BJC/PAD-207

DUF6 Conversion Facility Site Characterization Report, Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Tetra Tech, Inc.

contributed to the preparation of this document and should not be considered an eligible contractor for its review.

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DUF6 Conversion Facility Site Characterization Report, Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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Prepared by
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BECHTEL JACOBS COMPANY LLC
managing the
Environmental Management Activities at the
East Tennessee Technology Park
Oak Ridge Y-12 Plant   Oak Ridge National Laboratory
Paducah Gaseous Diffusion Plant   Portsmouth Gaseous Diffusion Plant
under contract DE-AC05-98OR22700
for the
U.S. DEPARTMENT OF ENERGY

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ACRONYMS

AOC	area of concern
ASTM	American Society for Testing and Materials
bgs	below ground surface
BJC	Bechtel Jacobs Company LLC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
DOE	U.S. Department of Energy
DUF6	depleted uranium hexafluoride
EIS	Environmental Impact Statement
EMEF	Environmental Management and Enrichment Facilities
EPA	U.S. Environmental Protection Agency
FFA	Federal Facilities Agreement
GC	gas chromatography
HSWA	Hazardous and Solid Waste Amendments of 1984
HU	Hydrologic Unit
KAR	*Kentucky Administrative Regulations*
KDEP	Kentucky Department for Environmental Protection
KPDES	Kentucky Pollutant Discharge Elimination System
LCD	Lower Continental Deposits
LCS	laboratory control sample
LMES	Lockheed Martin Energy Systems, Inc.
MCL	Maximum Contaminant Level
MS	mass spectrometry
MSA	method of standard additions
MS/MSD	matrix spike/matrix spike duplicate
NEPA	National Environmental Policy Act
NPL	National Priorities List
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act of 1976
RGA	Regional Gravel Aquifier
RI	remedial investigation
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SQL	sample quantitation limit
SRC	site-related constituent
SVOC	semivolatile organic compound

SWMU	Solid Waste Management Unit
TIC	Tentatively Identified Compound
TPE	Total Propagated Error
TPH	total petroleum hydrocarbons
UCD	Upper Continental Deposits
UCRS	Upper Continental Recharge System
USEC	United States Enrichment Corporation
VOC	volatile organic compound
WAG	Waste Area Grouping

EXECUTIVE SUMMARY

During the summer of 2000, a U.S. Department of Energy (DOE) site contiguous to the Paducah Gaseous Diffusion Plant (PGDP) was assessed and characterized in support of the DOE. DOE plans to use this site in Paducah, Kentucky, for constructing new facilities to convert its inventory of depleted uranium hexafluoride (DUF6) to a relatively stable form.

The DUF6 Conversion Facility site in Paducah was characterized to provide sufficient site information to support contractors submitting Request for Proposal bids and subsequent planning efforts. Use of existing site and plant documentation was maximized. Existing environmental documentation maintained by Bechtel Jacobs Company LLC (BJC), DOE's Environmental Management and Enrichment Facilities Contractor, indicated that the DUF6 Conversion Facility site has prior contamination associated with the Waste Area Grouping 28, Solid Waste Management Unit (SWMU) 194. Characterization of SWMU 194 and the remaining portion of the DUF6 Conversion Facility site had been performed and additional field investigations were conducted by Tetra Tech, Inc., a BJC subcontractor. Field investigations included surface soil, subsurface soil, groundwater, surface water, and sediment sampling of the site. Analytical results from the field characterization are consistent with preliminary historical information; metals and radionuclides were detected above background levels and are distributed throughout the site. Semivolatile organic compounds (SVOCs) were identified on the surface of the northern section of the site above background concentrations. Polychlorinated biphenyls (PCBs) were infrequently detected in subsurface soils.

The following is a list of the constituents determined to be above background concentrations at the DUF6 Conversion Facility site:

Surface Soil	Subsurface Soil	Sediment	Surface Water	Filtered Groundwater
Inorganics/Metals	**Inorganics/Metals**	**Inorganics/Metals**	**Inorganics/Metals**	**Inorganics/Metals**
Beryllium	Aluminium	Chromium	Cadmium	Aluminium
Calcium	Arsenic	Lead	Nickel	
Chromium	Barium	Zinc		**Radionuclides**
Copper	Beryllium			Alpha Activity
Lead	Calcium			Radium-226
Nickel	Chromium			
Silver	Copper			
Vanadium	Lead			
Zinc	Nickel			
	Vanadium			
Radionuclides	Zinc			
Activity of Uranium-235				
Cesium-137	**Radionuclides**			
Technetium-99	Activity of Uranium-235			
Uranium	Technetium-99			
Uranium-234	Uranium			
Uranium-238	Uranium-234			
	Uranium-238			
SVOCs				
Benz(a)anthracene	**PCBs**			
Benzo(a)pyrene	PCB-1242			
Benzo(b)Fluoranthene	Polychlorinated biphenyl			
Benzo(g,h,i)perylene				
Benzo(k)Fluoranthene				
Chrysene				
Fluoranthene				
Indeno (1,2,3-cd)pyrene				
Phenanthrene				
Pyrene				

The field characterization also included geotechnical sampling and analysis that indicates the site is suitable for constructing industrial facilities. The site is approximately 40 acres; the northern portion of the site is a relatively flat, grassy area, while the southern portion of the site is primarily wooded with underbrush. Geotechnical data are included in the report for use by bidders/contractors planning construction of the DUF6 Conversion Facility structures.

The environmental and geotechnical characterization data will also be used as input to the Environmental Impact Statement (EIS) for the DUF6 Conversion Facilities that will be prepared by Argonne National Laboratory. Additional EIS information and data have also been obtained and included in this report. Existing wetland information was obtained, and additional field wetland assessments of the DUF6 Conversion Facility site were performed. Much of the southern section of the site meets wetland criteria. Other EIS support information is in the appendixes of the report and includes site definition and mapping, cylinder yard drawings, air and biota monitoring data, vegetative cover and precipitation data, existing hydrogeologic information, groundwater and surface water usage patterns, PGDP waste management, site-specific seismic data, utility and transportation assessments, and future construction plans.

1. INTRODUCTION

1.1 PURPOSE OF THE REPORT

The U.S. Department of Energy (DOE) is preparing a Request for Proposal (RFP) for the disposition of the Department's depleted uranium hexafluoride (DUF6) inventory. Approximately 700,000 metric tons (1.4 million lb) of DUF6 is stored in approximately 57,700 cylinders (37,000 are in Paducah, Kentucky; 16,000 in Portsmouth, Ohio, and 4700 in Oak Ridge, Tennessee). DOE will require that uranium conversion facilities be designed, constructed, and operated at designated sites at the Paducah Gaseous Diffusion Plant (PGDP) and Portsmouth Gaseous Diffusion Plant. The uranium conversion facilities will involve chemical processing of DUF6 to remove the fluorine, create products that would provide a lower long-term storage hazard, and provide materials that would be suitable for use and disposal.

Industry will be submitting bid proposals to perform the uranium conversion work defined in the planned RFP. The purpose of this report is to provide DOE and the bidders with site characterization information as input to the proposal/bid for designing, constructing, and operating uranium conversion facilities at Paducah (analogous reports were prepared for the Portsmouth site). Site characterization information includes topography/site definition, soil geotechnical characterization, radiological and hazardous contamination characterization, hydrogeological characteristics, and utility availability and capacity.

Site characterization data will also be provided as input to National Environmental Policy Act (NEPA) documentation. The site-specific Environmental Impact Statement (EIS) for the Depleted Uranium Hexafluoride Conversion Facilities will be prepared by Argonne National Laboratory. Site environmental and geotechnical characterization data will be provided to Argonne National Laboratory to support the EIS. Other miscellaneous data required to support the EIS are also included in this report. The study maximizes the use of existing characterization data to the extent practical and was supplemented with additional field characterization efforts. The intent is that the site will be characterized before involvement of and use by the successful bidder.

1.2 SITE BACKGROUND

1.2.1 Site Description

The PGDP is located in western Kentucky as shown in Fig. 1.1. The DOE Paducah Reservation includes 3556 acres, of which 748 are within the main security fence. The proposed site for the DUF6 Conversion Facility is located outside the secured area of the PGDP on the south side as shown in Fig. 1.2. The site is adjacent to and west of the DUF6 cylinder yards, which will be an advantage for processing cylinders. Paducah plant utilities (water, storm sewer, sanitary sewer, electrical lines, etc.) are available at/near the site.

The total area of the site is approximately 40 acres. The site is bounded on the north by a fence and the C-810 Parking Lot; on the east by a fence, Patrol Road 5, and the C-745 cylinder storage yards; on the south by a 161-kVA power line and right-of-way that is maintained by the responsible utility; and on the

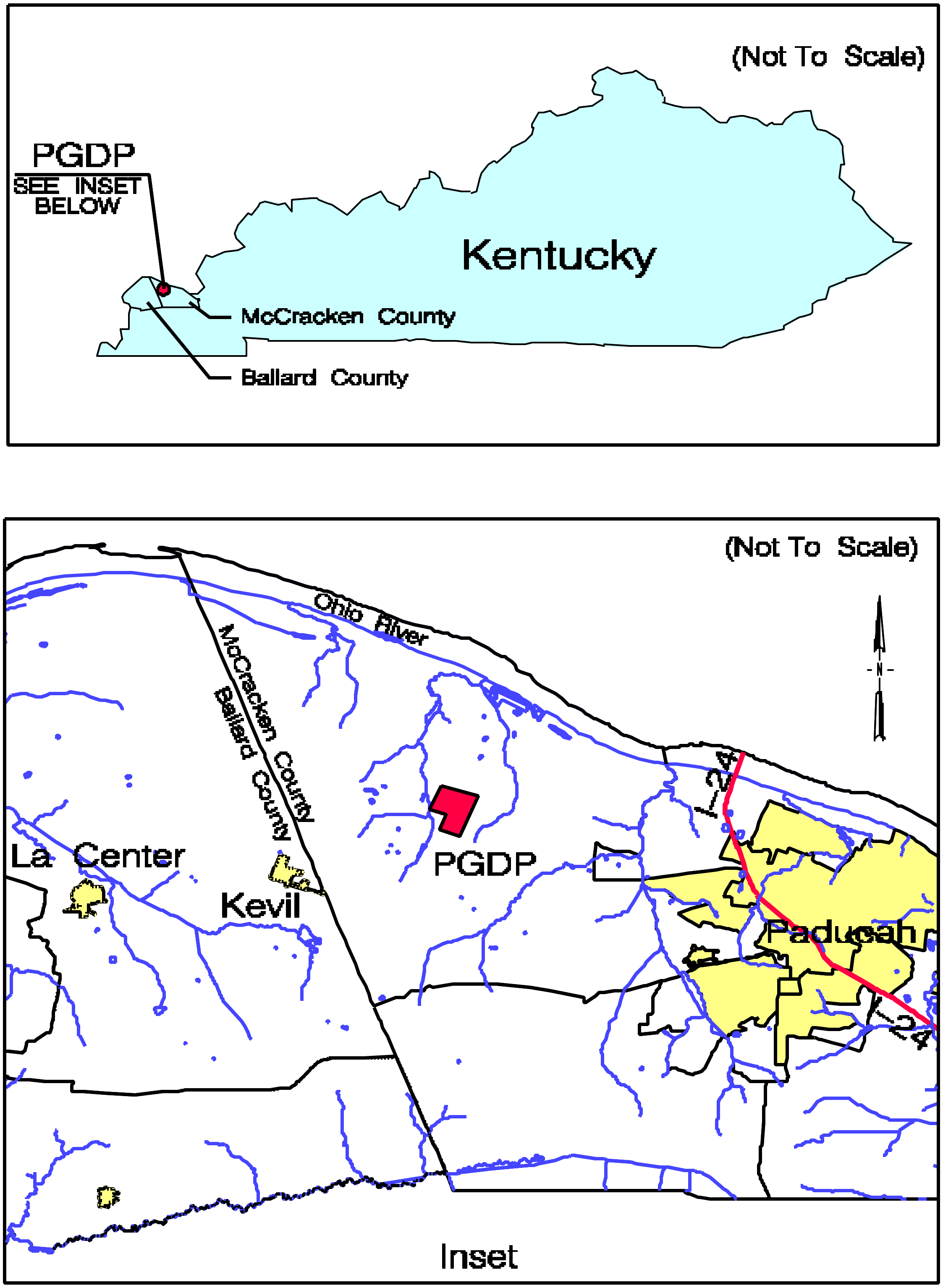
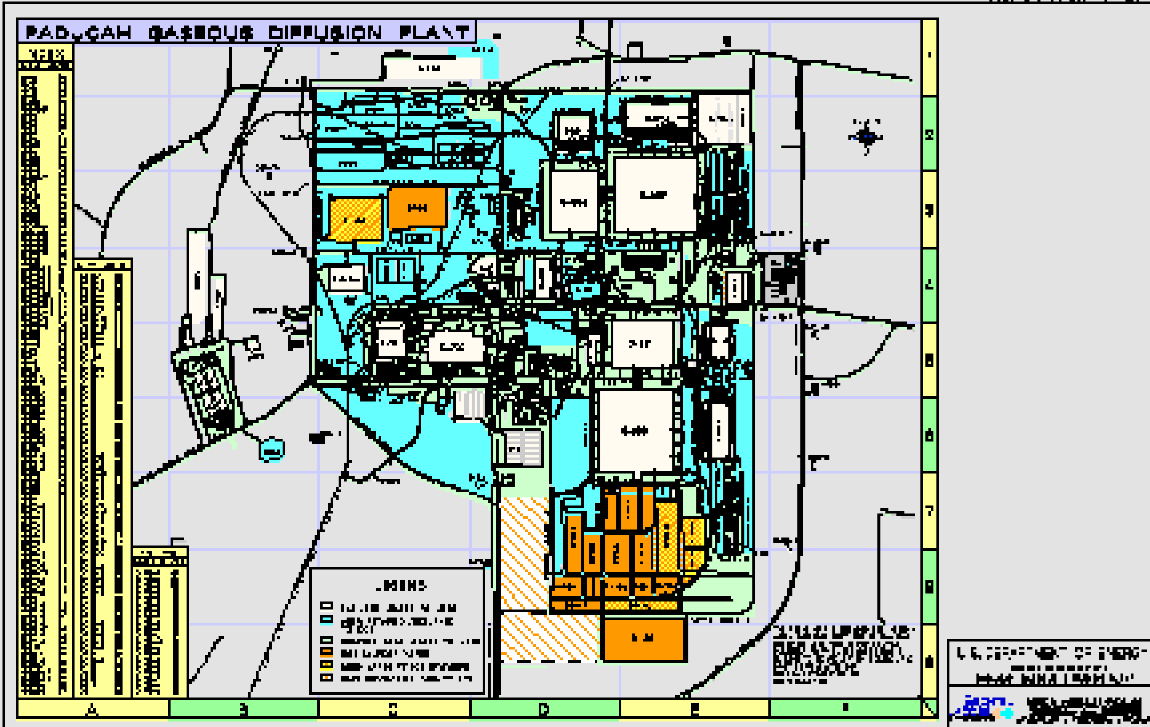


Fig. 1.1. General site location map for Paducah Gaseous Diffusion Plant.


PADUCAH GASEOUS DIFFUSION PLANT
LEGEND
U.S. DEPARTMENT OF ENERGY
A
B
C
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west by the main entrance roadway, Hobbs Road. Patrol Road 4 divides the site into northern and southern legs. The northern section (approximately 24 acres) of the site is flat and covered with grasses over most of its extent; a ditch line midway along the northern section of the site discharges surface water to the west via Kentucky Pollutant Discharge Elimination System (KPDES) Station 017. The southern portion (approximately 16 acres) of the site is relatively undisturbed with the majority of the site containing trees, underbrush, and wetlands. There are currently no facilities on the site.

1.2.2 Site History

The PGDP is an active uranium enrichment facility owned by DOE. Since July 1, 1993, United States Enrichment Corporation (USEC) has leased the uranium enrichment production facilities from DOE. USEC enriches uranium for use in nuclear power reactors. The plant has produced enriched uranium continuously since November 1952. DOE and USEC have employees and contractors on-site. Total site employment is approximately 2200 people with approximately 1800 USEC employees and approximately 400 contractor and subcontractor employees working on the DOE mission.

On April 1, 1998, Bechtel Jacobs Company LLC (BJC) replaced Lockheed Martin Energy Systems, Inc. (LMES) in implementing the Environmental Management and Enrichment Facilities (EMEF) Program. BJC is DOE's management and integration contractor, with responsibility for environmental remediation, waste management, and management of DUF6. The Environmental Management mission includes environmental cleanup and waste management; the Enrichment Facilities mission includes management of DUF6 generated before July 1993 and maintenance of nonleased buildings and grounds.

DOE and BJC have undertaken efforts to identify, investigate, and remediate, as necessary, all solid waste management units (SWMUs) and areas of concern (AOCs) at PGDP. The initial regulatory driver was the Resource Conservation and Recovery Act of 1976 (RCRA), as amended by provisions of Hazardous and Solid Waste Amendments of 1984 (HSWA). The Commonwealth of Kentucky issued the basic RCRA permit to PGDP that contains provisions to address hazardous waste management. The U.S. Environmental Protection Agency (EPA) issued the corrective action module of the RCRA permit (also known as the HSWA permit) because that portion of the RCRA program had not yet been delegated to Kentucky. The HSWA permit, combined with the Hazardous Waste Management permit issued by Kentucky, constitutes the RCRA—Part B permit for PGDP. The HSWA provisions require evaluation of hazardous constituent releases and implementation of interim and final corrective measures to address such releases.

In June 1994, PGDP was identified as a Superfund site under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and placed on the National Priorities List (NPL). Both RCRA and CERCLA requirements have been integrated into the Federal Facilities Agreement (FFA) that has been negotiated by DOE, EPA, and the Commonwealth of Kentucky. The FFA is intended to satisfy the requirements for an interagency agreement under Sect. 120 of CERCLA. CERCLA remedial investigations (RIs) of various sites at the PGDP have been conducted. The overall hydrogeology (surface water, groundwater, geology) of the PGDP site is well characterized and remediation of Operable Units (OUs) such as Groundwater OU, Surface Water OU, etc., is being performed. The individual contaminated sites or SWMUs are grouped into Waste Area Groupings (WAGs).

