *PROJECT NAME:* USACOE-RARITAN-18C
BEGIN DATE : 05/10/96 *END DATE :* 05/10/96

LOGGER/COMPANY : C. CADALSO

BOREHOLE COMPLETED IN (<O>verburden <B>edrock) : O

TOTAL DEPTH : 4.00 *DEPTH TO BEDROCK :* 0.00

BOREHOLE DIAMETER #1: 6.25
INTERVAL: 0.00 ft. to 2.00 ft. BGS
METHOD : HSA *FLUID :* NONE
BOREHOLE DIAMETER #2: 3.00
INTERVAL: 2.00 ft. to 4.00 ft. BGS
METHOD : SPS *FLUID :* NONE
BOREHOLE DIAMETER #3:
INTERVAL:
METHOD : *FLUID :*

DRILLING COMPANY : JC ANDERSON
DRILLER : S. BURGER
DRILL RIG TYPE : CME-550 ATV

	ESTIMATED	*SURVEYED*
SURFACE ELEVATION :	0.000	44.150
N. COORDINATE :	0.0000	611003.2400
E. COORDINATE :	0.0000	533417.6800

WELL PERMIT.....(Y)es (N)o: N *PERMIT # :*

HOLE ABANDONED...(Y)es (N)o: Y
WELL INSTALLED...(Y)es (N)o: N
WELL CLUSTER.....(Y)es (N)o: N *No. OF WELLS :* 0
WELL NEST.....(Y)es (N)o: N *No. OF WELLS :* 0
PUMPS INSTALLED..(Y)es (N)o: N

	TYPE	*DEPTH*
PURGE :		0.00
SAMPLE :		0.00

BOREHOLE TESTING
BOREHOLE GEOPHYSICS.....(Y)es (N)o: N
SLUG TESTS.....(Y)es (N)o: N
PACKER TESTS.....(Y)es (N)o: N
PUMPING TESTS.....(Y)es (N)o: N

COMMENTS :

DUE TO MAGNETIC ANOMALIES, DEEPER SAMPLES COULD NOT BE OBTAINED. REMAINING SAMPLES COLLECTED DURING TEST PIT PROGRAM.

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DATE: 10/02/96 **** Roy F. WESTON, Inc. LITHOLOGICAL DATA FOR - CLIENT ID: 18C *** PAGE: 1

BOREHOLE /WELL ID	SMP NUM	LTH NUM	LITHOLOGY INT. (FT BGS)		SAMPLING METHOD	SIZE GRAVEL	GRAVEL PCT.	SIZE SAND	SAND PCT	SILT PCT	CLAY PCT	ORGANIC PCT	ROCK TYPE	PLAST	SORT	STRENGTH	MOISTURE	STRAT UNIT
18C06	1	1	0.00	1.00	SPS		0	F	30	30	0	40		NON	MOD	NOC	MST	US
18C06	1	2	1.00	2.00	SPS		0		0	0	0	0						
18C06	1	1	2.00	2.80	SPS		0	M	60	25	0	15		NON	MOD	NOC	WET	US
18C06	1	2	2.80	4.00	SPS		0		0	0	0	0						

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	:	USACOE-RARITAN-18C	TOTAL DEPTH	:	4.00
SITE NAME	:	RARITAN ARSENAL-AREA 18C	LOGGER	:	C. CADALSO
BORING ID	:	18C06	DRILLING COMPANY	:	JC ANDERSON
NORTHING	:	611003.2400 surveyed	DRILLING RIG	:	CME-550 ATV
EASTING	:	533417.6800 surveyed	DATE STARTED	:	05/10/96
ELEVATION	:	44.150 surveyed	DATE COMPLETED	:	05/10/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
			50	Sandy silt, ML	DARK BROWN	NOC	MST	1 1 2	OVM 0.0	FILL. SS-18C06A(0-0.5' & VOC 2'-2.5') COLLECTED. ABUNDANT WOOD NOTED.
43	1			No Sample Recovered						
42	2			Silty sand, SM	DARK BROWN	NOC	WET	2 2 3	OVM 0.0	FILL. ADUNDANT WOOD NOTED. FIRST GW AT 2' BGS. TD AT 2' BGS.
41	3			No Sample Recovered						TD AT 2' BGS.
40	4									
39	5									
38	6									
37	7									
36	8									
35	9									
34	10									

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Borehole Location Data

Roy F. WESTON, Inc.

BOREHOLE ID : 18C07 *PROJECT NAME:* USACOE-RARITAN-18C
BEGIN DATE : 05/13/96 *END DATE :* 05/13/96

LOGGER/COMPANY : C. CADALSO

BOREHOLE COMPLETED IN (<O>verburden <B>edrock) : O

TOTAL DEPTH : 2.00 *DEPTH TO BEDROCK :* 0.00

BOREHOLE DIAMETER #1: 3.00
INTERVAL: 0.00 ft. to 2.00 ft. BGS
METHOD : SPLIT SPOON *FLUID :* NONE
BOREHOLE DIAMETER #2:
INTERVAL:
METHOD : *FLUID :*
BOREHOLE DIAMETER #3:
INTERVAL:
METHOD : *FLUID :*

DRILLING COMPANY : JC ANDERSION
DRILLER : S. BURGER
DRILL RIG TYPE : CME-550 ATV

	ESTIMATED	*SURVEYED*
SURFACE ELEVATION :	0.000	45.450
N. COORDINATE :	0.0000	610943.5300
E. COORDINATE :	0.0000	533388.0000

WELL PERMIT.....(Y)es (N)o: N *PERMIT # :*

HOLE ABANDONED...(Y)es (N)o: Y
WELL INSTALLED...(Y)es (N)o: N
WELL CLUSTER.....(Y)es (N)o: N *No. OF WELLS :* 0
WELL NEST.....(Y)es (N)o: N *No. OF WELLS :* 0
PUMPS INSTALLED..(Y)es (N)o: N

	TYPE	*DEPTH*
PURGE :		0.00
SAMPLE :		0.00

BOREHOLE TESTING
BOREHOLE GEOPHYSICS.....(Y)es (N)o: N
SLUG TESTS.....(Y)es (N)o: N
PACKER TESTS.....(Y)es (N)o: N
PUMPING TESTS.....(Y)es (N)o: N

COMMENTS :

DUE TO MAGNETIC ANOMALIES, DEEPER SAMPLES COULD NOT BE OBTAINED. REMAINING SAMPLES COLLECTED DURING TEST PIT PROGRAM.

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BOREHOLE /WELL ID	SMP NUM	LTH NUM	LITHOLOGY INT. (FT BGS)		SAMPLING METHOD	SIZE GRAVEL	GRAVEL PCT.	SIZE SAND	SAND PCT	SILT PCT	CLAY PCT	ORGANIC PCT	ROCK TYPE	PLAST	SORT	STRENGTH	MOISTURE	STRAT UNIT
18C07	1	1	0.00	1.50	SPS		0	F	25	50	10	15		NON	POR	SFT	MST	US
18C07	2	1	1.50	2.00	SPS		0		0	0	0	0						

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	:	USACOE-RARITAN-18C	TOTAL DEPTH	:	2.00
SITE NAME	:	RARITAN ARSENAL-AREA 18C	LOGGER	:	C. CADALSO
BORING ID	:	18C07	DRILLING COMPANY	:	JC ANDERSION
NORTHING	:	610943.5300 surveyed	DRILLING RIG	:	CME-550 ATV
EASTING	:	533388.0000 surveyed	DATE STARTED	:	05/13/96
ELEVATION	:	45.450 surveyed	DATE COMPLETED	:	05/13/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
45	0		75	Silt with sand, ML	DARK BROWN	SFT	MST	1 3 3 5	OVM 0.0	FILL, SS-1807A(0-0.5' & VOC 1'-1.5') COLLECTED. NATURAL SOIL NOT ENCOUNTERED.
44	1									
			75	No Sample Recovered						TD AT 2' BGS.
43	2									
42	3									
41	4									
40	5									
39	6									
38	7									
37	8									
36	9									
35	10									

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Borehole Location Data

Roy F. WESTON, Inc.

BOREHOLE ID : 18C08 PROJECT NAME: USACOE-RARITAN-18C
BEGIN DATE : 05/13/96 END DATE : 05/13/96

LOGGER/COMPANY : C. CADALSO

BOREHOLE COMPLETED IN (<O>verburden <B>edrock) : O

TOTAL DEPTH : 6.00 DEPTH TO BEDROCK : 0.00

BOREHOLE DIAMETER #1: 6.25
INTERVAL: 0.00 ft. to 4.00 ft. BGS
METHOD : HSA FLUID : NONE
BOREHOLE DIAMETER #2: 5.00
INTERVAL: 4.00 ft. to 6.00 ft. BGS
METHOD : SPLIT SPOON FLUID : NONE
BOREHOLE DIAMETER #3:
INTERVAL:
METHOD : FLUID :

DRILLING COMPANY : JC ANDERSON
DRILLER : S. BURGER
DRILL RIG TYPE : CME-550 ATV

	ESTIMATED	SURVEYED
SURFACE ELEVATION :	0.000	46.630
N. COORDINATE :	0.0000	610962.9300
E. COORDINATE :	0.0000	533370.3500

WELL PERMIT.....(Y)es (N)o: N PERMIT # :

HOLE ABANDONED...(Y)es (N)o: Y
WELL INSTALLED...(Y)es (N)o: N
WELL CLUSTER.....(Y)es (N)o: N No. OF WELLS : 0
WELL NEST.....(Y)es (N)o: N No. OF WELLS : 0
PUMPS INSTALLED..(Y)es (N)o: N

	TYPE	DEPTH
PURGE :		0.00
SAMPLE :		0.00

BOREHOLE TESTING
BOREHOLE GEOPHYSICS.....(Y)es (N)o: N
SLUG TESTS.....(Y)es (N)o: N
PACKER TESTS.....(Y)es (N)o: N
PUMPING TESTS.....(Y)es (N)o: N

COMMENTS :
PROPOSED LOCATION MOVED DUE TO MAGNETIC ANOMALY.

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DATE: 09/25/96 **** Roy F. WESTON, Inc. LITHOLOGICAL DATA FOR - CLIENT ID: 18C *** PAGE: 1

BOREHOLE /WELL ID	SMP NUM	LTH NUM	LITHOLOGY INT. (FT BGS)		SAMPLING METHOD	SIZE GRAVEL	GRAVEL PCT.	SIZE SAND	SAND PCT	SILT PCT	CLAY PCT	ORGANIC PCT	ROCK TYPE	PLAST	SORT	STRENGTH	MOISTURE	STRAT UNIT
18C08	1	1	0.00	2.00	SPS		0	F	5	75	0	20		NON	MOD	NOC	MST	US
18C08	2	1	2.00	3.00	SPS		0	F	55	25	0	20		NON	MOD	NOC	MST	US
18C08	2	2	3.00	4.00	SPS		0		0	0	0	0						
18C08	3	1	4.00	4.70	SPS	M	5	F	20	60	5	10		NON	POR	NOC	MST	US
18C08	3	2	4.70	6.00	SPS		0	M	80	5	10	5		NON	MOD	NOC	SAT	LS

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	:	USACOE-RARITAN-18C	TOTAL DEPTH	:	6.00
SITE NAME	:	RARITAN ARSENAL-AREA 18C	LOGGER	:	C. CADALSO
BORING ID	:	18C08	DRILLING COMPANY	:	JC ANDERSON
NORTHING	:	610962.9300 surveyed	DRILLING RIG	:	CME-550 ATV
EASTING	:	533370.3500 surveyed	DATE STARTED	:	05/13/96
ELEVATION	:	46.630 surveyed	DATE COMPLETED	:	05/13/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
46	0		75	Silt, ML	DK BRWN/RD/BLK	NOC	MST	3 4 8 4	OVM 0.0	FILL. SS-18C08A(0-0.5')& VOC 1.5'-2' COLLECTED. BRICK & WOOD NOTED.
45	1									
44	2		50	Silty sand, SM	DARK BROWN/RED	NOC	MST	3 5 2 4	OVM 0.0	FILL. SS-18C08B(3'-3.5') COLLECTED. BRICK FRAGMENTS & WOOD NOTED.
43	3			No Sample Recovered						
42	4		100	Silt with sand, ML	RED BROWN	NOC	MST	3 5 4 6	OVM 0.0	FILL. GROVEL & WOOD NOTED.
				Clayey sand, SC	TAN	NOC	SAT		OVM 0.0	NATURAL/GW AT 4.7', SS-18C08C (4.2'-4.7') COLLECTED. TD AT 6' BGS.
41	5									
40	6									
39	7									
38	8									
37	9									
36	10									

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Borehole Location Data

Roy F. WESTON, Inc.

BOREHOLE ID : 18C09 *PROJECT NAME:* USACOE-RARITAN-18C
BEGIN DATE : 05/13/96 *END DATE :* 05/13/96

LOGGER/COMPANY : C. CADALSO

BOREHOLE COMPLETED IN (<O>verburden <B>edrock) : O

TOTAL DEPTH : 4.00 *DEPTH TO BEDROCK :* 0.00

BOREHOLE DIAMETER #1: 6.25
INTERVAL: 0.00 ft. to 2.00 ft. BGS
METHOD : HSA *FLUID :* NONE
BOREHOLE DIAMETER #2: 3.00
INTERVAL: 2.00 ft. to 4.00 ft. BGS
METHOD : SPLIT SPOON *FLUID :* NONE
BOREHOLE DIAMETER #3:
INTERVAL:
METHOD : *FLUID :*

DRILLING COMPANY : JC ANDERSON
DRILLER : S. BURGER
DRILL RIG TYPE : CME-550 ATV

	ESTIMATED	*SURVEYED*
SURFACE ELEVATION :	0.000	47.800
N. COORDINATE :	0.0000	610968.2300
E. COORDINATE :	0.0000	533364.4100

WELL PERMIT.....(Y)es (N)o: N *PERMIT # :*

HOLE ABANDONED...(Y)es (N)o: Y
WELL INSTALLED...(Y)es (N)o: N
WELL CLUSTER.....(Y)es (N)o: N *No. OF WELLS :* 0
WELL NEST.....(Y)es (N)o: N *No. OF WELLS :* 0
PUMPS INSTALLED..(Y)es (N)o: N

	TYPE	*DEPTH*
PURGE :		0.00
SAMPLE :		0.00

BOREHOLE TESTING
BOREHOLE GEOPHYSICS.....(Y)es (N)o: N
SLUG TESTS.....(Y)es (N)o: N
PACKER TESTS.....(Y)es (N)o: N
PUMPING TESTS.....(Y)es (N)o: N

COMMENTS :
PROPOSED LOCATION MOVED & BORING NOT SAMPLED TO DEPTH DUE TO MAGNETIC ANOMALIES. REMAINING SAMPLES COLLECTED DURING TEST PIT PROGRAM.

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DATE: 09/25/96 **** Roy F. WESTON, Inc. LITHOLOGICAL DATA FOR - CLIENT ID: 18C *** PAGE: 1

BOREHOLE /WELL ID	SMP NUM	LTH NUM	LITHOLOGY INT. (FT BGS)		SAMPLING METHOD	SIZE GRAVEL	GRAVEL PCT.	SIZE SAND	SAND PCT	SILT PCT	CLAY PCT	ORGANIC PCT	ROCK TYPE	PLAST	SORT	STRENGTH	MOISTURE	STRAT UNIT
18C09	1	1	0.00	0.50	SPS		0	FM	30	45	0	25		NON	POR	NOC	MST	US
18C09	1	2	0.50	2.00	SPS		0		0	0	0	0						
18C09	2	1	2.00	3.40	SPS		0	FM	30	45	0	25		NON	POR	NOC	MST	US
18C09	2	2	3.40	4.00	SPS		0	M	80	5	10	5		NON	MOD	NOC	SAT	LS

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	:	USACOE-RARITAN-18C	TOTAL DEPTH	:	4.00
SITE NAME	:	RARITAN ARSENAL-AREA 18C	LOGGER	:	C. CADALSO
BORING ID	:	18C09	DRILLING COMPANY	:	JC ANDERSON
NORTHING	:	610968.2300 surveyed	DRILLING RIG	:	CME-550 ATV
EASTING	:	533364.4100 surveyed	DATE STARTED	:	05/13/96
ELEVATION	:	47.800 surveyed	DATE COMPLETED	:	05/13/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
			25	Sandy silt, ML	DARK BROWN	NOC	MST	6-5-5-7	OVM 0.0	FILL. COLLECT SS-18C09A (0-0.5') & VOC 1.5'-2'. AUGERED TO 1.5'. BRICK & WOOD NOTED IN CUTTINGS.
46	1			No Sample Recovered						
45	2		100	Sandy silt, ML	DARK BROWN	NOC	MST	4-4-5-6	OVM 0.0	NATURAL/GW AT 3.4', SS-18C09B(2.9'-3.4') COLLECTED.
44	3									
				Clayey sand, SC	TAN	NOC	SAT		OVM 0.0	TD AT 4' BGS.
43	4									
42	5									
41	6									
40	7									
39	8									
38	9									
37	10									