The northern section of the DUF6 Conversion Facility site is part of a contaminated site: WAG 28, SWMU 194. SWMU 194 is a flat, open area outside the security fence near the main plant entrance to the south and west of the C-333 Building. SWMU 194 was once the site of the administrative portion of the McGraw construction facilities and was the site of several support facilities during the construction of

PGDP. These facilities included an administration building (105,500 ft^2), cafeteria (10,200 ft^2), security guard headquarters (5360 ft^2), hospital (4480 ft^2), purchasing building (12,000 ft^2), paper and stationary warehouse (3900 ft^2), a boiler house, and two leach fields that were located west of Hobbs Road (not on the DUF6 Conversion Facility site). These buildings have since been removed from the site.

1.2.3 Previous Investigations

Site evaluations of SWMU 194 were undertaken as part of the Northeast Plume Investigation, the Groundwater Phase IV Investigation, and the WAG 28 RI. In 1999 11 borings were completed within the boundaries of SWMU 194; only 3 of the borings were within the DUF6 Conversion Facility site. Samples collected from borings were analyzed for trichloroethene, 1,2-dichloroethene, benzene, toluene, ethylbenzene, xylene, polychlorinated biphenyls (PCBs), total petroleum hydrocarbons (TPH), selected metals, and gross alpha/beta. No groundwater samples were collected from any of the borings. In addition, because any releases from the leach field would have been to the subsurface soils, no surface soil sampling was deemed necessary for characterization of the SWMU.

Soil samples collected from soil borings indicated the presence of metal contamination: cadmium (8.55 to 18.1 mg/kg), lead (5.03 to 13 mg/kg), and chromium (103 mg/kg). Radioactivity was measured as gross alpha (maximum activity 2.5 pCi/g) and gross beta (maximum activity 7.0 pCi/g). The only organics detected were ethyl benzene and xylene, which were slightly above the analytical detection limit.

In 1990, sediment samples were collected near Outfall 017 by the Army Corps of Engineers and DOE. The sediment samples contained reportable quantities of alpha activity (maximum activity 16.38 pCi/g), and beta activity (maximum activity 7.49 pCi/g). The radioisotopes $^{239/240}Pu$ (0.0244 pCi/g), ^{99}Tc (0.373 pCi/g), and thorium (0.684 pCi/g) were detected.

Additional information and data obtained from these prior investigations are included in Appendix A.

1.3 REPORT ORGANIZATION

The DUF6 Paducah site field characterization activities performed by Tetra Tech, Inc., during the summer of 2000 and the analytical results are included in this report. Geotechnical properties for soils and potential contamination of soil, groundwater, surface water, and sediment are addressed. The report includes the following chapters:

- Chapter 1 Introduction
- Chapter 2 Study Area Investigation
- Chapter 3 Physical Characteristics
- Chapter 4 Results
- Chapter 5 Summary
- Chapter 6 References

The appendixes include existing characterization information (information that existed before DUF6 site field characterization), detailed information supporting field characterization, and assessments and data that support preparation of an EIS. Contents of each appendix are as follows:

- Appendix A Historical Data
- Appendix B Site Definition and Mapping for DUF6 Conversion Facility
- Appendix C Miscellaneous Environmental Impact Statement Data
- Appendix D Utility Assessment
- Appendix E Transportation Assessment and Future Planning
- Appendix F Borehole Lithological Logs
- Appendix G Analytical Data
- Appendix H Quality Assurance/Quality Control Evaluation Results

2. STUDY AREA INVESTIGATION

This chapter presents a description of the field investigation activities and methods used during the site characterization (Summer 2000) work at the proposed DUF6 Conversion Facility site. Field activities for the site characterization included:

- geophysical survey for the purpose of obtaining an excavation/penetration permit,
- surface water/sediment sampling,
- surface and subsurface soil sampling,
- groundwater sampling,
- geotechnical sampling, and
- wetland survey.

A total of 20,152 analyses comprising five analyte groups are currently in the analytical database. The number of analyses of each analyte group performed during the proposed DUF6 Conversion Facility characterization is summarized in Table 2.1.

Table 2.1. Number of analyses conducted for each analyte group at Proposed DUF6 Conversion Facility Site

Media	Number of analytes	Metals	PPCB	RADS	SVOA	VOA
Groundwater unfiltered	1882	202	108	288	840	444
Groundwater filtered	335	144	NA	191	NA	NA
Surface soil	3297	357	189	504	1470	777
Subsurface soil	13229	1428	747	2062	5810	3182
Surface water	624	68	36	92	280	148
Sediments	785	85	45	120	350	185

PPCB - pesticide and PCB analysis
RADS - radiological analysis
SVOA - semivolatile organic analysis
VOA - volatile organic analysis
NA - Not Analyzed

2.1 GEOPHYSICAL INVESTIGATION

The geophysical data were collected using ground-penetrating radar and high-sensitivity metal detection (EM61) instruments at each location in the northern area of the site (area within SWMU 194), while only EM61 was used at the locations in the wooded area to the south. Details of the geophysical investigation including a map are provided in Appendix B, Sect. 2. Geophysical data were collected in a 25-ft radius around each location along parallel north-south and east-west survey lines spaced approximately 12.5 ft apart. Some areas required additional data coverage to further define site features. Ambient magnetic fields at background locations were used to identify anomalous readings. Ambient magnetic fields were measured at the beginning and end of each half-day period or at each boring location as appropriate.

2.2 SURFACE WATER/SEDIMENT SAMPLING

Three surface water and three sediment samples were collected at three locations from the drainage ditch located at SWMU 194 (Fig. 2.1). A fourth sediment sample was collected at the wooded area south of SWMU 194. A fourth surface water sample could not be collected from the wooded area due to the lack of surface water during the sampling event. The drainage ditch has a KPDES outfall on the west side of the Entrance Highway. Sample Stations at the drainage ditch were selected to separate potential sources of influence to the stream. Sample stations were (upstream) at the origin of the drainage ditch, just west of the Patrol Road; east of the entrance highway, Hobbs Road, and unimproved access road parallel to the highway; and (downstream) at the KPDES outfall K017 on the west side of the Entrance Highway.

All surface water/sediment sampling was performed in accordance with the requirements of the project Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) (BJC 2000), and technical operating procedure for collecting sediment (TT-DE-PTSA-4205-IAD). Sediment and surface water sampling proceeded from downstream to upstream to prevent any impact from the turbidity caused by the disturbance of sediment during sampling. At each sampling location, surface water samples were collected, at midstream, just below the water surface and before sediment samples. For volatile organic compounds (VOCs), surface water sample containers were filled directly from the stream. Unfiltered surface water samples were collected for metals analysis.

After surface water samples had been collected, sediment was sampled in the same vicinity, but only in a depositional area. Depositional areas will have slowly moving water and predominantly fine (clay and silt) particles. Sediment samples were restricted to the aerobic zone, up to a maximum depth of 6 in. Sediment samplers were either glass or stainless steel. Sediment samples for VOC analysis were collected first without mixing and immediately sealed with minimal headspace in the sample container. Several aliquots of fine sediment were composited and mixed in a stainless steel bowl from the depositional area to obtain sufficient sample volume for the remaining analytical parameters.

Immediately after collection, surface water and sediment samples were sealed and placed in a cooler at 4°C. Both surface water and sediment samples were sent to a laboratory for analyses of VOCs, semivolatile organic compounds (SVOCs), PCBs, metals, alpha spectroscopy, gamma spectroscopy, gross alpha/beta, and ^{99}Tc.

Water quality measurements, including dissolved oxygen, pH, specific conductance, temperature, and turbidity, were measured in the field using a Horiba U-10 at the time of surface water sampling.

2.3 SOIL SAMPLING

2.3.1 Surface Soil Sampling

Surface soil samples were collected for analytical parameters at each soil boring (Fig. 2.1) using a stainless steel spoon or split-spoon samplers. Collection of surface soil samples was performed in accordance with the project SAP and QAPP (BJC 2000), procedure TT-DE-PTSA-4201 for surface soil sampling, and EPA Region 4 Standard Operating Procedure. Sampling at UFSB15 was not performed due to wetland and power line structure interferences.

Surface soil samples were collected from the first 12 in. of soil at each soil boring and analyzed for VOCs, SVOCs, PCBs, metals, alpha spectroscopy, gamma spectroscopy, and ^{99}Tc.

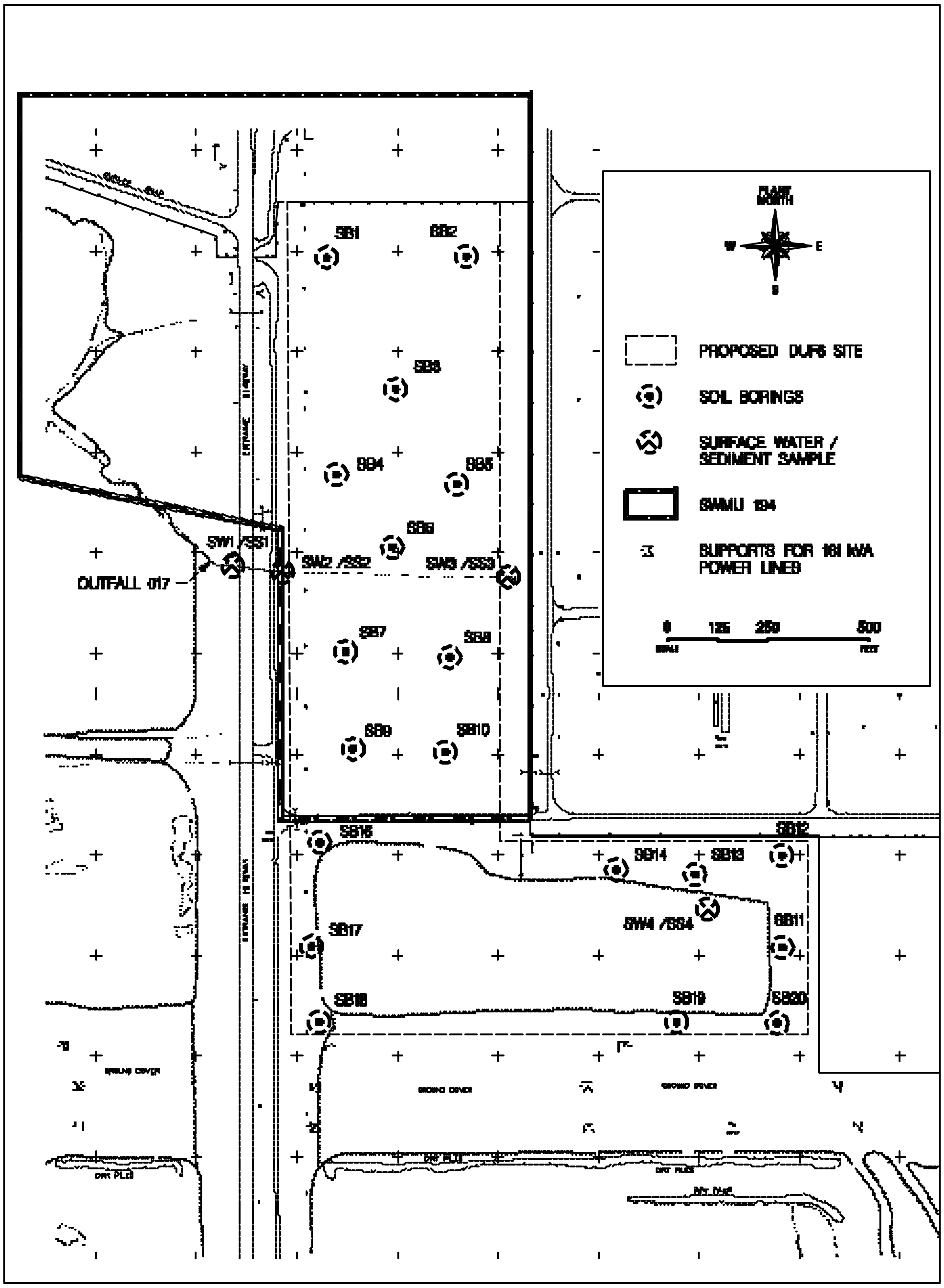

Fig. 2.1. Sampling locations at DUF6 Conversion Facility area.

The drilling locations were staked and cleared of all utilities before penetrating the subsurface. Personal protective clothing was donned before site activities as required by the site-specific health and safety plan. Exclusion and contamination reduction zones were established before work began. Surface vegetation was removed from the sample location and a stainless steel spoon or split spoon was used to obtain the required sample volume. Surface soil samples for VOC analysis were collected first without mixing and immediately sealed with minimum headspace in the sample container. Soil was placed in a stainless steel bowl, homogenized, and placed in the appropriate sample containers for SVOCs, PCBs, metals, and radionuclides in accordance with procedure TT-DE-PTSA-4204, "Composite Sample Preparation."

2.3.2 Subsurface Soil Sampling

Subsurface soil samples were collected using stainless steel split-spoon samplers (driven through hollow-stem augers). Collection of subsurface soil samples was performed in accordance with Tetra Tech procedure TT-DE-PTSA-4202 for subsurface soil sampling with the exception that 2-oz. glass jars were used to collect subsurface soil samples for VOC analysis. The use of 2-oz. glass jars was specified by the on-site laboratory.

Nineteen soil borings were completed at the proposed DUF6 Conversion Facility using 4.25-in.-ID hollow-stem augers. Soil boring locations are provided in Fig. 2.1. Ten soil borings (SB1–SB10) at the open field within SWMU 194 were advanced to perched groundwater encountered at approximately 15 to 24 ft below ground surface (bgs). Soil samples were collected at 5-ft intervals to the top of the water table using stainless steel split-spoon samplers, logged, and analyzed for VOCs, SVOCs, PCBs, metals, alpha spectroscopy, gamma spectroscopy, gross alpha/beta, and ^{99}Tc.

The remaining nine soil borings (UFSB11–UFSB20, except for UFSB15) were advanced to the perched groundwater at approximately 15 ft to 22 ft bgs at the wooded area south of Patrol Road 4. Soil samples were collected at 5-ft intervals using stainless steel split-spoon samplers, logged, and analyzed for VOCs, SVOCs, PCBs, metals, alpha spectroscopy, gamma spectroscopy, gross alpha/beta, and ^{99}Tc.

The drilling locations were staked and cleared of all utilities before penetrating the subsurface. Personal protective clothing was donned before site activities as required by the site-specific health and safety plan. An area surrounding the sample location was prepared by laying plastic sheeting on the ground over the work area. Decontaminated split-spoon samplers were used to collect soil samples through the hollow-stem augers. The drill rigs' downhole hammer was used with a 30-in. drop as specified by the American Society for Testing and Materials (ASTM) Method D-1586. The number of blows required to drive the spoon or tube through each 6-in. increment was recorded (refusal occurs when little or no progress is made for 50 blows of the hammer). After split-spoon retrieval, the contents of the spoon were described on field forms and in the logbooks. Soil cuttings were placed in drums and labeled. Detailed notes were recorded in the field logbook concerning soil sample collection. A decontaminated split-spoon was used each time a sample was collected.

2.4 GROUNDWATER SAMPLING

All groundwater sampling was performed in accordance with the QAPP and Tetra Tech technical operating procedure (TT-DE-PTSA-4303-IAD) for collecting groundwater. Groundwater samples were collected at soil borings UFSB1 through UFSB12 (except for UFSB3). A groundwater sample could not be collected at UFSB3 due to inadequate sample volume. At the request of the BJC and the Kentucky Department for Environmental Protection (KDEP) (Jones 2000), groundwater samples were collected once groundwater was encountered. Groundwater samples were collected using disposable Teflon bailers lowered inside the hollow-stem augers. The 40-mL glass vials for VOCs were filled first. This process continued until all 40-mL glass vials were filled. After completion of VOC sample collection, SVOC, metal, and PCB samples were collected. The radiological samples for alpha spectroscopy, gamma spectroscopy, gross alpha/beta, and ^{99}Tc analyses were collected last.

Water quality measurements, including dissolved oxygen, pH, specific conductance, temperature, and turbidity were recorded using a Horiba U-10 at the time of groundwater sampling.

Upon completion of the soil boring, the boreholes were grouted using a high-suspended solids bentonite grout mix in accordance with KDEP requirements.

2.5 GEOTECHNICAL SAMPLING

Soil samples to evaluate geotechnical characteristics were collected using soil cuttings, split spoons, and Shelby tubes at three boring locations (UFSB3, UFSB10, and UFSB14). Geotechnical soil samples were collected and analyzed for moisture content, grain size, California Bearing Ratio, compaction characteristics, soil classification, consolidation properties, triaxial shear strength, and Atterburg Limits as specified in the SAP (BJC 2000).

2.6 WETLAND SURVEY

A wetland survey using the updated electronic version of the 1987 *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) was used to identify the boundaries in the field. A report documenting the presence of field indicators used to delineate the boundary and identify the type, location, extent, and function of wetlands is included in Appendix C. The wetland survey report will be a supporting document for the Floodplain and Wetland Assessment prepared under 10 CFR 1022 and required for NEPA impact assessment. The wetland survey may also be used for permitting purposes if submitted to and approved by state and/or federal regulators.

The area of interest for the wetland survey included the 1400- by 550-ft wooded area west of the Cylinder Storage Yard C-745-T, south of Patrol Road 4, and east of the main entrance highway, Hobbs Road (Fig. 2.2). The area is bounded on the north by SWMU 194 and on the south by a high-voltage powerline easement.