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Borehole Location Data — *Roy F. WESTON, Inc.*

BOREHOLE ID : 18C10 *PROJECT NAME:* USACOE-RARITAN-18C
BEGIN DATE : 05/13/96 *END DATE :* 05/13/96

LOGGER/COMPANY : C. CADALSO

BOREHOLE COMPLETED IN (<O>verburden <B>edrock) : O

TOTAL DEPTH : 2.00 *DEPTH TO BEDROCK :* 0.00

BOREHOLE DIAMETER #1: 3.00
INTERVAL: 0.00 ft. to 2.00 ft. BGS
METHOD : SPLIT SPOON *FLUID :* NONE
BOREHOLE DIAMETER #2:
INTERVAL:
METHOD : *FLUID :*
BOREHOLE DIAMETER #3:
INTERVAL:
METHOD : *FLUID :*

DRILLING COMPANY : JC ANDERSON
DRILLER : S. BURGER
DRILL RIG TYPE : CME-550 ATV

	ESTIMATED	*SURVEYED*
SURFACE ELEVATION :	0.000	46.490
N. COORDINATE :	0.0000	610939.7100
E. COORDINATE :	0.0000	533370.7500

WELL PERMIT.....(Y)es (N)o: N *PERMIT # :*

HOLE ABANDONED...(Y)es (N)o: Y
WELL INSTALLED...(Y)es (N)o: N
WELL CLUSTER.....(Y)es (N)o: N *No. OF WELLS :* 0
WELL NEST.....(Y)es (N)o: N *No. OF WELLS :* 0
PUMPS INSTALLED..(Y)es (N)o: N

	TYPE	*DEPTH*
PURGE :		0.00
SAMPLE :		0.00

BOREHOLE TESTING
BOREHOLE GEOPHYSICS.....(Y)es (N)o: N
SLUG TESTS.....(Y)es (N)o: N
PACKER TESTS.....(Y)es (N)o: N
PUMPING TESTS.....(Y)es (N)o: N

COMMENTS :

BOREHOLE ABANDONED DUE TO MAGNETIC ANOMALY AT 2' BGS. THEREFORE, DEEPER SAMPLE WAS NOT OBTAINED. REMAINING SAMPLES COLLECTED DURING TEST PIT PROGRAM.

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DATE: 09/25/96 **** Roy F. WESTON, Inc. LITHOLOGICAL DATA FOR - CLIENT ID: 18C *** PAGE: 1

BOREHOLE /WELL ID	SMP NUM	LTH NUM	LITHOLOGY INT. (FT BGS)		SAMPLING METHOD	SIZE GRAVEL	GRAVEL PCT.	SIZE SAND	SAND PCT	SILT PCT	CLAY PCT	ORGANIC PCT	ROCK TYPE	PLAST	SORT	STRENGTH	MOISTURE	STRAT UNIT
18C10	1	1	0.00	0.50	SPS		0	F	25	60	0	15		NON	MOD	NOC	MST	US
18C10	1	2	0.50	2.00	SPS		0		0	0	0	0						

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: USACOE-RARITAN-18C	TOTAL DEPTH	: 2.00
SITE NAME	: RARITAN ARSENAL-AREA 18C	LOGGER	: C. CADALSO
BORING ID	: 18C10	DRILLING COMPANY	: JC ANDERSON
NORTHING	: 610939.7100 surveyed	DRILLING RIG	: CME-550 ATV
EASTING	: 533370.7500 surveyed	DATE STARTED	: 05/13/96
ELEVATION	: 46.490 surveyed	DATE COMPLETED	: 05/13/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
			25	Silt with sand, ML	DARK BROWN	NOC	MST	2 6 9 10	OVM 0.0	FILL. SS-18C10A(0-0.5')& VOC 1.5'-2' COLLECTED. AUGERED TO 1.5' BGS & COLLECTED VOC SAMPLE. GW/NATURAL NOT OBSERVED. MAGNETIC ANOMALY NOTED. TD AT 2' BGS.
				No Sample Recovered						
45	1									
44	2									
43	3									
42	4									
41	5									
40	6									
39	7									
38	8									
37	9									
36	10									

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Attachment E
Test Pit Logs

TEST PIT CLASSIFICATION LOG

PROJECT NAME Raritan Arsenal TEST PIT NO. TP-18C05-1 DATE 6/17/96

PROJECT NUMBER 03886-082-014-0002-00 GROUND SURFACE ELEV. 36.765 - 38.532

FIELD ENG./GEO. Mark Ellis

LOCATION Area 18C

EQUIPMENT USED John Deer 490E Trackhoe

PIT DIMENSIONS 11' (LENGTH) X 6' (WIDTH) X 8.5' (DEPTH)

GROUNDWATER LEVEL DATA		
DATE	ACTUAL TIME	DEPTH
	–	
	NOT ENCOUNTERED	x

DEPTH (FT)	DESCRIPTION	U.S.C.S. SYMBOL	REMARKS
0 - 7	Fill - Brown-Tan medium-fine Sand, some medium-fine gravel; moist. Fill consists of construction debris including: wood, bricks scrap metal, large sections of brick wall, and metal piping. [US] Note: Pipes were identified as 10 ft long building support columns.	SP	OVM = 0 Collected Sample TP-18C05-1B (6.0'-6.5' BGS) within fill.
7 - 8	Red-Brown medium-fine Sand & gravel, little silt, trace clay; moist grading to wet. [US] Note: Due to collapsing sidewalls, unable to excavate further to confirm groundwater, which is estimated at 8'-8.5 BGS. Total Depth at 8 feet BGS NOTE: Shallow sample collected from soil boring on 5/13/96 (See soil boring log for TP-18C05) test pit location moved 40 feet to northeast from soil boring TP-18C05 in order to provide better coverage of suspected asbestos land fill.	SP	OVM = 0 Collected Sample TP-18C05-1C (7.5'-8.0' BGS) Approximately 0'-0.5' above Groundwater. Groundwater and natural soil not observed.

TEST PIT CLASSIFICATION LOG

PROJECT NAME Raritan Arsenal TEST PIT NO. TP-18C06 DATE 6/17/96

PROJECT NUMBER 03886-082-014-0002-00 GROUND SURFACE ELEV. 36.765 - 38.532

FIELD ENG./GEO. Mark Ellis

LOCATION Area 18C

EQUIPMENT USED Case 580 Backhoe

PIT DIMENSIONS 10' (LENGTH) X 5' (WIDTH) X 10' (DEPTH)

GROUNDWATER LEVEL DATA		
DATE	ACTUAL TIME	DEPTH
6/17/96	1400	9.0
NOT ENCOUNTERED		

DEPTH (FT)	DESCRIPTION	U.S.C.S. SYMBOL	REMARKS
0 - 5.0	Fill - Dark Brown fine-medium Sand, trace fine gravel and silt; moist. Construction debris including: wood, brick, black suspect asbestos containing material and concrete fragments noted. [US]		OVM = 0 Collected Sample TP-18C06B (4.0'-4.5' BGS) within fill material.
5 - 9	Natural - Red-Brown fine-medium Sand, some fine round gravel, little silt, trace clay; dry. [LS]	SP	OVM = 0 Natural soil at 5.0' BGS Collected Sample TP-18C06C (8.5'-9.0' BGS) 0.0'-0.5' above Groundwater.
9 - 10	Tan-Gray medium-coarse Sand; wet.	SW	OVM = 0 Groundwater at 9.0' BGS
	Total Depth at 10.0 feet BGS		
	NOTE: Shallow soil sample collected from soil boring TP-18C06 on 5/10/96 (see soil boring for TP-18C06).		