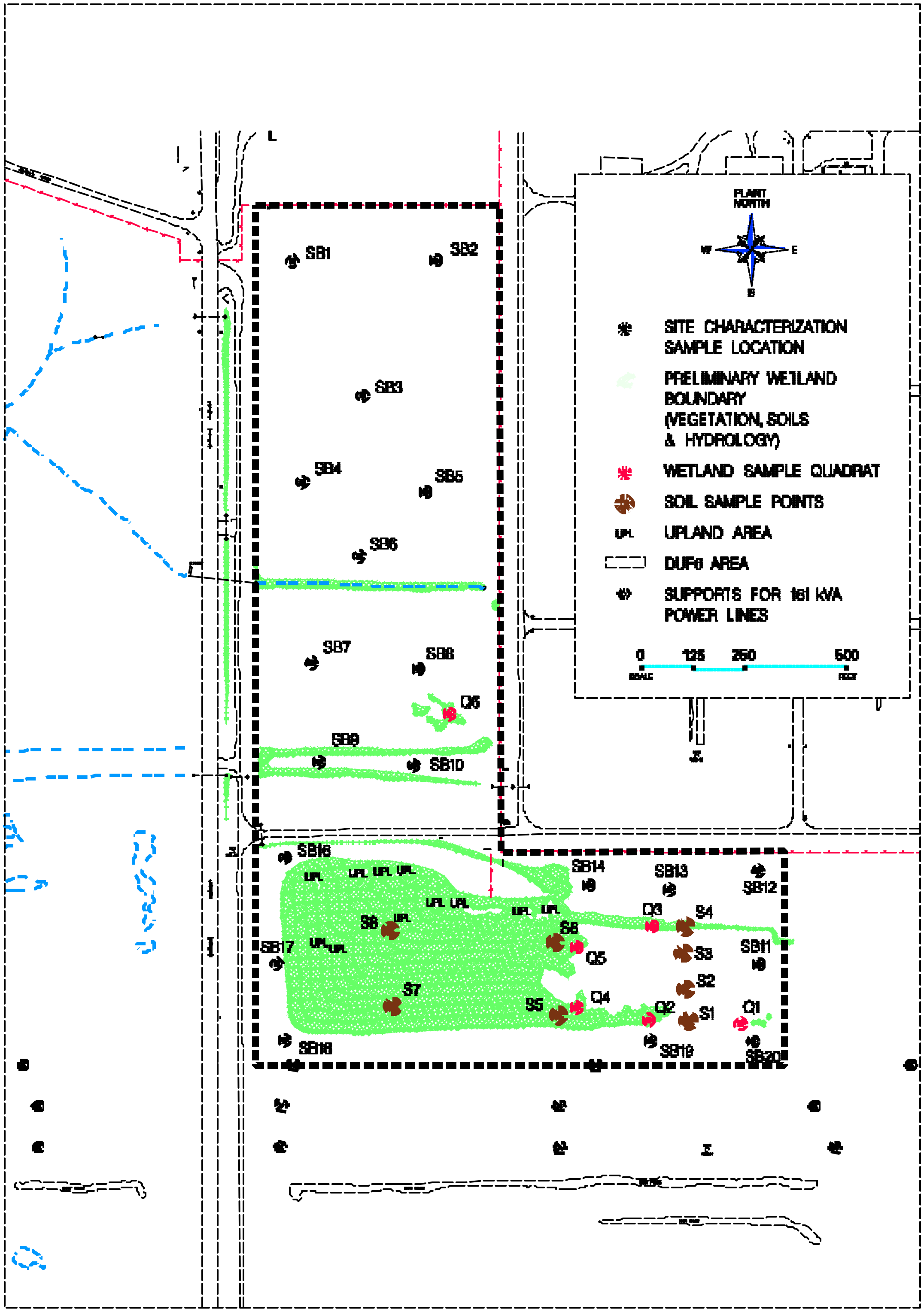

Fig. 2.2. Location of wetlands at DUF6 Conversion Facility area.

3. PHYSICAL CHARACTERISTICS

3.1 GEOLOGY

Physical characteristics of PGDP have been characterized in several previous investigations. The following discussion of the regional geology and groundwater is summarized from these investigations. The site-specific geology and groundwater summary is based on information derived from 19 soil borings completed during the DUF6 investigation.

3.1.1 Regional Geology

PGDP is located in the Jackson Purchase Region of western Kentucky, which represents the northern tip of the Mississippi Embayment portion of the Coastal Plain Province. The Jackson Purchase Region is an area of land that includes all of Kentucky west of the Tennessee River. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediments unconformably overlying Paleozoic bedrock.

Within the Jackson Purchase Region, strata deposited above the Precambrian basement rock attain a maximum thickness of 12,000–15,000 ft. Exposed strata in the region range in age from Devonian to Holocene. The Devonian stratum crops out along the western shore of Kentucky Lake. Mississippian carbonates form the nearest outcrop of bedrock and are exposed approximately 9 miles northwest of PGDP in southern Illinois (Clausen et al. 1992a). The Coastal Plain deposits unconformably overlie Mississippian carbonate bedrock and consist of the following: the Tuscaloosa Formation, the sand and clays of the Clayton/McNairy Formations, the Porters Creek Clay, and the Eocene sand and clay deposits (undivided Jackson, Claiborne, and Wilcox Formations). Continental deposits unconformably overlie the Coastal Plain deposits, which are in turn covered by loess and/or alluvium.

Bedrock

The entire PGDP area is underlain by Mississippian carbonates. The bedrock consists of dark gray limestone with some interbedded chert and shale. Regionally the Mississippian strata dips gently to the south. Bedrock was not encountered during the DUF6 investigation.

Rubble Zone

The rubble zone consists of angular to subangular chert and silicified limestone fragments (Olive 1980). Before deposition of the upper Cretaceous sediments, a long period of weathering occurred. During this time, erosion removed strata of the Upper Mississippian System (bedrock) and the Pennsylvanian System. Permian through early Cretaceous age strata are absent from the area due to non-deposition. Remnants of this weathering form the rubble zone. The rubble zone was not encountered during the DUF6 investigation.

McNairy Formation

In the late Cretaceous, a sea encroached northward, leading to deposition of the McNairy Formation (Clausen et al. 1992b). In the southeastern part of the Jackson Purchase Region, the McNairy Formation consists of mostly sand. Farther north, including PGDP, the McNairy Formation consists of light gray to dark gray clay with lenses of fine to coarse sand that weather to moderate yellow to reddish-brown. It is interbedded with varying amounts of gravel and dark gray silt. The middle portion of the McNairy is tentatively correlated to the Levings Member of Illinois. It is described as a lignitic silt in Illinois but as a series of silty, clayey sands extending from 135 to 270 ft bgs in Kentucky. It serves as an aquitard in the middle of the McNairy Formation, separating the upper and lower units.

The dominant lithology of the McNairy Formation is a dark gray to bluish-gray, micaceous, often pyritic or lignitic clay with interbedded silt and fine- to medium-grained sand.

Porters Creek Clay, Porters Creek Terrace, and Eocene Sands

The Porters Creek Clay consists of dark gray to black clay with varying amounts of silt and fine-grained, micaceous, glauconitic sand. This is indicative of marine and brackish-water sediments deposited in a sea that occupied most of the Mississippi Embayment (Olive 1980). Eocene sediments consisting of interbedded and interlensing sand, silt, and clay overlie the Porters Creek Clay in the southern portion of the DOE property. Abrupt change from fine-grained deposition of the Porters Creek Clay to coarser-grained sedimentation during the Eocene probably resulted from regional uplift.

Post-Eocene erosion into the Paleocene Porters Creek Clay resulted in an important feature known as the Porters Creek Terrace. The terrace lies immediately south, southeast, and southwest of PGDP, and it slopes northward toward the southern boundary of the PGDP fenced security area. Regionally, the Porters Creek Terrace is hydrogeologically important because it marks the southern extent of the Lower Continental Deposits (LCDs) and therefore the southern extent of the Regional Gravel Aquifer (RGA). It also serves as the aquitard below the RGA where the RGA laps onto the terrace slope.

Continental Deposits

Pleistocene Continental Deposits unconformably overlie the Cretaceous through Eocene strata throughout the area. Ancestral rivers bordered the Jackson Purchase Region in approximately the same position as the present Tennessee, Ohio, and Mississippi Rivers (Olive 1980). Increased flow in the ancestral Tennessee River, combined with large sediment loads, resulted in the formation of an alluvial fan in the area of the confluence of the Ohio and Tennessee Rivers (Olive 1980). The Continental Deposits resemble a large, low-gradient alluvial fan that covered much of the region and eventually buried the erosional topography.

Erosion and reworking of alluvial fan deposits have resulted in the present thickness and distribution of the Continental Deposits. The thicker sequences of Continental Deposits represent valley fill deposits and can be informally divided into a lower unit (gravel facies) and an upper unit (clay facies). The two distinct facies are as follows.

- **Lower Continental Deposits.** The LCD are found throughout the plant area and to the north, but pinch out to the south, southeast, and southwest along the slope of the Porters Creek Terrace. The LCD are gravel facies consisting of chert gravel in a matrix of poorly sorted sand and silt that rests on an erosional surface representing the beginning of the valley fill sequence. The LCD were deposited on an irregular east-west trending erosional surface exhibiting steps or terraces. Alluvial terraces are former floodplains corresponding to different glacial events. The gravel deposit averages approximately 30 ft thick, but some thicker deposits (as much as 50 ft) are found in deeper scour channels.

  The Pleistocene age LCD are a prominent fluvial gravel facies beneath PGDP and is considered to be the lower part of RGA. These coarser-grained sediments unconformably overlie the finer-grained Cretaceous McNairy Formation as a Pleistocene erosional surface. The top of this erosional surface rises to the east and south of PGDP. LCD are primarily distinguished from the overlying Upper Continental Deposits (UCD) by a coarser grain size.

In the area of SWMU 194 the LCD are known to pinch out against the Porters Creek Terrace Slope.

- **Upper Continental Deposits**. The UCD are primarily a fine-grained, clastic facies varying in thickness from 15 to 55 ft that consist of clayey silt with lenses of sand and occasional gravel. The UCD represent sediments deposited in a fluvial and lacustrine environment (Finch 1967, Frye et al. 1972). Widespread lacustrine sedimentation occurred along the present Ohio River and Tennessee River valleys when they became choked from draining glaciated areas. The sediment dammed valleys of tributaries, creating slackwater lakes that resulted in deposition of fine-grained sediments of the UCD. Depending on stages of glaciation, periods of lacustrine deposition were followed by periods of erosion. As aggradation of the fluvial system continued, stream gradients in the ancestral Tennessee River and tributaries lessened. Lower gradients likely favored a transition from a braided environment to a meandering environment. A very gravelly lower sequence becoming sandier upwards identifies the transition of the subsurface.

  The UCD consist primarily of fine-grained valley-fill deposits that are differentiated from the underlying LCD by grain size. The UCD represent a fining-upward sequence of interbedded clay, silt, sand, and gravel. The layers of clay silt, sand, and gravel were seen to grade laterally into adjacent units throughout the UCD.

  The UCD are comprised of three zones. The uppermost zone consists of silty clay to clayey silt to a depth of 15–20 ft in the north. To the northeast this zone thickens to approximately 40 ft. The middle zone consists of poorly sorted, dark yellowish-brown to yellow-brown silty sands and gravels that are interbedded with silts and clays. The middle zone differs from the upper zone by the presence of sand/gravel lenses and an increase in silt content. These coarser-grained sediments are prevalent between 20 and 40 ft bgs.

  The clay content of the UCD increases significantly near the base so that the dominant lithology is a silty clay with minor occurrences of lenticular sand and gravels. This silty clay unit acts as a semiconfining layer above the RGA. The contact between the middle and lower zones is dominantly gradational, but it can be locally sharp. The lower zone is present to the east and south of PGDP and consists of approximately 10 ft of yellowish-grayish-brown silty clay with minor sand content. All the UCD units rise and thin as they approach the Porters Creek Terrace to the south.

3.1.2 Surface Soil/Loess/Fill

The surface deposits found in the vicinity of PGDP are Pleistocene to recent in age and consist of loess and alluvium. Both units are composed of clayey silt or silty clay and range in color from yellowish-brown to brownish-gray or tan, making field differentiation difficult.

The eolian loess deposits overlie the UCD throughout the PGDP area. Only the most recent (Illinoisan- and Wisconsinan-aged) deposits are represented in the sedimentary sequence.

3.1.3 Site Geology

The site-specific geology is based on 19 soil borings completed during the DUF6 investigation. The soil borings were advanced until groundwater was encountered. Total depths of the soil borings ranged from 15 ft bgs at UFSB10 to 30 ft bgs at UFSB11.

The uppermost soils at the site consist of a layer ranging from 1 to 4 ft of fill, loam, or a combination. Fill material consisting of silty, clayey gravel with some plastic, metal, and wood fragments was observed in the northernmost borings (UFSB1 and UFSB3) at SWMU 194.

The next soil zone encountered was a light gray to tan silty clay that often had a coarser fraction of sand and some gravel at the base. This zone ranged in thickness from 12 to 27 ft. Below the clay interval was a medium brown to orange-brown, clayey, sandy gravel to a gravelly clay ranging in thickness from 2 to 8 ft at a minimum. The lower contact of this zone was not reached at most borings because perched groundwater was encountered in this interval. At UFSB5 a light gray, silty clay was immediately below this interval.

3.2 GROUNDWATER

3.2.1 Regional Groundwater

The Jackson Purchase Region is characterized by several hundred feet of unconsolidated Cretaceous through Holocene sediments deposited on an erosionally truncated Paleozoic surface. The local groundwater flow system in the vicinity of PGDP exists primarily within unconsolidated sediments. Information presented herein regarding the groundwater setting at PGDP was derived from the *Report of the Paducah Gaseous Diffusion Plant Groundwater Investigation Phase III* (Clausen et al. 1992b). The regional hydrogeology discussion is intended to provide a general overview of the groundwater flow regime for PGDP.

The regional groundwater flow system occurs within the Mississippian Bedrock, Cretaceous McNairy Formation, Eocene Sands, Pliocene Terrace Gravel, Pleistocene LCD, and UCD. Terms used to describe the hydrogeologic flow system are the McNairy Flow System, Eocene Sands, Pliocene Terrace Gravel, RGA, and Upper Continental Recharge System (UCRS). Specific components have been identified for the regional groundwater flow system and are defined in the following paragraphs.

Paleozoic Bedrock Aquifer

Limestone, believed to be the Mississippian-aged Warsaw Limestone, subcrops beneath PGDP. Groundwater production from the bedrock aquifers comes from fissures and fractures and from the weathered rubble zone near the top of the bedrock. The bedrock aquifer was not encountered during the DUF6 investigation.

McNairy Flow System

Formerly termed the “deep groundwater system,” this component consists of the interbedded and interlensing sand, silt, and clay of the Cretaceous McNairy Formation. Regionally the sand in the McNairy Formation is an excellent aquifer in the southeastern part of the Jackson Purchase Region. The McNairy Formation grades from mostly sand in those areas to containing significant amounts of silt and clay near PGDP (Clausen et al. 1992a). Regionally, the McNairy recharges along areas of outcrop in the eastern part of the region, near Kentucky Lake and Lake Barkley (Davis et al. 1973). Water movement is north and northwest toward discharge areas in Missouri and along the Ohio River.

The McNairy Formation subcrops beneath the plant at depths ranging from approximately 70 to 100 ft. Sand facies account for 40–50% of the total formation thickness of approximately 225 ft. In areas where the RGA overlies the McNairy Flow System and where the RGA is in direct hydraulic connection with coarser-grained sediments of the McNairy Formation, the McNairy flow is coincident with that of the RGA. The presence of McNairy Formation sands immediately below the RGA would promote potential downward flow of groundwater. Because the sands below the RGA are of limited extent, substantial downward flow does not occur. Groundwater flow in the McNairy is considered coincidental with the RGA having a lateral component to the north-northwest.

Pliocene Terrace Gravel and Eocene Sands

Pliocene-aged gravel deposits and Eocene-aged reworked sand and gravel locally overlie the Paleocene Porters Creek Clay in the southern portion of PGDP. Pliocene Terrace Gravel or Eocene Sands may have been encountered in borings previously installed at SWMU 194.

Regional Gravel Aquifer

The RGA consists of the gravel facies of the LCD. The RGA is the most prominent gravel facies beneath PGDP and is the primary local aquifer. The RGA consists of Pleistocene gravel deposit overlying an erosional surface. The RGA is found throughout the plant area and to the north, but pinches out to the south, southeast, and southwest along the slope of the Porters Creek Terrace. Regionally, the RGA includes the Holocene-aged alluvium found adjacent to the Ohio River.

The RGA is the dominant aquifer within the local flow system. Toward the southern part of PGDP, the RGA terminates against the Porters Creek Terrace. The restriction results in a high gradient and probably causes groundwater discharge to adjoining streams. In the north-central portion of the plant site, the lower gradients are a result of the thickened Pleistocene sequence containing higher fractions of coarse sand and gravel. Northward, near the Ohio River, the hydraulic gradient increases as a result of either a thinner section of the RGA or low-permeability bottom sediments in the Ohio River.

Regional groundwater flow within the RGA trends north-northeast toward base level represented by the Ohio River. The hydraulic gradient varies spatially but is on the order of 1.0×10^{-4} to 1.0×10^{-3} ft/ft.

In the SWMU 194 area, sand constitutes up to 30% of RGA lithology in discontinuous lens at various intervals and impedes groundwater flow where encountered. The RGA is recharged by infiltration from UCRS and some underflow from the terrace gravels that are in the southern portion of PGDP.

Upper Continental Recharge System

The UCRS consists of the surface loess and UCD. The UCRS consists of clayey silt with lenses of sand and occasional gravel. The UCRS has been divided into three general horizons:

- Hydrologic Unit 1 (HU1)—loess and alluvium,
- HU2—an intervening sand and gravel interval, and
- HU3—a lower silt and clay interval.

These horizons are highly subjective, but each exhibits clear features that stand out throughout the PGDP. "UCRS" generally refers to the sand and gravel lithofacies of HU2, but also the silty clays of HU3 that confine the uppermost water-saturated units. The HU2 permeable units are only seasonally saturated and may be considered perched groundwater aquifers. UCRS groundwater flows downward into the RGA; hence, the term “recharge system.”

Strong vertical gradients exist between the UCRS and RGA, which display hydraulic head differences of as much as 30 ft. Head differences between the RGA and UCRS indicate a primary downward gradient from the UCRS to the RGA. Horizontal flow in the UCRS may exist nearer to the Porters Creek Terrace and further south as HU3 increases in grain size to a sandy clay in the area of SWMU 194.