TEST PIT CLASSIFICATION LOG

PROJECT NAME Raritan Arsenal TEST PIT NO. TP-18C07 DATE 6/17/96

PROJECT NUMBER 03886-082-014-0002-00 GROUND SURFACE ELEV. 45.450

FIELD ENG./GEO. Mark Ellis

LOCATION Area 18C

EQUIPMENT USED John Deer 490E Track Hoe

PIT DIMENSIONS 10' (LENGTH) X 4' (WIDTH) X 9.5' (DEPTH)

GROUNDWATER LEVEL DATA		
DATE	ACTUAL TIME	DEPTH
6/17/96	1000	8.5
	NOT ENCOUNTERED	

DEPTH (FT)	DESCRIPTION	U.S.C.S. SYMBOL	REMARKS
0 - 1	Fill - Dark Brown medium-fine Sand, little fine-medium gravel; moist. Construction debris including wood, brick, and concrete fragments noted. [US]	SP	OVM = 0
1 - 4.5	Dark Brown medium-fine Sand, little fine-medium gravel; moist. Construction debris including wood, bricks, concrete fragments, black roofing material with possible suspect asbestos containing material, and 1" diameter metal pipe noted. [US]	SP	OVM = 0
4.5 - 8.0	Fill - Dark Brown medium-fine Sand, little fine-medium gravel; moist. Construction debris including: abundant small wood chips, brick, and black tar-like material suspect asbestos containing material noted. [US]		OVM = 0 Collected Sample TP-18C07B (5.0'-5.5' BGS) within fill.
8.0 - 9.5	Natural - Brown fine Sand, some silt, little clay; moist grading to wet. [LS]	SP	OVM = 0 Natural soil @ 8.0' BGS Collected Sample TP-18C07C (8.0'-8.5' BGS) 0'-0.5' below fill and 0'-0.5' above groundwater. Groundwater @ 8.5' BGS.
	Total Depth at 9.5 feet BGS NOTE: Shallow soil sample collected from soil boring on 5/13/96 (see soil boring log for TP-18C07).		

TEST PIT CLASSIFICATION LOG

PROJECT NAME Raritan Arsenal TEST PIT NO. 18C09-1 DATE 6/18/96

PROJECT NUMBER 03886-082-014-0002-00 GROUND SURFACE ELEV. 46.367

FIELD ENG./GEO. Paul James

LOCATION Area 18C

EQUIPMENT USED John Deer 490E Trackhoe

PIT DIMENSIONS 12' (LENGTH) X 9' (WIDTH) X 11' (DEPTH)

GROUNDWATER LEVEL DATA		
DATE	ACTUAL TIME	DEPTH
6/18/96	0815	10.0'
NOT ENCOUNTERED		

DEPTH (FT)	DESCRIPTION	U.S.C.S. SYMBOL	REMARKS
0 - 9.5	Fill - Brown medium-fine-course Sand, some fine-medium gravel, little silt & clay; moist. Construction debris including brick; concrete fragments, concrete slabs, miscellaneous metal, wood, chain link fence, and sections of rebar noted. [US]	SP	OVM = 0
9.5 - 11	Natural - Tan Orange fine Sand, some silt and clay, little fine-medium-coarse round gravel; moist grading to wet. [LS]	SP	OVM = 0 Collected Sample TP-18C09-1C (9.5'-10.0' BGS) 0'-0.5' below fill and 0'-0.5' above groundwater. Groundwater @ 10.0' BGS
	Total Depth at 11.0 feet BGS		
	NOTE: Shallow soil samples collected from soil boring on 5/13/96 (see boring log for TP-18C09). Test pit location moved (40 feet east) from soil boring in order to provide better coverage of suspected asbestos landfill.		

TEST PIT CLASSIFICATION LOG

PROJECT NAME Raritan Arsenal TEST PIT NO. TP-18C10 DATE 6/17/96

PROJECT NUMBER 03886-082-014-0002-00 GROUND SURFACE ELEV. 46.490

FIELD ENG./GEO. Mark Ellis

LOCATION Area 18C

EQUIPMENT USED John Deer 490E Track Hoe

PIT DIMENSIONS 10' (LENGTH) X 5.5' (WIDTH) X 9' (DEPTH)

GROUNDWATER LEVEL DATA		
DATE	ACTUAL TIME	DEPTH
6/17/96	1100	8.5
	NOT ENCOUNTERED	

DEPTH (FT)	DESCRIPTION	U.S.C.S. SYMBOL	REMARKS
0 - 7.0	Fill - Brown fine-medium sand, little silt, trace clay and fine gravel; moist. Construction debris including wood, black suspect asbestos containing material, brick, concrete and scrap metal noted. Note: A large brick structure appears to be remnant of a chimney or stack noted at 2.5'-5.5' BGS.	SP	OVM = 0 Collected Sample TP-18C10B (5.0'-5.5' BGS) within fill.
7 - 8.5	Natural - Orange Tan-Gray medium-fine Sand, some clay; moist.		OVM = 0 Natural soil at 7.0' BGS Collected Sample TP-18C10C (8.0'-8.5' BGS) 1.0'-1.5' below fill
	Total Depth at 8.5 feet BGS.		Groundwater not encountered.
	NOTE: Shallow soil sample collected from soil boring on 5/13/96 (see boring log for TP-18C10)		

Appendix D

December 2011 Letter from New York District USACE PM

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA, ROOM 1811
NEW YORK, N.Y. 10278-0090
21 December 2011

REPLY TO
ATTENTION OF
Programs and Project Management Division

Mr. Jay P. Elliot, Director of Health and Human Services
Edison Division of Health & Human Services
100 Municipal Boulevard
Edison, NJ 08817

SUBJECT: Special language for Township of Edison's construction permit
Unexploded Ordnance (UXO) construction awareness
Former Raritan Arsenal FUDS site
Edison, Middlesex County, New Jersey

Dear Mr. Elliot,

The New Jersey Department of Environmental Protection (NJDEP) recently raised concerns regarding the recent munitions findings at 30 Clearview Road (Area 15), part of the former Raritan Arsenal Formerly Used Defense Site (FUDS). In an effort to address NJDEP concerns, the US Army Corps of Engineers (responsible for administration and execution of the FUDS program) intends to implement a process of periodic notification to all landowners within the boundary of the former Raritan Arsenal. Following the recent munitions finding at 30 Clearview Avenue, we intend to generate a mass mailing distribution to landowners within the boundaries of the former Raritan Arsenal informing them that the property is located within the boundaries of the former Raritan Arsenal FUDS, and encouraging property owners to consider arranging for unexploded ordnance construction support during any earthmoving, land-clearing or in-water construction.

In response to your request for draft language for possible inclusion in Township of Edison construction permits as appropriate, we offer the enclosed language. In addition, we recommend that the Township implement a process of notification to construction permit applicants, as appropriate. The process of notification upon permit application is a mechanism to ensure awareness of property status by those in need of it without dependence on the individual knowledge or memory. It provides an additional safeguard for those future workmen, owners, and developers who may not have the benefit of familiarity with the local history.

If you have any questions or need additional information, please do not hesitate to contact me at (917) 790-8487.

Sincerely,



Sandra L. Piettro
Project Manager
Former Raritan Arsenal

Encls.

cc: USACE / Ms. Dorothy Richards
USACE / Ms. Betina Johnson
USACE / Ms. Ashley Roeske
USACE / Mr. James Kelly
USACE / Ms. Barbara Hebel
USACE / Mr. Gregory Goepfert
USACE / Mr. Allen Roos
NJDEP / Mr. Anthony Cinque

Construction Permit Application

Special Condition

Site History:

The former Raritan Arsenal (FRA) occupied approximately 3,200 acres and was bounded by Woodbridge Avenue and the Raritan River between Mill Road and Clearview Avenue in Edison, New Jersey. It was about 20 miles southwest of New York City. The arsenal operated from 1917 to 1963. During this time the operations at FRA included the receipt, storage, and maintenance of military munitions shipped from other facilities, or returned from overseas; the renovation of military munitions designated for long term storage; the salvage of outmoded or seriously deteriorated munitions; munitions research and development; and shipment and receipt of chemical weapons. During this period, waste materials, including military munitions (including chemical warfare materiel) were routinely buried in the ground.

Definition of residual unexploded ordnance (UXO) is military munitions that:

- have been primed, fused, armed, or otherwise prepared for action;
- have been fired, dropped, launched, projected or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material; and
- remain unexploded either by malfunction, design, or any other cause.

Prior to its transfer, the Letterkenny Army Depot cleaned the site to the standards acceptable during that time period. Some areas were so contaminated, however, that they were fenced, and it was recommended that their use be restricted. The northern portion of the site is currently occupied by Middlesex County College, Thomas Edison Park, U.S. Environmental Protection Agency, and Raritan Center. The southern portion of the site has not been developed since the arsenal closed. However, it is still important for property owners to be aware of the former Raritan Arsenal military history, as there is still always the possibility of encountering residual unexploded ordnance (UXO) from the site's past. Please refer to the Raritan Arsenal website for more information: www.nan.usace.army.mil/business/buslinks/raritan/index.htm

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Requirement: Prior to beginning any earthmoving, land clearing, or in-water construction work authorized by this permit, the permittee shall arrange for Unexploded Ordnance (UXO) construction support.

UXO contractors can be found on www.naoc.org. However, the Government does not recommend, nor guarantee the performance of any particular contractor. UXO Construction support will include the following:

- Presence of a UXO construction support safety specialist on site during any earthmoving, land clearing, or in-water construction work to identify any potential UXO found. (Refer to Engineer Pamphlet 75-1-2, dated August 2004 for personnel qualifications: http://140.194.76.129/publications/eng-pamphlets/ep75-1-2/toc.htm)
- UXO construction support will also include UXO awareness safety training of construction site personnel.

Permittee shall provide the name of the UXO support contractor to the Township of Edison's Building Official and Director of Health and Human Services and the US Army Corps of Engineers (USACE). Permittee shall coordinate with USACE with their munitions findings (providing GPS coordinates, photographic evidence, and general description of the munition or munition debris found).

In the event that an object resembling military munitions is discovered during construction activities, do not touch, move or disturb it, but immediately and carefully – do not run – leave the area following the same path on which you entered. UXO construction support personnel should stop work in the immediate vicinity of the discovery and immediately contact the local law enforcement – call 911. The local law enforcement personnel will investigate the item. Should a suspect discovery be confirmed to contain an explosive hazard, local law enforcement will remove or destroy the item, during which time UXO construction support contractor personnel will be required to maintain a safe distance from the item as specified by the local law enforcement personnel.

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Information: US Army Corps of Engineers (USACE) does not provide this service (Unexploded Ordnance (UXO) construction support) to private entities performing work on their properties (Refer to Engineer Regulation 1110-1-8153, dated June 2010, paragraph 6 (c)(3) available at the following website: http://140.194.76.129/publications/eng-regs/er1110-1-8153/toc.html). It is also important to note that the Formerly Used Defense Site (FUDS) program regulation does not allow for reimbursement to private landowners for the costs related to contracting for UXO construction support. Furthermore, the Government shall not be responsible for any damage/injury to person or property resulting from an encounter with UXO at their property. Permittee proceeds with the work authorized by this permit at its own risk.

Safety is a top priority for the Department of Defense and the Township of Edison. To protect themselves, property owners on the former Raritan Arsenal should learn and follow the 3Rs of Explosives Safety. The 3Rs of explosives safety:

- Recognize–when you may have encountered a munition and the potential danger;
- Retreat–do not touch, move or disturb it;
- Report–notify local law enforcement of what you saw and where you saw it.

For more information on the 3R of Explosives Safety visit the UXO Safety Education Website at: https://www.denix.osd.mil/uxosafety

Munitions are dangerous and may not be easily recognizable. Never touch, move or disturb a munitions or suspect munitions.

USACE Point of Contact for the former Raritan Arsenal site is:
Sandra L. Piettro
Project Manager, U.S. Army Corps of Engineers – New York District
Telephone: 917-790-8487

Appendix E

Available Soil and Sediment Data (CD Only)

Appendix F

Photo-Documentation Report

APPENDIX F

PHOTO-DOCUMENTATION REPORT
EPA/GSA Property Area
(Area 1, Area 18A, Area 18B, Area 18C, Area 18D, Area 18E, Area 18F, and Area 18G)
Former Raritan Arsenal

1. INTRODUCTION

Avatar Environmental, LLC (Avatar), under contract to the United States Army Corps of Engineers (USACE) – New England District (CENAE), conducted a photo-documentation of the soil and sediment sample locations at the U.S. Environmental Protection Agency/General Services Administration Property Area, referred to as the EPA/GSA, with elevated levels of polycyclic aromatic hydrocarbons (PAHs). The photo-documentation summary presented herein addresses these sample locations and demonstrates the potential contribution of parking lots, asphalt, vehicular traffic, and other non-Department of Defense (DoD) related sources of PAH levels observed at the former Raritan Arsenal.

2. AREA OF FOCUS

The former Raritan Arsenal ceased DOD operations in 1963 with numerous parcels of land being sold to various public and private entities shortly thereafter. After property transfer, the new property owners extensively developed the area. Development activities at the EPA/GSA Area included the construction of new buildings, roads, parking lots, and railroad tracks, all of which have likely introduced PAHs to the former Raritan Arsenal.

The former Raritan Arsenal is a Formerly Used Defense Site (FUDS) and is regulated under the Comprehensive Environmental Compensation and Liability Act (CERCLA). Since it is a FUDS, the DoD is not liable for any contamination that is present due to non-DoD activities such as site development activities. As such, it is important to get a clear understanding of the likely sources of the PAHs.

Sampling activities dating back to the 1980s and 1990s have shown levels of PAHs that exceed EPA risk-based screening criteria. The current Remedial Investigations (RIs) and risk assessments have evaluated the PAHs and have spatially presented the sample locations with elevated PAHs.

3. PHOTO-DOCUMENTATION PROCESS

The sample locations with PAH concentrations that exceed EPA's screening criteria in the EPA/GSA Ares are listed in Table 3-1 and include 151 samples in Area 1, Area 18A, Area 18B, Area 18C, Area 18D, Area 18E, Area 18F, and Area 18G. Figure 3-1 spatially presents the

locations of the PAH exceedances for the EPA/GSA Area. Soil data collected from the Asbestos Landfill located within Area 18C were not considered in this report as the source of the contamination (asbestos and non-asbestos) is not from DoD activities. The Asbestos Landfill is a result of GSA-directed demolition conducted in the late 1970s and early 1980s.

On August 20, 2013, Avatar personnel used sample location global positioning coordinates to navigate to each historic sample location, or clustered group of samples when appropriate. Upon arrival at a sampling location, the approximate sample point was flagged and a white-board was used to display the sample location ID(s) collected from the area for the photograph. In most cases, the photograph was not a close-up of a specific spot on the ground but rather a shot of the sampling area in relation to the surrounding landscape and potential sources of PAHs, such as walkways, streets, parking lots, railways (active and inactive), etc. Each photograph was accompanied by a brief description on the Photo-Documentation Form for each sample ID listed in Table 3-1. These descriptions and photographs can be seen in Attachment A. When appropriate, multiple sampling locations were included in the photographs.

4. PAH TRANSPORT/DEPOSITION AND PHOTO-DOCUMENTATION RESULTS

In general, PAHs in soil often are the result of atmospheric deposition from both local and long range transport. The presence of PAHs in the soil of regions remote from any industrial activity supports this contention (ATSDR, 1995). New Jersey Department of Environmental Protection (NJDEP) guidance recognizes that PAHs may be attributable to diffuse anthropogenic pollution (DAP), i.e., contaminants that have been broadly distributed, often arising from multiple sources of human activities. DAP generally arise from atmospheric deposition, but may also contain contributions from random, non-point sources that are not attributed to any discharge at the site. DAP contaminants typically include PAHs, which may be present above health-based soil remediation standards. The principal sources of PAHs in soil along highways and roads are vehicular exhausts and emissions from wearing of tires and asphalt.

In addition to the atmospheric deposition discussed above, other anthropogenic sources of PAHs not attributable to former site activities include: surface water runoff from asphalt pavement and

coal-tar based sealed pavement, leaching of PAHs, and analysis of samples with pieces of asphalt or road base material inadvertently included in the sample. Research has shown that coal-tar sealed pavements, which is a common practice in the Northeast U.S., can result in elevated soil PAH concentrations in adjacent soils (Mahler et al., 2012). While USACE has not researched the use of coal-tar-based sealcoat at the EPA/GSA Area or elsewhere at the former Raritan Arsenal, the research of Mahler et al., (2012) indicates that detected PAH concentrations are within the range typically found near paved surfaces and should be considered when making decisions at the former Raritan Arsenal with respect to PAHs.

Road base material and construction fill used prior to pouring concrete commonly includes asphalt millings, which contain approximately 5 to 7% asphalt, and is used as a binder for the quarry materials (stone, rock, sand, silt) that make up the load-bearing portion of the bituminous concrete surface. The base material may be difficult to distinguish from surface soil and inadvertently sampled. The source material for historical fill and construction activities in the EPA/GSA Area are not definitively known and could be a contributor to PAH levels in soil and sediment samples.

As can be seen in the photos included in Attachment A, many of the sample locations with PAHs that exceed screening criteria were collected near paved area or railroad tracks. In some cases, the original sample location has been redeveloped or reworked/landscaped. PAHs detected in historic EPA/GSA Area soil samples are believed to be attributed to anthropogenic sources of PAHs rather than historical site activities.