When the HU2 layer is saturated, historical data show that hydraulic conductivity values range from 3.7×10^{-6} to 3.97×10^{-5} cm/s and storage coefficients range from 7.43×10^{-3} to 5.9×10^{-2}. As discussed previously, this lower clay unit serves as an aquitard. Perched groundwater has been measured to 20 ft bgs.

Regionally, the UCRS thickness ranges from 0 ft to 50 ft. In a study by Clausen et al. (1992a), UCRS hydraulic conductivity ranged from 1×10^{-8} to 1×10^{-2}cm/s. Groundwater in the UCRS originates as infiltrating rainfall (area recharge), infiltration from surface water, flow from the terrace gravels (underflow), leakage from construction activities, and leakage from utilities and other plant structures (point and line source recharge). Groundwater in the sand and gravel units of the UCRS has independent flow directions and rates.

3.2.2 Site Groundwater

Groundwater at the proposed DUF6 Conversion Facility was encountered in a perched zone in the UCRS corresponding to HU2 encountered at depths ranging from 15 to 24 ft. This zone consisted of clayey, sandy gravel to gravelly clay with clay above and below this zone.

4. RESULTS

4.1 NATURE AND EXTENT OF CONTAMINATION

The purpose of this data evaluation is to identify potential contaminants likely to be related to former or current activities at the site and to compare the data results for environmental media to promulgated and/or background concentrations to characterize the nature and extent of contamination.

4.1.1 Data Evaluation

All samples were collected in accordance with the project work plan (BJC 2000). The sampling procedures and results were evaluated for precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters and found to meet the criteria in the work plan (see Appendix H). The analytical methods used by the laboratory were consistent with the requirements of the work plan and were conducted in accordance with EPA Contract Laboratory Program (CLP) methods and procedures (per SW-846 requirements) and conformed with EPA Level IV requirements. The sampling and analytical methods are deemed appropriate and adequate for use in this site characterization report of the DUF6 Conversion Facility.

Quantitation Limit and Site-Related Constituents

Samples were collected from four environmental media at the site: soil, groundwater, surface water, and sediment. All samples from each media were analyzed for volatiles and semivolatiles, inorganics/metals, PCBs, and a broad spectrum of radionuclides common to the PGDP site. The sample quantitation limits (SQLs) reported by the laboratory met the project requirements; therefore, no uncertainty in the data analysis is associated with the reported SQLs.

The data were next examined to determine if organic compounds, inorganic/metal analytes, or radionuclides were detected in any medium sampled (i.e., soil, water). Because the SQLs were all lower than the promulgated criteria or background concentrations used to evaluate the site (i.e., site screening), any constituent that was not detected in a medium was not evaluated further in the nature and extent discussion. These constituents were therefore eliminated as potential site-related constituents (SRCs). If a constituent was detected in at least one environmental medium, it was considered to be a potential SRC and retained for further discussion in the nature and extent of contamination evaluation. The complete list of results for all constituents analyzed is presented in tables for each medium in Appendix G. Tables are presented in the following section only for potential SRCs.

Data Qualifier Summary

All sample data used in this characterization were generated by an approved laboratory and 10% of all samples were validated in accordance with EPA Functional Guidelines for Organic and Inorganic Data (EPA 1994a, 1994b). The samples that were validated include all the samples from sediment and surface water media and the soil and groundwater samples from borings UFSB01 and UFSB05. Both the laboratory and the independent data validation processes used a system of codes and data qualifiers (hereafter referred to as qualifiers) that pertain to quality assurance (QA)/quality control (QC) issues and may indicate questions regarding constituent identity, concentration, or both. Nonvalidated results were provided with only laboratory-applied qualifiers (Table 4.1). A review of the constituent data set used in this characterization (see Appendix G) showed that the following laboratory qualifiers were attached to certain data.

Table 4.1. Laboratory qualifiers

Qualifier	Definition
Inorganic	
*****	Duplicate analysis not within control limits
+	Method of standard additions (MSA) correlation coefficient less than 0.995
A	Indicates that a Tentatively Identified Compound (TIC) is suspected aldol-condensation product
B	Applies when the analyte is found in the associated blank
D	All the compounds identified in the analysis at the secondary dilution factor
E	Result estimated due to interferences
J	Indicates an estimated value
M	Duplicate injection precision not met
N	Sample spike recovery not within control limits
Q	No analytical result available or not required because total analyses < practical quantitation limit
R	QC indicates that the data are not usable. Re-sampling and reanalysis are necessary
S	Result determined by MSA
U	Analyte analyzed for but not detected at or below the lowest concentration reported
W	Post-digestion spike recovery out of control limits
X	Other specific flags and footnotes may be required to properly define the results
Organic	
A	TIC is suspected aldol-condensation product
B	Compound found in blank as well as sample
C	Compound presence confirmed by GC/MS (GC/MS flag)
D	Compounds identified in an analysis at a secondary dilution factor
E	Result exceeds calibration range (GC/MS flag)
J	Indicates an estimated value
N	Presumptive evidence of a compound (GC/MS flag)
P	Difference between results from two GC columns unacceptable
U	Compound analyzed for but not detected at or below the lowest concentration reported
X	Other specific flags and footnotes may be required to properly define the results
Y	MS/MSD recovery and/or relative percent difference (RPD) failed acceptance criteria
Z	Reserved by CLP for a laboratory-defined organic data qualifier
Radionuclides	
A	Analyzed for but not detected at the analyte quantitation limit
B	Method blank not statistically different from sample at 95% level of confidence
D	Sample is statistically different from duplicate at 95% level of confidence
J	Indicates an estimated value
L	Expected and measured value for laboratory control sample (LCS) is statistically different at 95% level of confidence
M	Expected and measured value for MS is statistically different at 95% level of confidence
R	QC indicates that data are not usable. Re-sampling and reanalysis are necessary for verification
T	Tracer recovery is < or equal to 30% or > or equal to 105%
U	Value reported is < the minimum detectable activity and/or < 2 sigma TPE
X	Other specific flags and footnotes may be required to properly define the results

The following qualifiers (Table 4.2) were attached to the validated data by the independent data validation team that reviewed approximately 10% of all the data as described above.

Table 4.2. Validation qualifiers

Qualifier	Definition
U	The material was analyzed for, but was not detected. The associated numerical value is the quantitation limit
J	Estimated value, either because QC criteria were not met or because the amount detected is below the documented quantitation limit
UJ	Undetected but the number reported as the quantitation limit is an estimated value
NJ	Presumptively present at an estimated quantity
R	Rejected, so data are of "information only" quality and should be supplemented with additional data for decision making
=	Data were validated; however, no qualifier was added
X	Data were not validated

Blank Contaminant Evaluation

Equipment, field, trip, and refrigerator blank samples were collected during the field-sampling event. The blank samples were collected, preserved, shipped, and handled by the field team and the laboratory in the same manner as the environmental media samples with which they are associated. Blank samples were also analyzed along with and in the same manner as the environmental samples as part of the sampling and analysis QC program. The results of the blank samples analyses are presented in QC tables provided in Appendix G .

Blank samples analyses provided a measure of contamination that may have been introduced into a sample either (1) in the field while the samples were being collected or transported to the laboratory or (2) in the laboratory during sample preparation or analysis. Therefore, constituents detected in the blank samples were compared with the constituents detected in the environmental media samples to prevent the inclusion of non-SRCs in the evaluation.

The EPA (1989) has identified several constituents that are considered to be common laboratory contaminants: acetone, methyl ethyl ketone, methylene chloride, toluene, and phthalate esters. Therefore, unless there was compelling evidence that these chemicals had been released at the site, these constituents were not considered to be SRCs.

Background Comparisons

In some circumstances, concentrations of certain constituents may be present in environmental media that are not SRCs. These "background" concentrations may arise from two conditions: (1) naturally occurring constituents that have not been influenced by humans and (2) constituents that are present due to anthropogenic sources. Therefore, a comparison of the concentrations of constituents in environmental samples to background concentrations was included in this site characterization. Comparison with naturally occurring background concentrations was only performed for inorganic/metal and radiological constituents in soil. All organic constituents detected at the site are considered to be contaminants unless they can be attributed to anthropogenic sources or are investigation induced (e.g., blank contamination, laboratory contaminants).

Background samples were not specifically collected from the DUF6 Conversion Facility site during the Summer 2000 site characterization field investigation; however, background concentrations for soil at the PGDP have been published (DOE 1996, 1997). The published surface and subsurface soil background concentrations used in this report are the 95 percent upper confidence bound on the 95th percentile concentration for the constituents detected in the A and B soil horizons, respectively, for the three dominant soil series located near the PGDP (DOE 1997). Note that most of the subsurface soil samples collected during the DUF6 site characterization were collected at depths greater than the B soil horizons (4 ft depth or less) sampled during the background study. As is shown in the following sections, the number of inorganic/metal and radionuclide constituents that exceed the soil background concentrations, particularly in undisturbed subsurface soils, suggests that the PGDP background concentrations may be too low. A summary of the PGDP background concentrations for surface soil and subsurface soil is presented in Appendix G.

Background concentrations for the groundwater operable unit at the PGDP have been developed and are currently undergoing regulatory review. These draft concentrations include values for the RGA which lies beneath the UCD in which the DUF6 site investigation was conducted. However, it is recognized that these draft groundwater background concentrations may not be specifically representative of the perched groundwater zone that was sampled during this investigation. Based on a general description of the geologic setting, the flow of perched groundwater within a lithologic unit dominated by clay at the DUF6 site compared to the sand and gravel dominated RGA suggests that background for the perched groundwater zone may have naturally higher inorganic/metal and radionuclide concentrations than the RGA background.

Screening SRCs Against Other Criteria

Appropriate background concentrations for the perched groundwater at the DUF6 site were not available. Therefore, the Maximum Contaminant Levels (MCLs) published by EPA (2000) were used as a point of comparison for the groundwater data. Because inorganics/metals and radionuclides are common constituents of groundwater, the MCL comparison provides a means to identify the SRCs that might contribute risk and hazards to human health. The maximum detected concentration for each SRC in both filtered and unfiltered groundwater is compared to the MCLs in tables presented in the following sections. As previously stated, all organic constituents detected in groundwater at the site are considered to be contaminants unless they can be attributed to anthropogenic sources or are investigation induced (e.g., blank contamination, laboratory contaminants).

Flow in the ditch where the three surface water samples and three of the four sediment samples were collected is ephemeral. The fourth sediment sample was collected from a small wetlands area in the wooded portion of the site. The site hydrologic conditions and the current and future industrial land use setting suggest that it is unlikely that significant human or ecological exposure to these media occurs. Therefore, for this report sediments were evaluated as surface soils and the detected concentrations are compared to the PGDP published surface soil background concentrations as described above. For surface water, the allowable instream concentrations of toxic substances for the protection of warm water aquatic habitat have been published by the State of Kentucky (401 KAR 5:031, Sect. 4, Table 2). Therefore, these criteria were used as a point of comparison for the surface water results. The numeric value of many of these criteria are dependent upon the hardness of the surface water under investigation. Because hardness of the surface water collected at the DUF6 site was not determined, a value of 50 mg/L, consistent with default value used by EPA Region 4 for setting ecological surface water criteria, was used to calculate the surface water criteria for chronic affects used in this report.

4.1.2 Surface Soil

A total of 19 surface soil samples and 2 duplicate samples was collected from 19 soil borings located across the site (see Fig. 2.1). Surface soil samples were collected from the 0- to 1-ft depth interval at each soil boring locations, with the exception of UFSB15 where no surface soil sample was collected. All samples were analyzed for volatiles and semivolatiles, inorganics/metals, PCBs, and radionuclides. The complete listing of laboratory results is provided in Appendix G. Table 4.3 provides summary statistics for the detected constituents and lists PGDP background concentrations that were used for comparison with the detected concentrations of each constituent. Table 4.4 provides analytical results for all constituents detected in surface soil at the site; results that exceeded the PGDP background values are indicated in the table.

Volatile Organic Compounds

No VOCs were detected in the surface soil samples above the SQLs.

Semivolatile Organic Compounds

Twelve SVOCs were detected in surface soils at the site (see Table 4.3). Of these 12 constituents, 10 are classified as polycyclic aromatic hydrocarbons (PAHs) and 2 are phthalates. The frequency of detection for all SVOCs was low, 4 out of 21 samples, or less, with the exception of di-n-butyl phthalate that was detected in 14 out of 21 samples.

The PAH constituents were detected only in four surface soil samples located at borings UFSB01, -02, -03, and -04. All four of these borings are located in the northern portion of the site (Fig. 4.1). The maximum PAH concentration detected was 4700 μg/kg of fluoranthene at location UFSB02. The largest number of PAHs were detected at locations UFSB01 and -02 (10 PAHs each); four PAHs were detected at location UFSB04 and one was detected at UFSB03.

Phthalates were detected in 13 surface soil samples located across the site. However, bis(2-ethylhexyl)phthalate was detected in only one sample at a concentration of 650 μg/kg at location UFSB19 along the southern perimeter of the site. Di-n-butyl phthalate was detected at 13 sample locations with no apparent pattern or distribution. The range of detected concentrations of di-n-butyl phthalate was 660 to 34,000 μg/kg with the maximum at location UFSB13 near the southeastern corner of the site. Because phthalates are recognized by the EPA as common laboratory contaminants they were not considered to be SRCs.

Polychlorinated Biphenyls

No PCBs were detected in surface soils at the site.

Inorganics

Twelve inorganic/metal constituents were detected in surface soils at the site (see Table 4.3). The frequency of detection for eight inorganics/metals, aluminum, barium, calcium, chromium, copper, nickel, vanadium, and zinc was relatively high (18 out of 21 samples, or higher). One or more of these constituents was detected at every surface soil location. The frequency of detection for four inorganic/metal constituents, arsenic, beryllium, lead, and silver, was relatively low (7 out of 21 samples, or less). Arsenic, beryllium, and lead were widely distributed at locations across the site, however, silver was detected only at locations UFSB03 and -04 in the northern portion of the site.

As shown in Table 4.4, the following nine inorganic/metal constituents exceeded the PGDP background for surface soils: beryllium, calcium, chromium, copper, lead, nickel, silver, vanadium, and zinc.

TABLE 4.3
SUMMARY OF SURFACE SOIL ANALYTICAL RESULTS
DUF6 CONVERSION FACILITY SITE CHARACTERIZATION
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY

PARAMETER	FREQUENCY OF DETECTIONS [a]	MAXIMUM	MINIMUM NON DETECTS	MAXIMUM NON DETECTS	PGDP[b] BACKGROUND	EXCEEDENCE YES/NO
Inorganics (mg/kg)						
Aluminum	21/21	12100			13000	No
Arsenic	5/21	7.29	5	5	12	No
Barium	21/21	110			200	No
Beryllium	6/21	0.98	0.5	0.5	0.67	Yes
Calcium	21/21	218000			200000	Yes
Chromium	20/21	67.5	2.5	2.5	16	Yes
Copper	21/21	38.6			19	Yes
Lead	7/21	38.4	20	200	36	Yes
Nickel	21/21	83.7			21	Yes
Silver	2/21	4.63	4	4	2.3	Yes
Vanadium	21/21	63			38	Yes
Zinc	18/21	273	200	200	65	Yes
Radionuclides (pCi/g)						
Activity of U-235	1/21	0.776	0.00247	0.119	0.14	Yes
Alpha activity	16/21	9.47	1.02	6.29	NA	NA
Beta activity	19/21	13.16	3.33	3.8	NA	NA
Cesium-137	18/21	1.06	0.014	0.112	0.494	Yes
Potassium-40	21/21	14			16.031	No
Protactinium-234m	1/21	16.6	-2.57	6.54	NA	NA
Radium-226	2/21	0.858	0.244	1.02	1.481	No
Technetium-99	1/21	4.1	-0.0887	2.85	2.535	Yes
Thorium-228	21/21	0.514			1.582	No
Thorium-230	21/21	0.605			1.452	No
Thorium-232	21/21	0.498			1.476	No
Uranium	1/21	34	1.72	3.48	4.9	Yes
Uranium-234	1/21	15.1	0.183	2.33	2.485	Yes
Uranium-238	1/21	18.2	0.679	2.02	1.221	Yes
Semivolatiles (ug/kg)						
Benz(a)anthracene	2/21	2200	440	500	NA	NA
Benzo(a)pyrene	2/21	2200	440	500	NA	NA
Benzo(b)fluoranthene	3/21	2800	440	500	NA	NA
Benzo(ghi)perylene	2/21	1200	440	500	NA	NA
Benzo(k)fluoranthene	2/21	1800	440	500	NA	NA
Bis(2-ethylhexyl)phthalate	1/21	650	440	500	NA	NA
Chrysene	3/21	2.5	0.44	0.5	NA	NA
Di-n-butyl phthalate	12/21	34000	480	2100	NA	NA
Fluoranthene	4/21	4700	440	500	NA	NA
Indeno(1,2,3-cd)pyrene	2/21	1400	440	500	NA	NA
Phenanthrene	2/21	2200	440	500	NA	NA
Pyrene	3/21	3400	440	500	NA	NA

NA - Criteria not available.
(a) Frequency of detections includes duplicate samples.
(b) PGDP background values for surface soil (A horizon) as published in DOE 1996 and 1997.