5. REFERENCES

Agency for Toxic Substance and Disease Registry (ATSDR). 1995. *Toxicological Profile for Polycyclic Aromatic Hydrocarbons*. U.S. Department of Health and Human Services.

Mahler, B. J., Van Metre, P. C., Crane, J. L., Watts, A. W., Scoggins, M., and Williams, E. S. 2012. *Coal-Tar-Based Pavement Sealcoat and PAHs: Implications for the Environment, Human Health, and Stormwater Management*. Environmental Science and Technology. 2012, 46, 3039-3045.

Table

Table 3-1
Summary of PAH Sample Locations Exceeding Screening Criteria
Photo-Documentation Task - EPA/GSA Area
Former Raritan Arsenal

Investigation Area	Sample Type	Sample ID	Sample Date
Area 18A	Soil Sample	SS-18A18A	5/5/1994
Area 18A	Soil Sample	SS-18A13A	5/5/1994
Area 18A	Soil Sample	SS-18A08A	5/4/1994
Area 18A	Soil Sample	SS-18A17A	5/4/1994
Area 18A	Soil Sample	SS-18A07A	5/4/1994
Area 18A	Soil Sample	SS-18A12A	5/3/1994
Area 18A	Soil Sample	SS-18A24A	5/3/1994
Area 18A	Soil Sample	SS-18A26A	5/3/1994
Area 18A	Soil Sample	SS-18A10A	5/2/1994
Area 18A	Soil Sample	SS-18A05A	5/2/1994
Area 18A	Soil Sample	SS-18A16A	4/15/1994
Area 18A	Soil Sample	SS-18A03A	4/14/1994
Area 18A	Soil Sample	SS-18A02A	4/14/1994
Area 18A	Soil Sample	SS-18A04A	4/14/1994
Area 18A	Soil Sample	SS-18A01A	4/14/1994
Area 18A	Soil Sample	SS-18A01Y	4/25/1996
Area 18A	Soil Sample	SS-18A30A	4/25/1996
Area 18A	Soil Sample	SS-18A31A	4/25/1996
Area 18A	Soil Sample	SS-18A32A	4/25/1996
Area 18A	Soil Sample	SS-18A33A	4/25/1996
Area 18A	Soil Sample	SS-18A33B	4/25/1996
Area 18B	Soil Sample	SS18B81	7/19/2005
Area 18B	Soil Sample	SS-18B05B	5/14/1996
Area 18B	Soil Sample	SS-18B05C	5/14/1996
Area 18B	Soil Sample	SS-18B05A	5/9/1996
Area 18B	Soil Sample	SS-18B17A	5/9/1996
Area 18B	Soil Sample	SS-18B17B	5/9/1996
Area 18B	Soil Sample	SS-18B10A	5/8/1996
Area 18B	Soil Sample	SS-18B11A	5/8/1996
Area 18B	Soil Sample	SS-18B13A	5/8/1996
Area 18B	Soil Sample	SS-18B15A	5/8/1996
Area 18B	Soil Sample	SS-18B06A	5/7/1996
Area 18B	Soil Sample	SS-18B06B	5/7/1996
Area 18B	Soil Sample	SS-18B07A	5/7/1996
Area 18B	Soil Sample	SS-18B08A	5/7/1996
Area 18B	Soil Sample	SS-18B12A	5/7/1996
Area 18B	Soil Sample	SS-18B01A	5/6/1996
Area 18B	Soil Sample	SS-18B01C	5/6/1996
Area 18B	Soil Sample	SS-18B02A	5/6/1996
Area 18B	Soil Sample	SS-18B09A	5/6/1996
Area 18B	Soil Sample	SS-18B09C	5/6/1996
Area 18B	Sediment	SD-1803	8/2/1994
Area 18B	Sediment	SD-1804	8/2/1994
Area 18B	Sediment	SD-1805	8/2/1994
Area 18B	Sediment	SD-1806	8/2/1994
Area 18B	Sediment	SD-1809	8/2/1994
Area 18B	Sediment	SD-1818	8/2/1994
Area 18C	Soil Sample	SS-18C35A	7/18/1996
Area 18C	Soil Sample	SS-18C38A	7/18/1996
Area 18C	Soil Sample	SS-18C38B	7/18/1996
Area 18C	Soil Sample	SS-18C40A	7/17/1996
Area 18C	Soil Sample	SS-18C41A	7/17/1996
Area 18C	Soil Sample	SS-18C37A	7/16/1996
Area 18C	Test Pit	TP-18C69B	7/11/1996
Area 18C	Test Pit	TP-18C75A	7/11/1996
Area 18C	Test Pit	TP-18C153B	7/11/1996
Area 18C	Test Pit	TP-18C75B	7/11/1996
Area 18C	Test Pit	TP-18C73A	7/10/1996
Area 18C	Test Pit	TP-18C73B	7/10/1996
Area 18C	Test Pit	TP-18C151A	7/9/1996
Area 18C	Test Pit	TP-18C71A	7/9/1996
Area 18C	Test Pit	TP-18C72A	7/9/1996
Area 18C	Test Pit	TP-18C65A	7/8/1996
Area 18C	Test Pit	TP-18C70A	7/8/1996
Area 18C	Test Pit	TP-18C70B	7/8/1996
Area 18C	Test Pit	TP-18C57A	7/3/1996
Area 18C	Test Pit	TP-18C66A	7/3/1996
Area 18C	Test Pit	TP-18C55A	7/2/1996
Area 18C	Test Pit	TP-18C55C	7/2/1996
Area 18C	Test Pit	TP-18C56A	7/2/1996
Area 18C	Test Pit	TP-18C56C	7/2/1996
Area 18C	Test Pit	TP-18C62A	7/1/1996
Area 18C	Soil Sample	SS-18C11A	5/14/1996
Area 18C	Soil Sample	SS-18C12A	5/14/1996
Area 18C	Soil Sample	SS-18C12B	5/14/1996
Area 18C	Soil Sample	SS-18C46A	5/14/1996
Area 18C	Sediment	SD-1812	8/1/1994
Area 18C	Sediment	SD-1815	8/1/1994
Area 18C	Sediment	SD-1810	8/1/1994
Area 18C	Sediment	SD-1811	8/1/1994
Area 18C	Sediment	SD-1813	8/1/1994
Area 18C	Soil Sample	SS-18C19A	5/2/1996

Table 3-1
Summary of PAH Sample Locations Exceeding Screening Criteria
Photo-Documentation Task - EPA/GSA Area
Former Raritan Arsenal