TABLE 4.4

ANALYTICAL RESULTS - DETECTED CONSTITUENTS FOR SURFACE SOIL [(a)]

DUF6 CONVERSION FACILITY SITE CHARACTERIZATION

PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH, KY

Sample ID	UFSB01S001	UFSB02S001	UFSB03S001	UFSB04S001	UFSB05S001	UFSB06S001	UFSB06S001D	UFSB07S001	UFSB08S001	UFSB09S001
Sample Date	7/12/00	7/21/00	7/19/00	7/20/00	7/18/00	7/21/00	7/21/00	7/19/00	7/19/00	7/18/00
Sample Depth	0' - 1'	0' - 1'	0' - 1'	0' - 1'	0' - 1'	0' - 1'	0' - 1'	0' - 1'	0' - 1'	0' - 1'
Inorganics (mg/kg)										
Aluminum	8760 *NW J	9540 *NW X	4170 *NW X	4760 *NW X	3860 *NW =	10200 *NW X	11300 *NW X	10300 *NW X	8390 *NW X	6420 *NW X
Arsenic					6.72 W =			5.11 W X		
Barium	45.5 =	65.8 * X	30.1 * X	36.7 X	27.2 *N J	84.2 X	100 X	83.9 * X	80.8 * X	100 *N X
Beryllium					**0.98 =**			0.51 X		0.53 X
Calcium	92200 *N =	53000 *NW X	**218000 *NW X**	196000 N X	5580 *N J	82700 N X	98800 N X	1580 *NW X	1350 *NW X	1610 *N X
Chromium	13.2 * =	11.6 X		5.85 X	**67.5 N J**	8.14 X	10.3 X	12.4 X	10.7 X	**17.1 N X**
Copper	6.21 =	9.54 X	4.63 X	4.9 X	8.73 =	**32.4 X**	**38.6 X**	8 X	7.7 X	6.04 X
Lead		23.8 N X						20.3 N X		
Nickel	9.31 =	11.6 X	7.12 X	8.86 X	**83.7 =**	10.4 X	12.4 X	10.4 X	7.78 X	11.5 X
Silver			**4.63 X**	**4.3 X**						
Vanadium	19.8 *N J	19.6 X	10 X	13.1 X	**63 W =**	16.4 X	20.8 X	22.2 X	18.1 X	20.4 W X
Zinc		61.8 X			46.4 N J	**67.7 X**	64.8 X	37.9 X	34.2 X	34.3 N X
Radionuclides (pCi/g)										
Activity of U-235		**0.776 X**								
Alpha activity		5.09 X	9.14 X		3.04 =	7.34 X		9.47 X	6.97 X	4.13 X
Beta activity	4.43 =		4.89 X	5.08 X	3.16 =		5.59 X	7.83 X	13.16 X	3.61 X
Cesium-137	0.112 =	**1.06 X**	**0.72 X**	0.385 X	0.0775 =	0.192 X	0.187 X	0.438 X	0.418 X	
Potassium-40	1.75 =	6.91 X	2.22 X	2.62 X	4.64 =	5.13 X	5.27 X	14 X	11.9 X	9.76 X
Protactinium-234m		16.6 X								
Radium-226						0.603 X		0.858 X		
Technetium-99							**4.1 X**			
Thorium-228	0.308 =	0.188 X	0.136 X	0.138 X	0.385 =	0.22 X	0.311 X	0.344 X	0.514 X	0.203 X
Thorium-230	0.49 =	0.486 X	0.537 X	0.605 X	0.352 =	0.44 X	0.43 X	0.345 X	0.443 X	0.149 X
Thorium-232	0.233 =	0.244 X	0.176 X	0.158 X	0.384 =	0.224 X	0.344 X	0.325 X	0.473 X	0.152 X
Uranium		**34 X**								
Uranium-234		**15.1 X**								
Uranium-238		**18.2 X**								
Semivolatiles (µg/kg)										
Benz(a)anthracene	980 =	2200 X								
Benzo(a)pyrene	950 =	2200 X								
Benzo(b)fluoranthene	1100 =	2800 X		490 X						
Benzo(ghi)perylene	480 =	1200 X								
Benzo(k)fluoranthene	920 =	1800 X								
Bis(2-ethylhexyl)phthalate										
Chrysene	1200 =	2500 X		550 X						
Di-n-butyl phthalate		1700 B X	1100 B X	2600 B X				660 B X	1900 B X	
Fluoranthene	2300 =	4700 X	540 X	820 X						
Indeno(1,2,3-cd)pyrene	570 =	1400 X								
Phenanthrene	1100 =	2200 X								
Pyrene	1700 =	3400 X		760 X						

TABLE 4.4

ANALYTICAL RESULTS - DETECTED CONSTITUENTS FOR SURFACE SOIL [(a)]

DUF6 CONVERSION FACILITY SITE CHARACTERIZATION

PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH, KY

(Continued)

Sample ID	UFSB10S001	UFSB11S001	UFSB12S001	UFSB13S001	UFSB14S001	UFSB16S001	UFSB17S001	UFSB18S001	UFSB19S001	UFSB19S001D	UFSB20S001
Sample Date	7/20/00	7/9/00	7/9/00	7/10/00	7/10/00	7/11/00	7/11/00	7/12/00	7/12/00	7/12/00	7/13/00
Sample Depth	0' - 1'	0' - 1'	0' - 1'	0' - 1'	0' - 1'	0' - 1'	0' - 1'	0' - 1'	0' - 1'	0' - 1'	0' - 1'
Inorganics (mg/kg)											
Aluminum	5750 *NW X	10600 *NW X	8570 *NW X	6910 *NW X	4470 *NW X	6320 NW X	7810 NW X	6780 NW X	5930 NW X	5580 NW X	12100 *NW X
Arsenic		5.19 B X						7.29 BW X			5.61 W X
Barium	60.3 X	74.9 * X	69.8 * X	41.3 * X	27.3 * X	83 X	77.5 X	110 X	58.2 X	57.7 X	90 X
Beryllium	**0.69 X**							0.58 X			0.58 X
Calcium	5580 W X	8760 *NW X	102000 *NW X	65100 *NW X	71500 *NW X	1040 *N X	731 *N X	1420 *N X	696 *N X	800 *N X	12700 NW X
Chromium	**17.4 X**	13.6 X	14.7 X	**33.9 X**	5.73 X	8.9 * X	14.1 * X	11.9 * X	8.08 * X	13.4 * X	**16.1 * X**
Copper	10 X	9.18 X	8.33 X	5.9 X	3.42 X	7.4 X	7.66 X	9.07 X	6.19 X	6.72 X	10.7 X
Lead			**38.4 X**	30.1 X	26.7 X	23.4 X		27.8 X			
Nickel	12.1 X	9.67 X	12.3 X	10.1 X	7.22 X	7.4 X	9.04 X	8.59 X	5.56 X	6.05 X	11.6 X
Silver											
Vanadium	24.6 X	26.9 X	19.4 X	18.5 X	16.9 X	16.4 *N X	22.1 *N X	26.2 *N X	16.9 *N X	26.6 *N X	34.9 *N X
Zinc	**273 X**	32.2 X	50.5 X	48.9 X	35.9 X	30.4 X	32.5 X	57.3 X	24.5 X	28.9 X	39.5 X
Radionuclides (pCi/g)											
Activity of U-235											
Alpha activity	4.52 X	5.23 X	5.82 X			7.93 X	5.93 X	8.1 X	6.33 X	7.2 X	3.93 X
Beta activity	1.81 X	10.87 X	3.97 X	4.93 X	8.02 X	5.4 X	4.42 X	5.26 X	3.76 X	3.3 X	3.57 X
Cesium-137	0.16 X	0.0593 X	0.128 X	0.261 X	0.0851 X	0.207 X	0.0888 X	0.168 X	0.0856 X		
Potassium-40	6.78 X	10.7 X	5.2 X	5.13 X	1.52 X	11.9 X	11 X	10.8 X	9.64 X	10.6 X	8.46 X
Protactinium-234m											
Radium-226											
Technetium-99											
Thorium-228	0.205 X	0.395 X	0.255 X	0.308 X	0.101 X	0.336 X	0.351 X	0.497 X	0.474 X	0.442 X	0.418 X
Thorium-230	0.23 X	0.413 X	0.391 X	0.379 X	0.453 X	0.39 X	0.349 X	0.364 X	0.331 X	0.432 X	0.393 X
Thorium-232	0.204 X	0.4 X	0.252 X	0.264 X	0.094 X	0.347 X	0.389 X	0.455 X	0.389 X	0.498 X	0.418 X
Uranium											
Uranium-234											
Uranium-238											
Semivolatiles (µg/kg)											
Benz(a)anthracene											
Benzo(a)pyrene											
Benzo(b)fluoranthene											
Benzo(ghi)perylene											
Benzo(k)fluoranthene											
Bis(2-ethylhexyl)phthalate									650 X		
Chrysene											
Di-n-butyl phthalate		1300 B X		34000 BDJX X		950 BJX X		1300 BJ X	1300 B X	1700 B X	1100 B X
Fluoranthene											
Indeno(1,2,3-cd)pyrene											
Phenanthrene											
Pyrene											

(a) All constituents detected in surface soils are listed. Result field consists of lab results followed by the result qualifier and validation qualifier, respectively.

See Tables 4.1 and 4.2 for explanation of qualifiers.

Blank cell indicates that result was below laboratory SQLs.

Shaded/bold result indicates exceedance of PGDP background for surface soil, A horizon (DOE 1996, 1997).

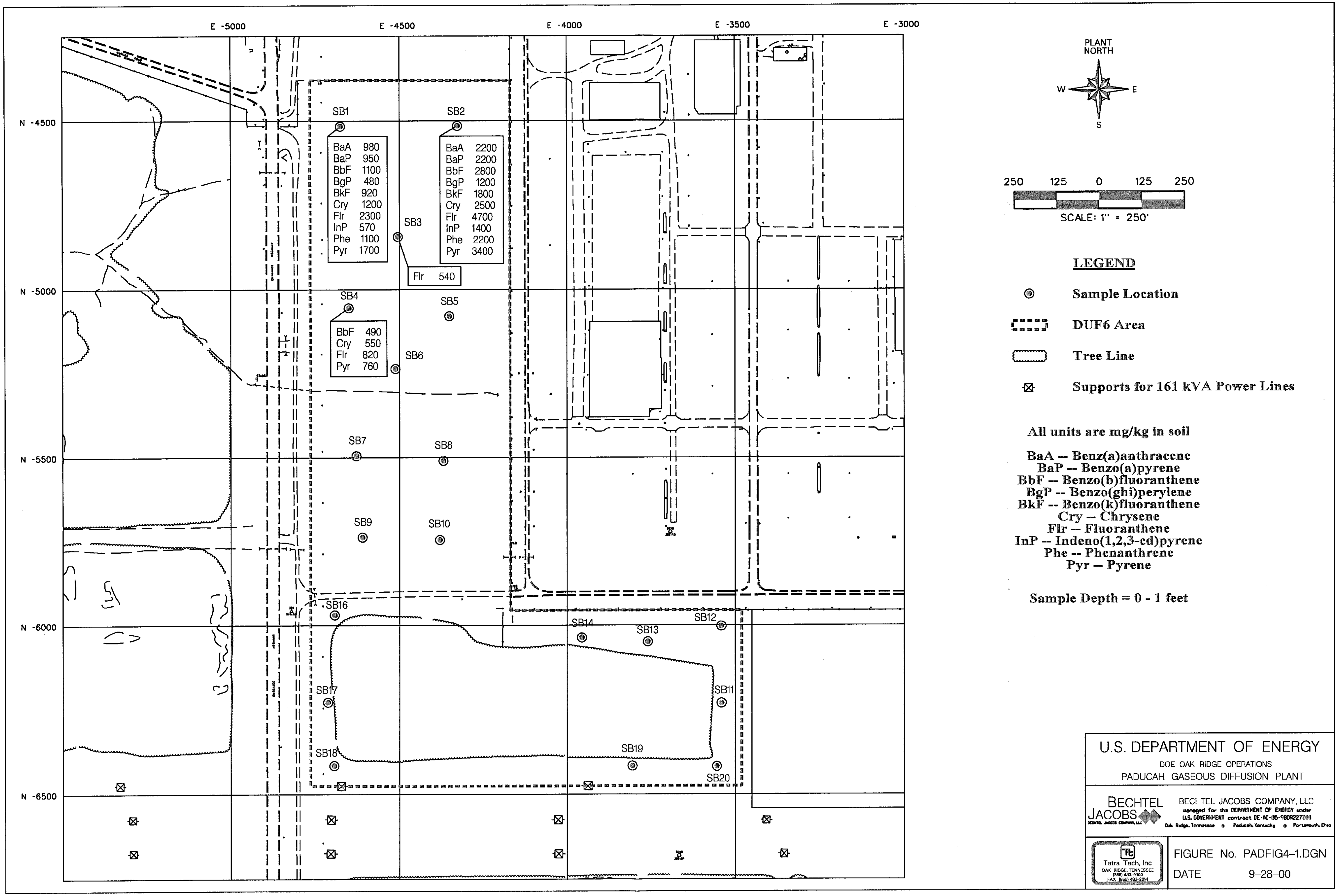

Fig. 4.1. Detections of organic constituents in surface soil.

Radionuclides

Twelve radionuclides and both alpha and beta activity were detected in surface soils at the site (see Table 4.3). The frequency of detections for alpha and beta activity, ^{137}Cs, ^{40}K, ^{228}Th, ^{230}Th, and ^{232}Th, was 16 out of 21 samples, or greater, and one or more of these isotopes was detected at every surface soil location. The maximum activity detected for this group of isotopes was 14 pCi/g of ^{40}K at location UFSB07 near the center of the site.

The frequency of detections for U, ^{234}U, ^{235}U, ^{238}U, ^{234}Pa, ^{226}Ra, and ^{99}Tc was relatively low (2 out of 21 samples, or less). The uranium isotopes and ^{234}Pa were only detected at one location, UFSB02, in the northern portion of the site. Radium-226 and ^{99}Tc were only detected at locations UFSB06 and -07 near the center of the site. The maximum activity detected for this group of isotopes was 34 pCi/g of U at location UFSB02.

As indicated in Table 4.4, the activity of six radionuclides exceeded the PGDP background for surface soils. Only samples from locations UFSB02, -03, and -06 exceeded background. The distribution of all radionuclides that exceed background at the site are shown in Fig. 4.2.

4.1.3 Subsurface Soil

A total of 81 subsurface soil samples and 5 duplicate samples was collected from 19 soil borings located across the site (see Fig. 2.1). Subsurface soil samples were collected at depths greater than 1 ft, and typically one sample representative of every 5-ft-depth interval was collected in each boring to the depth where groundwater was encountered. No soil samples were collected from UFSB15. All samples were analyzed for volatiles and semivolatiles, inorganics/metals, PCBs, and radionuclides. The complete listing of laboratory results is provided in Appendix G. Table 4.5 provides summary statistics for the detected constituents and lists the PGDP background concentrations that were used for comparison with the detected concentrations of each constituent. Table 4.6 provides analytical results for all constituents detected in subsurface soil at the site; results that exceeded the PGDP background values are indicated in the table.

Volatile Organic Compounds

Two VOCs, 2-butanone and acetone, were detected in the the surface soil samples at the site (see Table 4.5). 2-Butanone was detected in only one sample from 5 ft depth at location UFSB01 (see Fig. 2.1). Acetone was detected in 27 of 86 samples and was widely distributed at various depths across the site. The range of detected concentrations for acetone was 0.011 to 0.89 mg/kg.

The single detected concentration of 2-butanone was 0.01 mg/kg, but it was noted by the laboratory that the matrix spike (MS)/matrix spike duplicate (MSD), and/or the RPD failed acceptance criteria. It was also noted in the validated samples (see Appendix G) that 2-butanone in soil was typically rejected. Therefore, 2-butanone is not considered to be an SRC.

Acetone is recognized by the EPA as a common laboratory contaminant. Acetone was also detected in one field blank sample at a concentration of 0.07 mg/L. Approximately one-half of the acetone results were qualified by the laboratory as estimated concentrations (J qualifier), or the result exceeded the calibration range (E qualifier) of the equipment. For these reasons, acetone in subsurface soils at the site is considered to be a laboratory artifact and not an SRC.

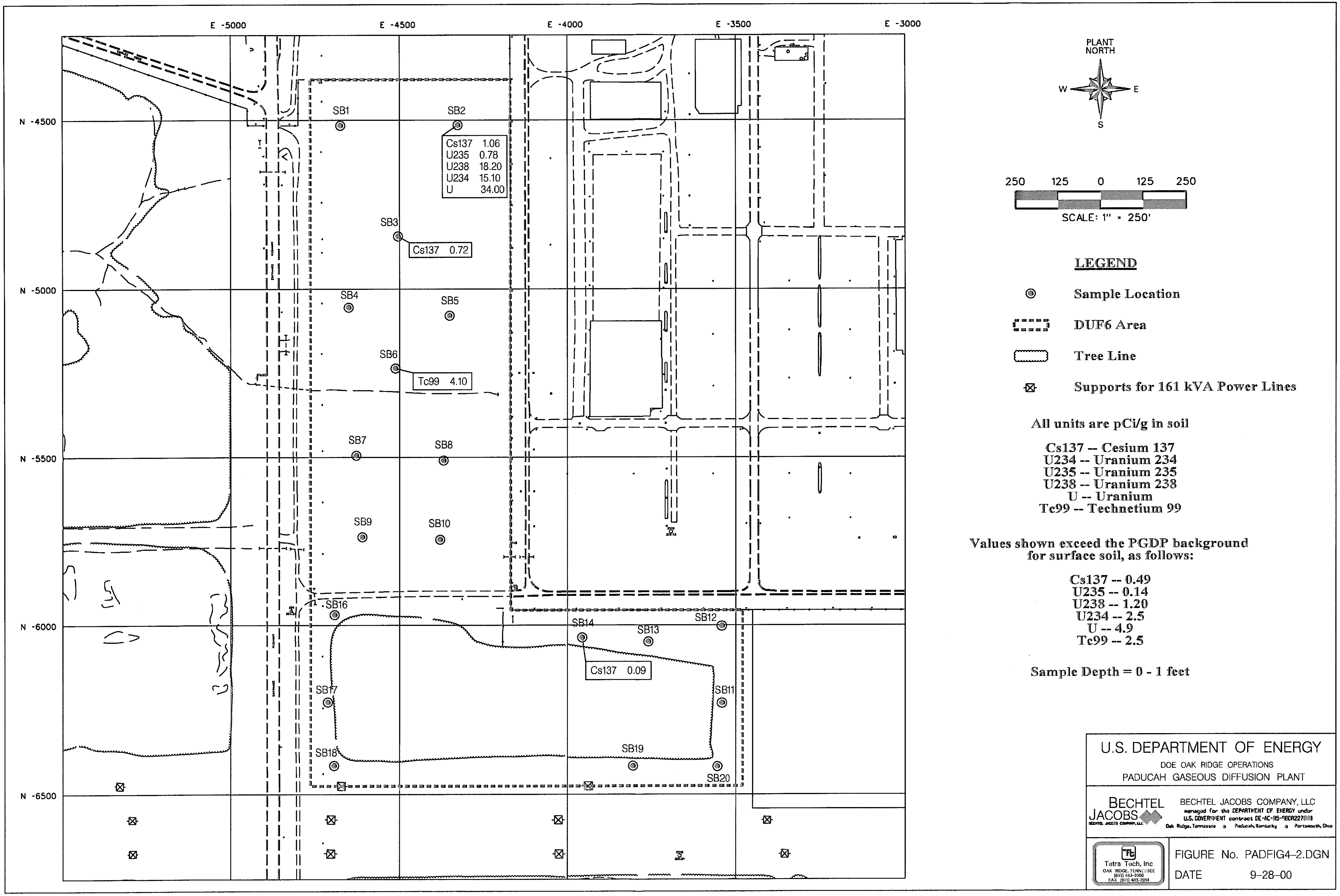

Fig. 4.2. Radionuclides that exceed background in surface soil.

TABLE 4.5
SUMMARY OF SUBSURFACE SOIL ANALYTICAL RESULTS
DUF6 CONVERSION FACILITY SITE CHARACTERIZATION
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY

PARAMETER	FEQUENCY OF DETECTIONS [a]	MAXIMUM	MINIMUM NON DETECTS	MAXIMUM NON DETECTS	PGDP[b] BACKGROUND	EXCEEDENCE YES/NO
Inorganics (mg/kg)						
Aluminum	84/84	15500			12000	Yes
Arsenic	15/84	13.4	5	5	7.9	Yes
Barium	84/84	1700			170	Yes
Beryllium	27	1.33	0.5	0.5	0.69	Yes
Calcium	84/84	132000			6100	Yes
Chromium	84/84	83.7			43	Yes
Copper	84/84	42.1			25	Yes
Lead	5/84	32.2	20	200	23	Yes
Nickel	76/84	50.5	5	5	22	Yes
Vanadium	84/84	63.9			37	Yes
Zinc	52/84	123	20	200	60	Yes
PCBs (mg/kg)						
PCB-1242	4/83	0.3	0.1	0.1	NA	NA
Polychlorinated biphenyl	4/83	0.3	0.1	0.1	NA	NA
Radionuclides (pCi/g)						
Activity of U-235	12/86	0.88	-0.0836	0.106	0.14	Yes
Alpha activity	1/86	10.2	6.52	6.52	NA	NA
Americium-241	1/86	0.141	-0.155	0.187	NA	NA
Beta activity	81	31.42	0.47	3.81	NA	NA
Cesium-137	1	0.0651	-0.0409	0.0375	0.283	No
Potassium-40	83/86	13.3	1.41	3.9	16.248	No
Protactinium-234m	1/86	55.4	-2.7	5.78	NA	NA
Radium-226	10/86	0.855	0.0094	0.994	1.518	No
Technetium-99	4/86	4.33	-0.776	2.8	2.779	Yes
Thorium-228	85/86	0.675	0.117	0.117	1.586	No
Thorium-230	81/86	0.549	0.0872	0.124	1.445	No
Thorium-232	86/86	0.596			1.487	No
Uranium	1/85	45.9	0.0835	6.72	4.6	Yes
Uranium-234	1/86	14.7	0.0282	3.38	2.438	Yes
Uranium-238	1/86	30.3	0	3.17	1.166	Yes
Semivolatiles (ug/kg)						
Bis(2-ethylhexyl)phthalate	2	2500	300	500	NA	NA
Di-n-butyl phthalate	44/83	22000	430	1400	NA	NA
Di-n-octylphthalate	1/83	300	430	500	NA	NA
Volatiles (ug/kg)						
2-Butanone	1/86	10	10	10	NA	NA
Acetone	27/86	890	10	43	A	NA

NA - Criteria not available.
(a) Frequency of detections includes duplicate samples.
(b) PGDP background values for subsurface soil (B horizon) as published in DOE 1996 and 1997.

TABLE 4.6
ANALYTICAL RESULTS - DETECTED CONSTITUENTS FOR SUBSURFACE SOIL [(a)]
DUF6 CONVERSION FACILITY SITE CHARACTERIZATION
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY

Sample ID	UFSB01S005	UFSB01S010	UFSB01S013	UFSB01S018	UFSB01S023	UFSB02S005	UFSB02S005D	UFSB02S010	UFSB02S015	UFSB02S020
Sample Date	7/12/00	7/12/00	7/12/00	7/13/00	7/13/00	7/21/00	7/21/00	7/21/00	7/21/00	7/21/00
Sample Depth	1' - 5'	5' - 10'	10' -13'	13' - 18'	18' - 23'	1' - 5'	1' - 5'	5' - 10'	10' - 15'	15' - 20'
Inorganics (mg/kg)										
Aluminum	11800 *NW J	9530 *NW J	10200 *NW J	5830 *NW J	7660 *NW J	**14100 *NW X**	**12600 *NW X**	10900 *NW X	7390 *NW X	4060 *NW X
Arsenic		5.47 W J								
Barium	49.4 =	116 =	63.7 =	24.5 =	20.3 =	45.7 * X	113 * X	**189 * X**	44.8 X	20.1 X
Beryllium			0.6 =	**0.89 =**	**0.75 =**		0.66 X	**1.13 X**		0.52 X
Calcium	858 NW =	1960 NW =	1450 NW =	785 NW =	910 NW =	3960 *NW X	**9550 *NW X**	3120 *NW X	1340 X	395 X
Chromium	12.5 * =	16.2 * =	15.2 * =	**49.9 * =**	**45.5 * =**	15.1 X	15.7 X	15.8 X	12.2 X	**55.3 X**
Copper	10.9 =	12.1 =	10.4 =	6.11 =	4.75 =	12.2 X	14.4 X	**42.1 X**	7.39 X	2.56 X
Lead							**25.9 N X**	**28.7 N X**		
Nickel	8.92 =	15.3 =	10.7 =	6.11 =	8.39 =	7.97 X	12.2 X	**50.5 X**	6.94 X	
Vanadium	22.7 *N J	25.6 *N J	32.7 *N J	**63.9 *N J**	**61 *N J**	13.7 X	20.2 X	**63.6 X**	18 X	**60.5 X**
Zinc	34.7 =	48 =	24.9 =			45.5 X	51.2 X	**123 X**		
PCBs (mg/kg)										
PCB-1242										
Polychlorinated biphenyl										
Radionuclides (pCi/g)										
Activity of U-235		0.0553 =					0.0807 X			
Alpha activity	8.07 =	7.59 =	6.81 =	4.87 =	2.8 =	8.16 X	3.48 X	8.65 X	5.61 X	5.11 X
Americium-241										
Beta activity	5.49 =	4.69 =	3.61 =	4.25 =	2.42 =		1.45 X	4.4 X	2.49 X	2.92 X
Cesium-137										
Potassium-40	9.82 =	9.78 =	8.06 =		1.21 =	10.7 X	12.1 X	12 X	7.58 X	2.01 X
Protactinium-234m										
Radium-226					0.409 =	0.855 X				
Technetium-99						**3.9 X**	**3.58 X**			
Thorium-228	0.533 =	0.504 =	0.539 =	0.465 =	0.166 =	0.316 X	0.145 X	0.404 X	0.35 X	0.232 X
Thorium-230	0.491 =	0.398 =	0.44 =	0.456 =	0.339 =	0.499 X	0.155 X	0.364 X	0.311 X	0.165 X
Thorium-232	0.493 =	0.469 =	0.487 =	0.384 =	0.227 =	0.394 X	0.165 X	0.385 X	0.397 X	0.251 X
Uranium										
Uranium-234										
Uranium-238										
Semivolatiles (µg/kg)										
Bis(2-ethylhexyl)phthalate						490 B X				
Di-n-butyl phthalate						1900 B X				1000 B X
Di-n-octylphthalate										
Volatiles (µg/kg)										
2-Butanone	10 Y J									
Acetone	74 J	19 J							350 E X	410 E X

TABLE 4.6

ANALYTICAL RESULTS - DETECTED CONSTITUENTS FOR SUBSURFACE SOIL [(a)]

DUF6 CONVERSION FACILITY SITE CHARACTERIZATION

PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH, KY

(Continued)

Sample ID	UFSB03S005	UFSB03S010	UFSB03S015	UFSB03S017	UFSB03S023	UFSB04S005	UFSB04S009	UFSB04S013	UFSB04S017	UFSB04S023
Sample Date	7/19/00	7/19/00	7/19/00	7/19/00	7/19/00	7/20/00	7/20/00	7/20/00	7/20/00	7/20/00
Sample Depth	1' - 5'	5' - 10'	10' - 15'	15' - 17'	17' - 23'	1' - 5'	5' - 9'	9' -13'	13' - 17'	17' - 23'
Inorganics (mg/kg)										
Aluminum	7970 *NW X	8540 *NW X	8220 *NW X	**13000 *NW X**	6200 *NW X	5890 *NW X	11100 *NW X	6590 *NW X	7970 *NW X	6070 *NW X
Arsenic				6.91 W X						
Barium	51.5 * X	106 * X	56.1 * X	69.5 * X	27.7 * X	34.7 X	83.5 X	73.4 X	90.3 X	38.8 X
Beryllium	0.61 X			0.64 X						
Calcium	**30500 *NW X**	2180 *NW X	1350 *NW X	1640 *NW X	971 *NW X	**132000 N X**	547 X	1090 X	1070 X	2160 X
Chromium	32.5 X	12.8 X	12.1 X	15 X	27.3 X	9.1 X	12.8 X	14.7 X	11.6 X	12.6 X
Copper	7.45 X	10.2 X	5.07 X	4.46 X	4.16 X	4.07 X	8.47 X	7.17 X	8.41 X	5.3 X
Lead										
Nickel	17.7 X	12.9 X	6.29 X	8.52 X	7.01 X	8.46 X	9.46 X	9.15 X	11 X	6.05 X
Vanadium	27.6 X	20.6 X	15.3 X	27.9 X	18.3 X	13.7 X	17.5 X	22.8 X	31.1 X	20.9 X
Zinc	59.7 X	35.1 X					36.2 X			
PCBs (mg/kg)										
PCB-1242										
Polychlorinated biphenyl										
Radionuclides (pCi/g)										
Activity of U-235										
Alpha activity	2.09 X	5.35 X	6.7 X	4.5 X	3.72 X		8.37 X	7.45 X	5.96 X	3.8 X
Americium-241										
Beta activity	2.03 X	2.94 X	3.58 X	1.93 X	1.98 X		2.85 X	3.81 X	2.62 X	1.21 X
Cesium-137										
Potassium-40	5.99 X	8.07 X	7.18 X	6.52 X	2.29 X	5.03 X	10.5 X	8.92 X	6.31 X	1.87 X
Protactinium-234m										
Radium-226					0.207 X					
Technetium-99								**3.56 X**		
Thorium-228	0.257 X	0.486 X	0.334 X	0.359 X	0.227 X	0.195 X	0.405 X	0.414 X	0.292 X	
Thorium-230	0.28 X	0.472 X	0.313 X	0.213 X	0.189 X	0.427 X	0.384 X	0.352 X	0.228 X	0.112 X
Thorium-232	0.258 X	0.557 X	0.379 X	0.353 X	0.255 X	0.219 X	0.397 X	0.404 X	0.253 X	0.0817 X
Uranium										
Uranium-234										
Uranium-238										
Semivolatiles (µg/kg)										
Bis(2-ethylhexyl)phthalate	2500 X									
Di-n-butyl phthalate	610 B X	1300 B X	1100 B X	1300 B X	1100 B X	2500 B X	2100 B X			3100 B X
Di-n-octylphthalate										
Volatiles (µg/kg)										
2-Butanone										
Acetone			11 X			88 X				

TABLE 4.6
ANALYTICAL RESULTS - DETECTED CONSTITUENTS FOR SUBSURFACE SOIL [(a)]
DUF6 CONVERSION FACILITY SITE CHARACTERIZATION
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY
(Continued)

Sample ID	UFSB04S027	UFSB05S005	UFSB05S010	UFSB05S013	UFSB05S017	UFSB05S023	UFSB06S005	UFSB06S007	UFSB06S013	UFSB07S005	UFSB07S010
Sample Date	7/20/00	7/18/00	7/18/00	7/18/00	7/18/00	7/18/00	7/21/00	7/21/00	7/21/00	7/19/00	7/19/00
Sample Depth	23' - 27'	1' - 5'	5' - 10'	10' - 13'	13' - 17'	17' - 23'	1' - 5'	5' - 7'	7' - 13'	1' - 5'	5' - 10'
Inorganics (mg/kg)											
Aluminum	4600 *NW X	7700 *NW =	11800 *NW =	6650 *NW =	7270 *NW =	8360 *NW =	11800 *NW X	**14600 *NW X**	7100 *NW X	**15500 *NW X**	7950 *NW X
Arsenic		5.94 W =						**13.4 W X**			
Barium	14.6 X	50.4 *N J	**208 *N J**	54 *N J	65.8 *N J	19.9 *N J	116 X	156 X	62.2 X	129 * X	88.6 * X
Beryllium		**0.81 =**	**1.09 =**					**0.92 X**		0.62 X	
Calcium	453 X	1600 *N J	1720 *N J	1520 *N J	1390 *N J	1200 *N J	2310 X	1710 X	1300 X	570 *NW X	1420 *NW X
Chromium	9.46 X	**83.7 N J**	13.2 N J	10.5 N J	10.1 N J	8.61 N J	15 X	17.2 X	10.6 X	19.3 X	15.1 X
Copper	3.34 X	8.22 =	14.6 =	7.34 =	7.8 =	3.62 =	9.43 X	17 X	7.15 X	13.8 X	8.12 X
Lead											
Nickel		9.78 =	21.6 =	7.6 =	8.13 =		13.6 X	21.1 X	6.98 X	18 X	13.2 X
Vanadium	22.1 X	**53.8 W =**	16.6 W =	15.2 W =	15.5 W =	11.7 W =	23.7 X	27.5 X	13.6 X	33 X	19.5 X
Zinc			59.4 N J	22.7 N J	25.6 N J		40 X	53.2 X		53.7 X	29 X
PCBs (mg/kg)											
PCB-1242											
Polychlorinated biphenyl											
Radionuclides (pCi/g)											
Activity of U-235	**0.88 X**							0.101 X			
Alpha activity	2.93 X	5.84 =	2.54 =	4.89 =	4.89 =	2.33 =	8.06 X	6.97 X	10.2 X	5.28 X	6.11 X
Americium-241											
Beta activity		3.96 =		3.1 =	2 =	1.41 =	4.52 X	3.63 X	3.08 X	7.46 X	2.28 X
Cesium-137											
Potassium-40	1.1 X	2.93 =	9.99 =	8.36 =	3.94 =	2.12 =	9.52 X	9.55 X	6.92 X	12.9 X	12.8 X
Protactinium-234m	55.4 X										
Radium-226					0.321 =						
Technetium-99											
Thorium-228	0.13 X	0.217 =	0.276 =	0.439 =	0.371 =	0.387 =	0.385 X	0.485 X	0.265 X	0.675 X	0.276 X
Thorium-230	0.136 X	0.187 =	0.203 =	0.389 =	0.213 =	0.258 =	0.439 X	0.549 X	0.227 X	0.409 X	0.303 X
Thorium-232	0.18 X	0.236 =	0.224 =	0.479 =	0.341 =	0.33 =	0.413 X	0.483 X	0.272 X	0.559 X	0.335 X
Uranium	**45.9 X**										
Uranium-234	**14.7 X**										
Uranium-238	**30.3 X**										
Semivolatiles (µg/kg)											
Bis(2-ethylhexyl)phthalate											
Di-n-butyl phthalate			22000 BE =					510 B X			580 B X
Di-n-octylphthalate											
Volatiles (µg/kg)											
2-Butanone											
Acetone			50 J		70 J			19 X			

TABLE 4.6
ANALYTICAL RESULTS - DETECTED CONSTITUENTS FOR SUBSURFACE SOIL [a]
DUF6 CONVERSION FACILITY SITE CHARACTERIZATION
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY
(Continued)

Sample ID	UFSB07S015	UFSB08S005	UFSB08S010	UFSB08S015	UFSB09S005	UFSB09S010	UFSB09S015	UFSB09S020	UFSB10S005	UFSB10S005D	UFSB10S010
Sample Date	7/19/00	7/19/00	7/19/00	7/19/00	7/18/00	7/18/00	7/18/00	7/18/00	7/20/00	7/20/00	7/20/00
Sample Depth	10' - 15'	1' - 5'	5' - 10'	10' - 15'	1' - 5'	5' - 10'	10' - 15'	15' - 20'	1' - 5'	1' - 5'	5' - 10'
Inorganics (mg/kg)											
Aluminum	6720 *NW X	9680 *NW X	9490 *NW X	8300 *NW X	11600 *NW X	9590 *NW X	9170 *NW X	8320 *NW X	6610 *NW X	8510 *NW X	7410 *NW X
Arsenic			6.58 W X								
Barium	39.8 * X	103 * X	136 * X	50 * X	111 *N X	94 *N X	35.1 *N X	32.4 *N X	82.8 X	102 X	70 X
Beryllium			**0.85 X**		**0.87 X**			0.63 X		0.5 X	
Calcium	860 *NW X	1190 *NW X	1640 *NW X	1160 *NW X	1030 *N X	1420 *N X	789 *N X	902 *N X	956 W X	1350 W X	1210 W X
Chromium	9.4 X	12.1 X	15.8 X	13.8 X	3.57 N X	14.5 N X	21.2 N X	26.9 N X	8.34 X	10.4 X	11.7 X
Copper	5.51 X	9.49 X	13.3 X	6.5 X	13.9 X	10 X	5.48 X	5.25 X	6.65 X	6.91 X	6.52 X
Lead											
Nickel	8.17 X	9.2 X	19.9 X	7.03 X	12.1 X	11.3 X	8.45 X	6.02 X	6.56 X	7.96 X	7.37 X
Vanadium	19.7 X	14.5 X	30.1 X	18.1 X	29.5 W X	21.2 W X	25.2 W X	35.6 W X	17.3 X	16.4 X	20.4 X
Zinc		34.7 X	42.9 X	20 X	32.2 N X	29.6 N X			26.3 X	27.9 X	
PCBs (mg/kg)											
PCB-1242											
Polychlorinated biphenyl											
Radionuclides (pCi/g)											
Activity of U-235										**0.164 X**	
Alpha activity	5.56 X	9.27 X	7.23 X	5.67 X	7.25 X	5.38 X	5.38 X	6.66 X	8.81 X	3.19 X	7.99 X
Americium-241											
Beta activity	5.7 X	15.78 X	21.09 X	31.42 X	4.2 X	5.58 X	3.58 X	2.77 X	4.09 X	2.26 X	4.12 X
Cesium-137											
Potassium-40	7.12 X	12 X	10.2 X	6.09 X	11.8 X	9.37 X	4.34 X	5.47 X	11 X	12 X	10.1 X
Protactinium-234m											
Radium-226											0.569 X
Technetium-99									**4.33 X**		
Thorium-228	0.283 X	0.309 X	0.35 X	0.361 X	0.409 X	0.283 X	0.454 X	0.32 X	0.479 X	0.332 X	0.254 X
Thorium-230	0.219 X	0.106 X	0.342 X	0.279 X	0.389 X	0.184 X	0.269 X	0.17 X	0.413 X	0.426 X	0.27 X
Thorium-232	0.312 X	0.366 X	0.361 X	0.341 X	0.486 X	0.215 X	0.455 X	0.244 X	0.549 X	0.456 X	0.276 X
Uranium											
Uranium-234											
Uranium-238											
Semivolatiles (µg/kg)											
Bis(2-ethylhexyl)phthalate											
Di-n-butyl phthalate	1100 B X	1200 B X	1200 B X	1900 B X	630 B X		1900 B X	570 B X	1100 B X	1300 B X	1500 B X
Di-n-octylphthalate											
Volatiles (µg/kg)											
2-Butanone											
Acetone				68 X					140 X	220 E X	