Investigation Area	Sample Type	Sample ID	Sample Date
Area 18C	Soil Sample	SS-18C19B	5/2/1996
Area 18C	Soil Sample	SS-18C20A	5/2/1996
Area 18C	Soil Sample	SS-18C44A	5/2/1996
Area 18C	Soil Sample	SS-18C21A	5/2/1996
Area 18C	Soil Sample	SS-18C22A	5/2/1996
Area 18C	Remediation Floor Excavation	SA-18C-01	11/4/1997
Area 18C	Remediation Wall Excavation	PE-18C221A	11/15/2002
Area 18C	Remediation Wall Excavation	PE-18C223A	11/15/2002
Area 18C	Remediation Wall Excavation	PE-18C402A	3/25/1998
Area 18C	Remediation Wall Excavation	PE-18C403A	3/25/1998
Area 18C	Remediation Wall Excavation	PE-18C404A	3/25/1998
Area 18D	Soil Sample	SS18D24	7/19/2005
Area 18D	Soil Sample	SS18D23	7/19/2005
Area 18D	Soil Sample	SS-18D22A	8/26/1999
Area 18D	Soil Sample	SS-18D22B	8/26/1999
Area 18D	Soil Sample	SS-18D21A	8/26/1999
Area 18D	Soil Sample	SS-18D21B	8/26/1999
Area 18D	Test Pit	TP-18D02A	6/7/1996
Area 18D	Test Pit	TP-18D04A	6/7/1996
Area 18D	Test Pit	TP-18D06A	6/7/1996
Area 18D	Test Pit	TP-18D06B	6/7/1996
Area 18D	Test Pit	TP-18D06C	6/7/1996
Area 18D	Test Pit	TP-18D10A	6/7/1996
Area 18D	Soil Sample	SS-18D01A	5/31/1996
Area 18D	Soil Sample	SS-18D01B	5/31/1996
Area 18D	Soil Sample	SS-18D01C	5/31/1996
Area 18D	Soil Sample	SS-18D03A	5/31/1996
Area 18D	Soil Sample	SS-18D03B	5/31/1996
Area 18D	Soil Sample	SS-18D09A	5/31/1996
Area 18D	Soil Sample	SS-18D05A	5/31/1996
Area 18D	Soil Sample	SS-18D05B	5/31/1996
Area 18D	Soil Sample	SS-18D07A	5/31/1996
Area 18D	Soil Sample	SS-18D15A	8/13/1999
Area 18D	Soil Sample	SS-18D15B	8/13/1999
Area 18D	Soil Sample	SS-18D14A	8/13/1999
Area 18D	Soil Sample	SS-18D13A	8/13/1999
Area 18D	Soil Sample	SS-18D13B	8/13/1999
Area 18D	Soil Sample	SS-18D12A	8/13/1999
Area 18D	Soil Sample	SS-18D12B	8/13/1999
Area 18D	Soil Sample	SS-18D11B	8/13/1999
Area 18D	Soil Sample	SS-18D23B	8/13/1999
Area 18D	Soil Sample	SS-18D11A	8/13/1999
Area 18G	Soil Sample	SS-18G01A	5/23/1996
Area 18G	Soil Sample	SS-18G01B	5/23/1996
Area 18G	Soil Sample	SS-18G02A	5/17/1996
Area 18G	Soil Sample	SS-18G02B	5/17/1996
Area 18G	Soil Sample	SS-18G04A	5/17/1996
Area 18G	Soil Sample	SS-18G04B	5/17/1996
Area 18G	Soil Sample	SS-18G03A	5/16/1996
Area 18G	Soil Sample	SS-18G03B	5/16/1996
Area 18G	Soil Sample	SS-18G18Z	5/6/1996
Area 18G	Soil Sample	SS-18G19A	5/6/1996
Area 18G	Soil Sample	SS-18G20A	5/6/1996
Area 18G	Soil Sample	SS-18G09A	5/3/1996
Area 18G	Soil Sample	SS-18G10A	5/3/1996
Area 18G	Soil Sample	SS-18G11A	5/3/1996
Area 18G	Soil Sample	SS-18G13A	5/3/1996
Area 18G	Soil Sample	SS-18G14A	5/3/1996
Area 18G	Soil Sample	SS-18G15A	5/3/1996
Area 18G	Soil Sample	SS-18G15B	5/3/1996
Area 18G	Soil Sample	SS-18G16A	5/3/1996
Area 18G	Soil Sample	SS-18G17A	5/3/1996
Area 18G	Soil Sample	SS-18G18A	5/3/1996
Area 18G	Soil Sample	SS-18G18B	5/3/1996
Area 18G	Soil Sample	SS-18G22A	5/3/1996
Area 18G	Soil Sample	SS-18G05A	5/2/1996
Area 18G	Soil Sample	SS-18G06A	5/2/1996
Area 18G	Soil Sample	SS-18G07A	5/2/1996
Area 18G	Soil Sample	SS-18G08A	5/2/1996

Figure

AVATAR ENVIRONMENTAL

1999 Geophysical Survey Area

Area 18E Excavation Areas - 2011

One 57-mm projectile was recovered from 18E sometime between 1991 and 1994

Beechwood Development

Area 18E

Building 15 demo'd 1997

Building 19 demo'd 1997

Building 14 demo'd 1997

Building 18

Building 212

Area 18F

Building 209

Building 205

Building 203 demo'd 1994

Building 202 demo'd 1994

Owens-Illinois

Former Gas Station

Former UST

Former UST

Former Bldg.241 Automotive Shop

Building 238

Building 241 demo'd 1994

Former Columbia Salvage Company dump

1999 Geophysical Survey Area

Numerous sinkholes and mounds. A cultural Resource Survey including installation of two trenches 360 and 60 ft. long, 2-4 ft. deep - 1 machine gun shell on ground surface.

Area 18G

AOC8

Former UST

AOC3

Wash Out Area

Former USTs

Building 256 demo'd 2014

Grit Blast Room

1998 and 2002 Removal Areas

Leach field

2004 Removal (concrete sumps)

Building 255 demo'd 2014

Building 229

Building 231

Area 18D

Building 245 demo'd 2015

Building 246 demo'd 2015

UST removal in 2004 caches at 529783.2, 609711.6

Meadow Road

Avenue D

Two 48" Stormwater Discharge Pipes

1998 Removal Area

1992 Removal Area

2002 Lead Removal Area Former Firing Range Backstop

1993 Geophysical Survey Area

1993 Geophysical Survey Area

1993 Geophysical Survey Area

1993 Geophysical Survey Area

2002 Lead Removal Area

Area 18A

Area 18B

Asbestos Landfill (Approx.)

GSA stored 55 gallon drums of unknown origin or contents. In 1992, EPA investigation of marshy area (18C) revealed no OE.

1998 and 2002 Buried Drum Removal Area

Area 18C

2002 Lead Removal Area

1993 Geophysical Survey Area

1999 Geophysical Survey Area

1996 Geophysical Survey Area

Building 151

Building 165

AOC2

AOC4

Area 1

1989 Geophysical Survey Area

Area 1 - 0.57 acres inspected by the Office of the Chief of Ordnance and Surface Investigations completed by UXB Int'l. over entire area. - no OE found

Building 409

Building 410

Building 422

Building 423

Building 424

Building 425

Building 426

Building 427

INVESTIGATION AREA DESCRIPTIONS

Area 1 – Former Demolition Area
Area 18A – Former GSA/U.S. Army Pond Area
Area 18B – Former Firing Range
Area 18C – Former Landfill, Disposal, and Vehicle Processing Area
Area 18D – Trench of Shell Casings
Area 18E – Former Maintenance Area
Area 18F – Former Warehouses
Area 18G – Former Dump

Legend

- Criterion Exceedance
- PAH Sample Locations
- Stormwater Discharge
- Former Railroads
- Existing Railroads
- Monitoring Wells
- Former UST Locations
- Former Buildings
- Tax Parcels
- EPA/GSA Property
- 1992 Removal Areas
- Excavation Areas
- Soil Investigation Areas
- GW Plume Boundary
- Former Dump/Landfill
- Beechwood Development
- Geophysical Survey

Analyte	Human Health Screening Criteria (mg/kg)			
	EPA Restricted Use	EPA Unrestricted Use	NJDEP Restricted Use	NJDEP Unrestricted Use
Benzo(a)anthracene	2.9	0.16	2	0.6
Benzo(a)pyrene	0.29	0.016	0.2	0.2
Benzo(b)fluoranthene	2.9	0.16	2	0.6
Benzo(k)fluoranthene	29	1.6	23	6
Chrysene	290	16	230	62
Dibenz(a,h)anthracene	0.29	0.016	0.2	0.2
Indeno(1,2,3,cd)pyrene	2.9	0.16	2	0.6
Naphthalene	17	3.8	17	6

200 0 200 400
Scale in Feet

Source:
Aerial Photos from NJ Imagery, Natural 2012, WMS Serice, http://njwebmap.state.nj.us/njimagery. Tax Parcels, EPA/GSA Boundary, Exposure Units, and sample locations from Weston Solutions, Inc. May, 2007.

U.S. EPA and GSA Property Area
Former Raritan Arsenal Site, Edison, NJ

FIGURE 3-1
EXCEEDANCES OF HUMAN HEALTH SOIL SCREENING CRITERIA - PAHs

I:\Raritan\EPA_Data_Report\MXD\EPA_DR_Fig4-2_HH_Exceed_012815.mxd

Attachment A

Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 9/20/12 @ 1313

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS-18B12A

City/State: Edison, NJ

Location Description:

Gravel area between oak trees, looking south. ~ 50 ft to asphalt road.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1317

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS-18B13A

City/State: Edison, NJ

Location Description:

Along road with crushed / loose stones, no asphalt though. Picture looking SE.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1321

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS-18B15A

City/State: Edison, NJ

Location Description:

Looking N, on edge of asphalt lot. Otherwise shrubery.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @1325

Project: Former Raritan Arsenal

City/State: Edison, NJ

Photographer: SPECK

Sample ID: SS-18B11A

Location Description:

Looking NW, on edge of asphalt walking path. Otherwise in shrubery.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1332

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS-18B16A

City/State: Edison, NJ

Location Description:

Looking E, large chunks of asphalt evident. Large rocks, loose in piles. On pavement.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1337

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS-18B09A, SS-18B09C

City/State: Edison, NJ

Location Description:

Looking SE, wooded area. No signs of PAH contributing material.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1342

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS-18B07A, SS-18B08A

City/State: Edison, NJ

Location Description:

Loose stone path down to sample location. MW, (steel - casing, 4 inch) in vicinity. Wooded area looking SE.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1349

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS-1806A/B

City/State: Edison, NJ

Location Description:

Looking W, wooded area beside wet/dry sediment / stream area.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1351

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SD-1802

City/State: Edison, NJ

Location Description:

Looking SW, wooded area in wet/dry creek which leads to Raritan River. ~ 45 ft from asphalt walking path.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1357

Project: Former Raritan Arsenal

City/State: Edison, NJ

Photographer: SPECK

Sample ID: SS-18A24A
SS-18A26A
SS-18A41

Location Description:

Looking NE, wooded area. ~ 50 ft from birm which goes down to the dry stream.
mostly sandy



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1400

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS-18A23A

City/State: Edison, NJ

Location Description:

Looking SE, wooded / shrubery area on the side of the "sandy" stream channel. ~ 75 ft from ponds where removal occurred.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1403

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS-18A - 05A
07A
08A
13A
14A
16A
17A
18A
22A
43

City/State: Edison, NJ

Location Description:

Picture 1: looking NE

Picture 2: looking N

Picture 3: looking NW

Pond removal area. Patches of shrubs, sandy gravel. Some loose rock.