TABLE 4.6

ANALYTICAL RESULTS - DETECTED CONSTITUENTS FOR SUBSURFACE SOIL [(a)]

DUF6 CONVERSION FACILITY SITE CHARACTERIZATION

PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH, KY

(Continued)

Sample ID	UFSB10S015	UFSB11S005	UFSB11S005D	UFSB11S010	UFSB11S015	UFSB11S020	UFSB11S025	JFSB11S027	UFSB12S005	UFSB12S010	UFSB12S015
Sample Date	7/20/00	7/9/00	7/9/00	7/9/00	7/9/00	7/9/00	7/9/00	7/9/00	7/9/00	7/9/00	7/9/00
Sample Depth	10' - 15'	1' - 5'	1' - 5'	5' - 10'	10' - 15'	15' - 20'	20' - 25'	25' - 27'	1' - 5'	5' - 10'	10' - 15'
Inorganics (mg/kg)											
Aluminum	7320 *NW X	9100 *NW X	6850 *NW X	11300 *NW X	10600 *NW X	7930 *NW X	8540 *NW X		10900 *NW X	9820 *NW X	10100 *NW X
Arsenic		**8.86 B X**	6.04 B X	5.64 B X					6.05 X		
Barium	49.1 X	61.6 * X	50.3 * X	109 * X	107 * X	56.5 * X	73.3 * X		111 * X	103 * X	85.2 * X
Beryllium				0.655 X			0.555 X		0.66 X		
Calcium	1140 W X	1490 *NW X	1140 *NW X	1520 *NW X	1160 *NW X	944 *NW X	1360 *NW X		**37800 *NW X**	3970 *NW X	2800 *NW X
Chromium	11.6 X	11.9 X	10 X	16.7 X	17.2 X	10.6 X	10.1 X		24.5 X	17.3 X	13 X
Copper	4.99 X	7.53 X	6.12 X	13.7 X	5.4 X	4.63 X	5.09 X		11.3 X	6.95 X	6.46 X
Lead				20.2 X					**32.2 X**		
Nickel	7.05 X	7.34 X	6.38 X	20.4 X	9.31 X	7.21 X	5.74 X		18.7 X	12.1 X	7.3 X
Vanadium	17.9 X	29 X	21.5 X	32.4 X	28.8 X	23.4 X	12 X		24.9 X	21.4 X	23.3 X
Zinc		33.7 X	26.9 X	54.3 X	26.7 X		21 X		53.7 X	33.5 X	29.8 X
PCBs (mg/kg)											
PCB-1242		0.2 X		0.1 X			0.1 X				0.3 X
Polychlorinated biphenyl		0.2 X		0.1 X			0.1 X				0.3 X
Radionuclides (pCi/g)											
Activity of U-235					0.0905 X						0.0946 X
Alpha activity	5.53 X	6.29 X	5.81 X	5.34 X	4.17 X	5.86 X	5.65 X	6.62 X	5.47 X	6.08 X	4.71 X
Americium-241											
Beta activity	2.47 X	6.32 X	6.78 X	7.58 X	19.53 X	5.89 X	3.82 X	3.22 X	10.03 X	12.85 X	4.52 X
Cesium-137											
Potassium-40	7 X	11.1 X	9.39 X	12.8 X	6.81 X		8.2 X	7.51 X	9.07 X	9.2 X	5.31 X
Protactinium-234m											
Radium-226						0.669 X					
Technetium-99											
Thorium-228	0.185 X	0.501 X	0.375 X	0.365 X	0.375 X	0.302 X	0.458 X	0.249 X	0.379 X	0.366 X	0.295 X
Thorium-230	0.147 X	0.384 X	0.369 X	0.349 X	0.26 X	0.294 X	0.439 X		0.426 X	0.369 X	0.198 X
Thorium-232	0.173 X	0.502 X	0.465 X	0.394 X	0.336 X	0.406 X	0.43 X	0.208 X	0.413 X	0.433 X	0.311 X
Uranium											
Uranium-234											
Uranium-238											
Semivolatiles (µg/kg)											
Bis(2-ethylhexyl)phthalate											
Di-n-butyl phthalate	1500 B X	1200 B X								1100 BJ X	
Di-n-octylphthalate											
Volatiles (µg/kg)											
2-Butanone											
Acetone			260 EJ X			20 J X	24 J X	240 EJ X	22 J X	25 J X	11 J X

TABLE 4.6

ANALYTICAL RESULTS - DETECTED CONSTITUENTS FOR SUBSURFACE SOIL [a]

DUF6 CONVERSION FACILITY SITE CHARACTERIZATION

PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH, KY

(Continued)

Sample ID	UFSB12S020	UFSB13S005	UFSB13S010	UFSB13S015	UFSB13S020	UFSB14S005	UFSB14S010	UFSB14S015	UFSB14S018	UFSB16S005	UFSB16S010
Sample Date	7/9/00	7/10/00	7/10/00	7/10/00	7/10/00	7/10/00	7/10/00	7/10/00	7/10/00	7/11/00	7/11/00
Sample Depth	15' - 20'	1' - 5'	5' - 10'	10' - 15'	15' - 20'	1' - 5'	5' - 10'	10' - 15'	15' - 18'	1' - 5'	5' - 10'
Inorganics (mg/kg)											
Aluminum	6530 *NW X	11800 *NW X	**12600 *NW X**	9180 *NW X	10100 *NW X		10800 *NW X	**13700 *NW X**	6330 NW X	8960 NW X	7780 NW X
Arsenic		**8.22 X**			7.32 X				**10.1 BW X**		
Barium	162 * X	94.5 * X	**1700 * X**	71.6 * X	30.2 * X		87.1 * X	**1040 * X**	20.1 X	84.8 X	92 X
Beryllium					0.522 X				0.577 X		
Calcium	993 *NW X	2860 *NW X	4480 *NW X	1160 *NW X	829 *NW X		996 *NW X	1430 *NW X	439 *N X	713 *N X	1000 *N X
Chromium	16.3 X	17.9 X	18.6 X	14.3 X	40 X		18.7 X	17.7 X	**61.4 * X**	12.5 * X	11.6 * X
Copper	4.16 X	8.25 X	9.18 X	6.16 X	4 X		8.12 X	9.33 X	5.22 X	7.79 X	7.31 X
Lead											
Nickel	5.6 X	10.3 X	19 X	7.39 X	6.44 X		9.88 X	11.1 X	5.32 X	7.99 X	9.68 X
Vanadium	19.6 X	27.3 X	30 X	23.8 X	**49.1 X**		20.8 X	25.6 X	**63.8 *N X**	17.8 *N X	16.2 *N X
Zinc		35.4 X	41.1 X	23.6 X	20 X		35.8 X	28.3 X		37.5 X	29.4 X
PCBs (mg/kg)											
PCB-1242											
Polychlorinated biphenyl											
Radionuclides (pCi/g)											
Activity of U-235							0.0751 X				
Alpha activity	5.09 X	7.58 X	5.26 X	4.43 X	4.52 X	1.56 X	5.02 X	5.4 X	3.13 X	8.11 X	6.33 X
Americium-241											
Beta activity	4.06 X	6.44 X	3.82 X	3.63 X	2.91 X	2.84 X	5.7 X	2.69 X	3.03 X	4.79 X	3.7 X
Cesium-137		0.0651 X									
Potassium-40	4.79 X	8.02 X	12.1 X	7.17 X	3.23 X		11.1 X	7.23 X	3.25 X	11.1 X	9.97 X
Protactinium-234m											
Radium-226											
Technetium-99											
Thorium-228	0.216 X	0.391 X	0.449 X	0.326 X	0.272 X	0.118 X	0.466 X	0.383 X	0.156 X	0.372 X	0.471 X
Thorium-230		0.384 X	0.373 X	0.319 X	0.151 X	0.32 X	0.387 X	0.467 X		0.328 X	0.418 X
Thorium-232	0.128 X	0.376 X	0.447 X	0.336 X	0.25 X	0.13 X	0.465 X	0.433 X	0.146 X	0.307 X	0.41 X
Uranium											
Uranium-234											
Uranium-238											
Semivolatiles (µg/kg)											
Bis(2-ethylhexyl)phthalate											
Di-n-butyl phthalate	970 B X			640 BJX X	660 BJX X			500 BJX X	680 BJX X	7000 BJX X	1000 BJX X
Di-n-octylphthalate									300 JX X		
Volatiles (µg/kg)											
2-Butanone											
Acetone		33 X	620 EX X						350 E X		

TABLE 4.6

ANALYTICAL RESULTS - DETECTED CONSTITUENTS FOR SUBSURFACE SOIL [(a)]

DUF6 CONVERSION FACILITY SITE CHARACTERIZATION

PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH, KY

(Continued)

Sample ID	UFSB16S015	UFSB16S020	UFSB16S025	UFSB17S005	UFSB17S010	UFSB17S015	UFSB17S020	UFSB18S005	UFSB18S010	UFSB18S010D
Sample Date	7/11/00	7/11/00	7/11/00	7/11/00	7/11/00	7/12/00	7/12/00	7/12/00	7/12/00	7/12/00
Sample Depth	10' - 15'	15' - 20'	20' - 25'	1' - 5'	5' - 10'	10' - 15'	15' - 20'	1' - 5'	5' - 10'	5' - 10'
Inorganics (mg/kg)										
Aluminum	9510 NW X	4600 NW X	3940 NW X	10500 NW X	10600 NW X	5860 NW X	5090 NW X	11000 NW X	7700 NW X	7890 NW X
Arsenic								7.05 W X		
Barium	35.5 X	32.5 X	19.7 X	73.9 X	93.9 X	41.5 X	49.7 X	69.5 X	95.1 X	90.2 X
Beryllium					0.62 X		**1.33 X**			
Calcium	830 *N X	577 *N X	652 *N X	611 *N X	1230 *N X	1110 *N X	463 *N X	720 *N X	971 *N X	1130 *N X
Chromium	10 * X	18.3 * X	6.29 * X	12.3 * X	16.3 * X	8.6 * X	22.6 * X	14 X	22.3 * X	12.1 * X
Copper	4.29 X	4.02 X	2.81 X	8.76 X	10 X	5.28 X	5.5 X	8.71 X	8.72 X	8.02 X
Lead					21.7 X					
Nickel	6 X			9.39 X	13 X		6.39 X	9.43 X	15.1 X	10.2 X
Vanadium	12.3 *N X	17.9 *N X	9.61 *N X	18.7 *N X	31.7 *N X	8.7 *N X	**41.7 *N X**	23 *N X	19.6 *N X	17.7 *N X
Zinc				34.8 X	31.3 X		28.6 X	35.8 X	38.6 X	33.7 X
PCBs (mg/kg)										
PCB-1242										
Polychlorinated biphenyl										
Radionuclides (pCi/g)										
Activity of U-235					0.0554 X		0.0899 X			
Alpha activity	5.01 X	7.4 X	3.46 X	8.59 X	6.83 X	4.63 X	4.25 X	8.3 X	7.15 X	5.78 X
Americium-241										0.141 X
Beta activity	3.26 X	2.86 X	2.02 X	4.2 X	3.48 X	2.63 X	1.96 X	3.76 X	3.69 X	2.68 X
Cesium-137										
Potassium-40	6.08 X	4.8 X	2.12 X	10.1 X	8.76 X	5.5 X	4.51 X	9.33 X	9.12 X	9.44 X
Protactinium-234m										
Radium-226	0.591 X				0.486 X					0.458 X
Technetium-99										
Thorium-228	0.151 X	0.268 X	0.121 X	0.528 X	0.381 X	0.4 X	0.206 X	0.456 X	0.399 X	0.343 X
Thorium-230		0.342 X		0.437 X	0.23 X	0.338 X	0.17 X	0.382 X	0.329 X	0.28 X
Thorium-232	0.203 X	0.226 X	0.202 X	0.596 X	0.359 X	0.395 X	0.238 X	0.444 X	0.368 X	0.369 X
Uranium										
Uranium-234										
Uranium-238										
Semivolatiles (µg/kg)										
Bis(2-ethylhexyl)phthalate										
Di-n-butyl phthalate		3400 BJX X	820 BJX X	700 BJX X				730 B X	680 B X	770 B X
Di-n-octylphthalate										
Volatiles (µg/kg)										
2-Butanone										
Acetone										

TABLE 4.6
ANALYTICAL RESULTS - DETECTED CONSTITUENTS FOR SUBSURFACE SOIL [a]
DUF6 CONVERSION FACILITY SITE CHARACTERIZATION
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY
(Continued)

Sample ID	UFSB18S015	UFSB18S017	UFSB19S005	UFSB19S010	UFSB19S015	UFSB19S020	UFSB20S005	UFSB20S005D	UFSB20S010	UFSB20S015	UFSB20S020	UFSB20S025
Sample Date	7/12/00	7/12/00	7/12/00	7/12/00	7/12/00	7/12/00	7/13/00	7/13/00	7/13/00	7/13/00	7/13/00	7/13/00
Sample Depth	10' - 15'	15' - 17'	1' - 5'	5' - 10'	10' - 15'	15' - 20'	1' - 5'	1' - 5'	5' - 10'	10' - 15'	15' - 20'	20' - 25'
Inorganics (mg/kg)												
Aluminum	7460 NW X	4630 NW X	**14300 *NW X**	9100 *NW X	7370 *NW X	9980 *NW X	8870 *NW X	9000 *NW X	10600 *NW X	10800 *NW X	8050 *NW X	6080 *NW X
Arsenic							5.28 W X		5.3 W X			
Barium	58.1 X	24.8 X	142 X	95.7 X	50 X	19 X	83 X	83.5 X	144 X	81.9 X	33.6 X	15.3 X
Beryllium			0.58 X		0.53 X	0.53 X					0.62 X	
Calcium	1030 *N X	483 *N X	725 NW X	1170 NW X	785 NW X	544 NW X	1260 NW X	1170 NW X	1360 NW X	1100 NW X	668 NW X	347 NW X
Chromium	22 * X	22.7 * X	15 * X	15.7 * X	32.4 * X	29 * X	12.9 * X	14.1 * X	14 * X	17.1 * X	**55 * X**	12.7 * X
Copper	4.44 X	4.53 X	12.4 X	6.36 X	3.77 X	5.65 X	8.11 X	8.18 X	13.4 X	6.95 X	5.49 X	4.49 X
Lead												
Nickel	8.26 X		15.2 X	9.64 X	8.23 X	7.85 X	8.2 X	8.02 X	18.7 X	10.6 X	8.97 X	
Vanadium	15.1 *N X	16.9 *N X	20.8 *N X	18.6 *N X	27.7 *N X	32.6 *N X	27 *N X	24.4 *N X	23.5 *N X	25.2 *N X	**48.7 *N X**	15.2 *N X
Zinc			49.8 X	26.7 X		20.6 X	34.2 X	32.8 X	**60.5 X**	24.2 X		
PCBs (mg/kg)												
PCB-1242												
Polychlorinated biphenyl												
Radionuclides (pCi/g)												
Activity of U-235			0.0961 X							0.0721 X		
Alpha activity	5.28 X	8.72 X	7.95 X	8.6 X	5.26 X	3.24 X	4.55 X	4.45 X	5.12 X	3.29 X	5.69 X	3.65 X
Americium-241												
Beta activity	2.96 X	4.07 X	3.76 X	4.12 X	1.54 X		5.36 X	3.45 X	3.45 X	3.13 X	2.51 X	1.79 X
Cesium-137												
Potassium-40	7.2 X	9.28 X	9.47 X	7.98 X	4.51 X	1.6 X	11.1 X	13.3 X	9.77 X	6.88 X	3.9 X	1.98 X
Protactinium-234m												
Radium-226				0.474 X								
Technetium-99												
Thorium-228	0.248 X	0.382 X	0.507 X	0.468 X	0.432 X	0.304 X	0.47 X	0.474 X	0.588 X	0.412 X	0.37 X	0.14 X
Thorium-230	0.194 X	0.393 X	0.501 X	0.381 X	0.325 X	0.228 X	0.366 X	0.328 X	0.415 X	0.313 X	0.299 X	0.173 X
Thorium-232	0.256 X	0.453 X	0.465 X	0.404 X	0.4 X	0.198 X	0.465 X	0.502 X	0.586 X	0.337 X	0.426 X	0.21 X
Uranium												
Uranium-234												
Uranium-238												
Semivolatiles (µg/kg)												
Bis(2-ethylhexyl)phthalate												
Di-n-butyl phthalate	670 B X		2000 B X	1500 B X	2500 B X	2000 B X						
Di-n-octylphthalate												
Volatiles (µg/kg)												
2-Butanone												
Acetone			43 X				860 EX X	890 E X		60 X X	22 X X	

(a) All constituents detected in subsurface soils are listed. Result field consists of lab results followed by the result qualifier and validation qualifier, respectively.
See Tables 4.1 and 4.2 for explanation of qualifiers.
Blank cell indicates that result was below laboratory SQLs.
Shaded/bold result indicates exceedance of PGDP background for subsurface soil, B horizon (DOE 1996, 1997).