3



2



1



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1409

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS-18A30A | SS-18A33A/B
SS-18A31A | SS-18A01A/Y
SS-18A32A | SS-18A02A
SS-18A03A
SS-18A04A

City/State: Edison, NJ

Location Description:

Looking NE down roadway, concrete roadway. (L) (R)
All locations directly adjacent to roadway.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1413

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS-18B17 A/B

City/State: Edison, NJ

Location Description:

Looking SE along roadway, looking into wooded area. ~5 ft from concrete roadway.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1418

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SD-1809, SD-1818

City/State: Edison, NJ

Location Description:

Looking NE, ~20 ft from concrete roadway. Deeper part of stream next to culvert. "Teal haze" described as stream color.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1421

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS-18B02A

City/State: Edison, NJ

Location Description:

Looking SE in wooded area. Above stream channel ~ 20 ft.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1429

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS-19BDSA/B/C

City/State: Edison, NJ

Location Description:

Looking S, ~ 10-15 ft from stream channel. Wooded area.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1435

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SD-1810

City/State: Edison, NJ

Location Description:

Looking NW at stream bed. Culvert to right, shrubs along bank. ~35 ft from asphalt walking path.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1438

Project: Former Raritan Arsenal

City/State: Edison, NJ

Photographer: SPECK

Sample ID: SS01-01A
SS01-05A

Location Description:

Looking NE away from stream bed. Wooded area.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1442

Project: Former Raritan Arsenal

City/State: Edison, NJ

Photographer: SPECK

Sample ID: SS01-04A
SS01-03A
SD01-01
SD01-02

Location Description:

Looking SW, at Four locations.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1447

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SD-1801

City/State: Edison, NJ

Location Description:

Looking NW at stream. Wooded area, taken from above stream ~ 15ft. Large fallen tree adjacent.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1458

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS-18G13A
SS-18G14A SS-18G16A
SS-18G15A/B
~~SS-18G16~~ (MS)

City/State: Edison, NJ

Location Description:

Asphalt observed throughout area. Chunks, solid layers, etc.
Large field area looking NW.





Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1506

Project: Former Raritan Arsenal

City/State: Edison, NJ

Photographer: SPECK

Sample ID: SS-18B01A
SS-18B01C

Location Description:

Looking SW, shrubery area, across drainage basin, ~ 50 ft or more from roadway.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1511

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS-18G05A
-06A
-07A
-08A
-09A
-10A
-11A

City/State: Edison, NJ

Location Description:

Looking NE, grasses, shrubs. No signs of PAH contributing material.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1520

Photographer: SPECK

Project: Former Raritan Arsenal

City/State: Edison, NJ

Sample ID: SS-18D-01A/B/C TP18D-06A/B/C
-02A
-03A/B -09A -10A
-05A/B -23B -04A
~~-06~~ -12A/B
-11A/B -13A/B
-24 -07A
-15A/B
-14A

Location Description:

Looking SW, large open field w/ tall grasses. Locations (SS- and TP-) all in field downhill. No obvious signs of PAH contributing material.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1527

Project: Former Raritan Arsenal

City/State: Edison, NJ

Photographer: SPECK

Sample ID: SS186-03A/B

~~SS186-04~~ (TMS)

Location Description:

Looking NE off corner of asphalt helipad ~5 Ft.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1528

Project: Former Raritan Arsenal

City/State: Edison, NJ

Photographer: SPECK

Sample ID: ~~SS-18G-04~~ (TMS) SS18G-04 A/B

Location Description:

Looking E off corner of concrete helipad. Asphalt area of pad ~ 10-15 ft away.

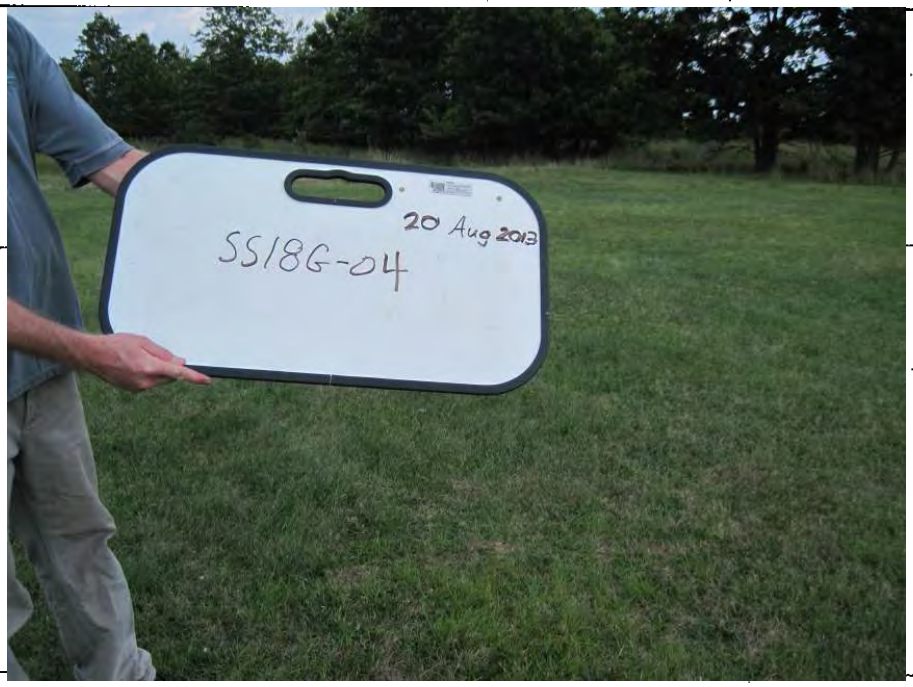

Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1530

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS18G-01A/B

City/State: Edison, NJ

Location Description:

Looking NW ~ 15-20 ft from asphalt roadway. Area is a grassy lawn.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1531

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS18G-02 A/B

City/State: Edison, NJ

Location Description:

Looking SW at grassy lawn; patches of asphalt and gravel evident everywhere.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1536

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS18D-21 A/B

City/State: Edison, NJ

Location Description:

Looking SE at corner of concrete/asphalt mixed pad. Pad a couple hundred ft long by 100 ft.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1538

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SS18D-22 A/B

City/State: Edison, NJ

Location Description:

Looking SE along concrete/asphalt mixed pad. More vegetation here though.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1549

Project: Former Raritan Arsenal

City/State: Edison, NJ

Photographer: SPECK

Sample ID: SS18G-17A
-18A/B/2
-19A
-20A
-22A

Location Description:

Looking SE. Grassy lawn adjacent to Building 238. Concrete sewer plate in vicinity. Also note downspout discharges to lawn area exactly at sample locations; asphalt roof.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1607

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: SD-1815

City/State: Edison, NJ

Location Description:

Looking E, adjacent to railroad tracks. Stream bed ~ 15 ft below next to culvert.



Photo-Documentation Form

EPA Area

AVATAR ENVIRONMENTAL

Date/Time: 8/20/13 @ 1614

Photographer: SPECK

Project: Former Raritan Arsenal

Sample ID: TP18C-55A/C PE18C-402A
-56A/C -403A
-62A -404A
-57A
-70A/B SS18C-35A
-66A
-65A

City/State: Edison, NJ

Location Description:

Looking SE, grassy field, contains fill from a removal operation. ~100 ft or more from railroad tracks.
↳ drum disposal