Semivolatile Organic Compounds

Three SVOCs were detected in subsurface soils at the site (see Table 4.5). All three of the SVOCs detected are phthalates. The frequency of detection for bis(2-ethylhexyl)phthalate and di-n-octylphthalate was low (2 and 1 out of 83 samples, respectively) and their maximum concentrations were 2500 and 300 μg/kg, respectively. On the other hand, di-n-butyl phthalate was detected in 52 out of 83 samples analyzed; its maximum concentration was 2200 μg/kg. With the exception of bis(2-ethylhexyl)phthalate and di-n-octylphthalate in one sample each, all detections of phthalates were qualified by the laboratory as occurring in associated blank samples (B qualifier). The EPA also recognizes the phthalate esters as common laboratory contaminants. For these reasons, phthalates are considered to be laboratory artifacts and not SRCs.

Polychlorinated Biphenyls

One PCB compound, PCB-1242, was detected in subsurface soils at the site (see Table 4.5). PCB-1242 was detected in 4 out of 83 samples. PCB-1242 was detected only at the 5, 10, and 25 ft depth in boring UFSB11 and at the 15 ft depth in boring UFSB12 that are located along the southeast perimeter of the site (see Fig. 2.1). As shown in Table 4.6, the maximum concentration of PCB-1242 was 0.3 mg/kg.

Inorganics

Eleven inorganic/metal constituents were detected in subsurface soils at the site (see Table 4.5). Six of these constituents, aluminum, barium, calcium, chromium, copper, and vanadium, were detected in every subsurface soil sample. Nickel and zinc were detected in 76 and 52 out of 84 samples, respectively. Arsenic and lead were detected in 15 and 5 out of 84 samples, respectively.

As shown in Table 4.5, all 11 inorganic/metal constituents detected at the site (aluminum, arsenic, barium, beryllium, calcium, chromium, copper, lead, nickel, vanadium, and zinc) exceeded the PGDP background for subsurface soils. As shown earlier in Sect. 4.1.1, and as pointed out in the following paragraph, the large number of inorganic/metal constituents that exceed background in undisturbed soils suggest that the PGDP subsurface soil background concentrations may not accurately represent the DUF6 site.

Radionuclides

Thirteen radionuclides and both alpha and beta activity were detected in subsurface soils at the site (see Table 4.5). The frequency of detections for alpha and beta activity, ^{40}K, ^{228}Th, ^{230}Th, and ^{232}Th, was 81 out of 86 samples, or greater, and one or more of these isotopes was detected in every subsurface soil sample. The maximum activity detected for this group of isotopes was 31.42 pCi/g of beta activity at 15 ft depth at boring location UFSB08 near the center of the site (see Fig. 2.1). As shown in Table 4.6, none of these isotopes exceeded the PGDP background concentrations for subsurface soil. There were no available criteria for alpha or beta activity.

The frequency of detections for ^{235}U, ^{226}Ra, and ^{99}Tc was relatively low (12, 10, and 4 out of 86 samples, respectively). Uranium and its isotopes ^{234}U and ^{238}U, ^{241}Am, ^{137}Cs and ^{234}Pa were each detected in only one sample. Uranium, ^{234}U, ^{238}U, and ^{234}Pa were only detected at 27 ft depth in boring location UFSB04, located near the center of the site. Americium-241 and ^{137}Cs were detected only at 10 and 5 ft depths at boring locations UFSB18 and -13, respectively, in the southern portion of the site. The maximum activity detected for this group of isotopes was 55.4 pCi/g of ^{234}Pa at location UFSB04 (see Fig. 2.1).

As indicated in Table 4.6, the activity of five radionuclides exceeded the PGDP background for subsurface soils. A total of nine samples from boring locations UFSB02, -04, and -10 exceeded background. The distribution of all radionuclides that exceeded background at the site is shown in Fig. 4.3.

4.1.4 Groundwater

Groundwater samples were collected from a perched groundwater zone encountered during the DUF6 site characterization. The data indicate that the perched zone is thin, likely to have a low yield, and a limited areal extent.. Only grab samples from open boreholes that penetrated a perched groundwater zone were collected and sample turbidity was visibly high. Therefore, only the filtered groundwater sample results are considered to have relevance to the MCLs used in the screening presented below.

Eleven groundwater samples and one duplicate were collected from 11 soil boring locations (UFSB01, UFSB02, UFSB04, UFSB05, UFSB06, UFSB07, UFSB08, UFSB09, UFSB10, UFSB11, and UFSB12). Sample UFSB05W027D is the duplicate groundwater sample from UFSB5. No groundwater sample was collected at location UFSB03. All of the groundwater samples except samples from UFSB11 and UFSB12 were collected from SWMU 194. All of the groundwater samples were collected from the perched zone that was encountered within a depth range of 15 to 24 ft. Groundwater samples were analyzed for VOCs, SVOCs, inorganics/metals, PCBs, and radionuclides. The analytical results of groundwater samples collected during the DUF6 site characterization are provided in Appendix G. Tables 4.7 and 4.9 summarize the statistical analysis of the unfiltered and filtered data, respectively. MCL concentrations are also presented in Tables 4.7 and 4.9. Tables 4.8 and 4.10 provide analytical results for all constituents detected in unfiltered and filtered groundwater at the site, respectively; results that exceed the MCLs are indicated in the table.

Volatile Organic Compounds

Acetone was the only VOC detected above SQLs. Acetone was detected in 6 of 11 groundwater samples at concentrations ranging from 12 µg/L to 57 µg/L. Acetone is recognized by the EPA as a common laboratory contaminant, and it was detected in one field blank sample at a concentration of 70 µg/L. For these reasons, acetone in groundwater at the site is considered to be a laboratory artifact and not an SRC.

Semivolatile Organic Compounds

Benzenemethanol was the only SVOC detected with three detections at two locations (UFSB05 and UFSB10) above SQLs. Benzenemethanol concentrations ranged from 5J µg/L to 6 µg/L; an MCL has not been established for this constituent.

Polychlorinated Biphenyls

All groundwater samples were analyzed for PCBs. There were no groundwater samples with PCB concentrations above SQLs.

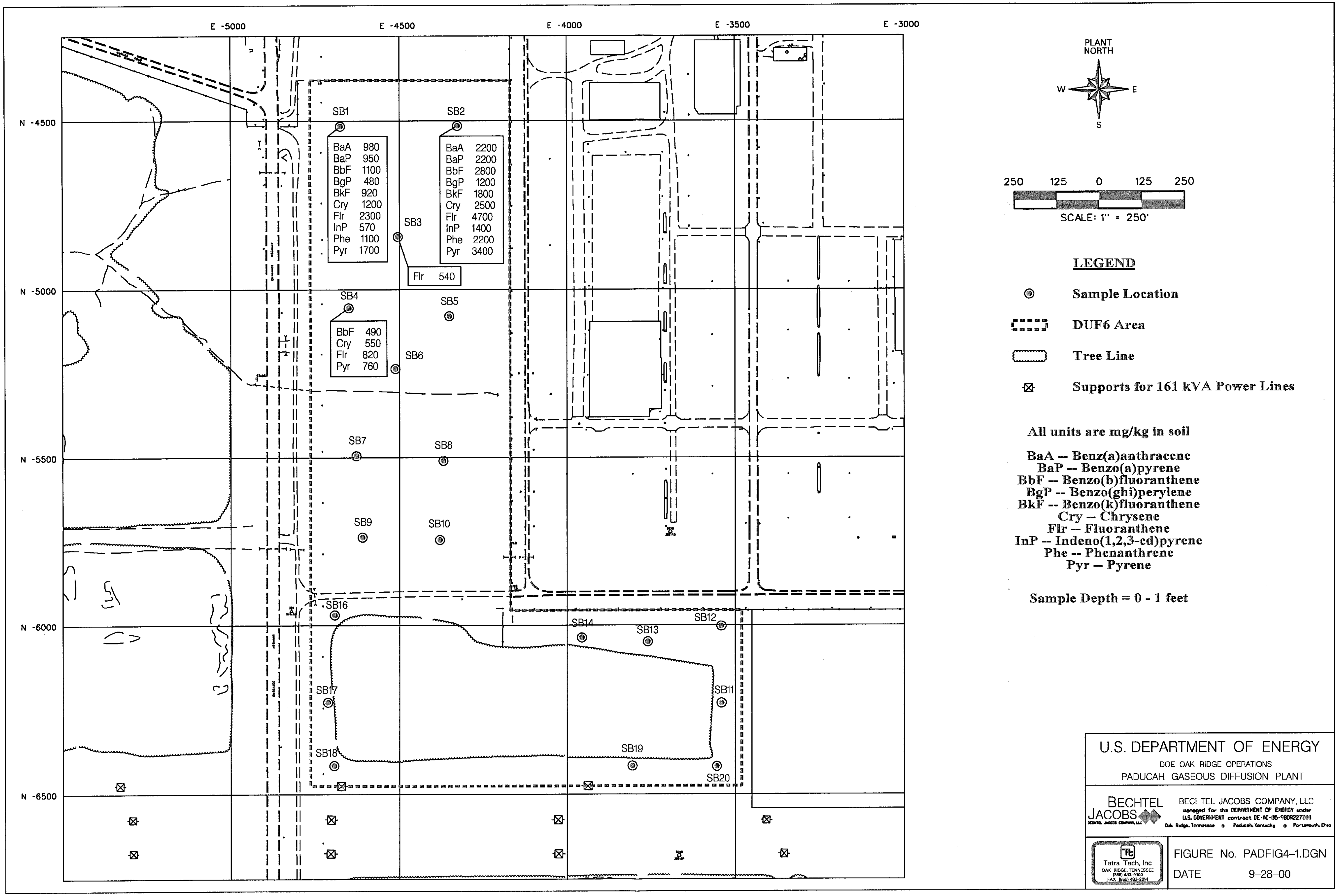

Fig. 4.1. Detections of organic constituents in surface soil.

TABLE 4.7
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS (UNFILTERED)
DUF6 CONVERSION FACILITY SITE CHARACTERIZATION
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY

PARAMETER	FREQUENCY OF DETECTION [a]	MAXIMUM	MINIMUM NON DETECTS	MAXIMUM NON DETECTS	MCL [b]	EXCEEDENCE YES/NO
Inorganics (mg/L)						
Aluminum	12/12	1200			0.2	Yes
Arsenic	5/12	0.012	0.005	0.05	0.005	Yes
Barium	12/12	3.89			2	Yes
Beryllium	7/12	0.055	0.005	0.005	0.004	Yes
Calcium	12/12	164			NA	NA
Chromium	11/12	2.52	0.025	0.025	0.1	Yes
Copper	10/11	0.397	0.025	0.025	1	No
Lead	4/12	0.967	0.2	0.2	0.015	Yes
Mercury	5/12	0.0011	0.0002	0.0002	0.002	No
Nickel	11/12	0.752	0.025	0.025	NA	NA
Selenium	1/12	0.012	0.005	0.05	0.05	No
Vanadium	11/12	3.67	0.025	0.025	NA	NA
Zinc	11/12	1.43	0.2	0.2	5	No
Radionuclides (pCi/L)						
Alpha activity (pCi/ml)	2/10	1.26	-0.01	0.06	0.015	Yes
Beta activity (pCi/ml)	2/10	1.14	-0.01	0.06	NA	NA
Potassium-40	5/10	1270	-219	271	NA	NA
Radium-226	5/10	294	169	398	5	Yes
Technetium-99	1/10	25.6	0	22.3	NA	NA
Thorium-228	6/10	0.937	-0.709	0.134	NA	NA
Thorium-230	4/10	0.977	-0.142	0.534	NA	NA
Thorium-232	3/10	0.498	-0.162	0.384	NA	NA
Volatiles (µg/L)						
Acetone	6/12	57	10	10	NA	NA
Benzenemethanol	3/12	6	5	5	NA	NA

NA - Criteria not available.

(a) Frequency of detections includes duplicate samples.

(b) MCLs as published by the EPA Office of Water, Summer 2000.

TABLE 4.8
ANALYTICAL RESULTS - DETECTED CONSTITUENTS FOR GROUNDWATER (UNFILTERED) [(a)]
DUF6 CONVERSION FACILITY SITE CHARACTERIZATION
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY

Sample ID	UFSB01W025	UFSB02W020	UFSB04W029	UFSB05W027	UFSB05W027D	UFSB06W018	UFSB07W018	UFSB08W075	UFSB09W020	UFSB10W015	UFSB11W020	UFSB12W020
Sample Date	7/13/00	7/21/00	7/20/00	7/18/00	7/18/00	7/21/00	7/19/00	7/19/00	7/18/00	7/20/00	7/10/00	7/10/00
Inorganics (mg/L)												
Aluminum	**1200 N J**	**159 N X**	**92.7 N X**	**127 N =**	**168 N =**	**84.6 N X**	**122 N X**	**906 N X**	**169 N X**	**314 N X**	**364 N X**	**1.32 N X**
Arsenic		**0.005 BNW X**	**0.007 BNW X**	**0.006 NW J**	**0.007 NW J**	**0.012 BNW X**						
Barium	**2.8 N J**	0.826 N X	0.4 N X	0.772 N J	1.08 N J	0.458 N X	0.391 N X	**3.89 N X**	1.06 N X	**2.15 N X**	**2.17 X**	0.164 X
Beryllium	**0.055 N J**	**0.007 X**			**0.006 =**			**0.029 X**	**0.006 X**	**0.012 X**	**0.022 X**	
Calcium	164 N J	65.9 N X	145 N X	44.6 N J	55.7 N J	61.4 N X	12.4 N X	118 N X	95.9 N X	82.6 N X	53.1 X	21.3 X
Chromium	**2.52 N J**	**0.242 X**	**0.206 X**	**0.148 =**	**0.217 =**	**0.139 X**	**0.122 X**	**1.24 X**	**0.202 X**	**0.583 X**	**0.435 X**	
Copper	0.397 N J	0.105 B X	0.045 B X	0.058 B =	0.105 B =	0.062 B X	0.044 B X	0.326 B X	NA	0.201 B X	0.144 B X	
Lead	**0.967 N J**							**0.304 N X**		**0.235 N X**	**0.216 N X**	
Mercury	0.0006 W =				0.0002 N J			0.0009 N X		0.0005 N X	0.0011 X	
Nickel	0.752 N =	0.081 X	0.114 X	0.086 =	0.127 =	0.063 X	0.059 X	0.574 X	0.107 X	0.281 X	0.202 X	
Selenium						0.012 NW X						
Vanadium	3.67 N J	0.371 X	0.107 X	0.241 =	0.327 =	0.19 X	0.183 X	1.55 X	0.322 X	0.638 X	0.661 X	
Zinc	1.4 N J	0.329 X	0.2 X	0.33 =	0.569 =	0.43 X	0.221 X	1.43 X	0.352 X	0.699 X	1.17 X	
Radionuclides (pCi/L)												
Alpha activity (pCi/ml)	**1.26 =**								**0.07 X**		NA	NA
Beta activity (pCi/ml)	1.14 =	0.07 X									NA	NA
Potassium-40			219 X			636 X		592 X	1270 X	598 X	NA	NA
Radium-226	**135 =**					**205 X**	**294 X**	**267 X**	**199 X**		NA	NA
Technetium-99					25.6 =						NA	NA
Thorium-228	0.937 =			0.211 =	0.517 =		0.145 X	0.327 X	0.47 X		NA	NA
Thorium-230	0.521 =		0.977 X	0.119 =	0.0892 =						NA	NA
Thorium-232	0.498 =			0.135 =	0.151 =						NA	NA
Volatiles (µg/ml)												
Benzenemethanol				5 J J	6 =					5 JX X		
Acetone		57 X	21 X	12 J				27 X		24 X	22 X	

(a) All constituents detected in unfiltered groundwater are listed. Result field consists of lab results followed by the result qualifier and validation qualifier, respectively.
See Tables 4.1 and 4.2 for explanation of qualifiers.
Blank cell indicates that result was below laboratory SQLs.
Shaded/bold result indicates exceedance of EPA MCL (published Summer 2000).

TABLE 4.9
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS (FILTERED)
DUF6 CONVERSION FACILITY SITE CHARACTERIZATION
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY

PARAMETER	FREQUENCY OF DETECTIONS [(a)]	MAXIMUM	MINIMUM NON DETECTS	MAXIMUM NON DETECTS	MCL [(b)]	EXCEEDENCE YES/NO
Inorgancis (mg/L)						
Aluminum	2/11	1.42	0.2	0.2	0.2	Yes
Barium	11/11	0.403			2	No
Calcium	11/11	78.5			NA	NA
Radionuclides (pCi/L)						
Activity of U-235	1/9	42.4	-15.6	0	NA	NA
Alpha activity (pCi/ml)	1/10	0.09	-0.04	0.06	0.015	Yes
Americium-241	1/10	56.9	-40	17.8	NA	NA
Beta activity	3/10	310	0	60	NA	NA
Plutonium-238	2/10	0.888	-0.378	0.132	NA	NA
Potassium-40	1/10	439	-298	239	NA	NA
Radium-226	1/10	179	-5.24	181	5	Yes
Technetium-99	2/10	24	0	22.1	NA	NA
Thorium-228	2/10	15.5	-1.01	0.115	NA	NA
Thorium-232	1/10	0.258	-0.526	0.0752	NA	NA

NA - Criteria not available.
(a) Frequency of detections includes duplicate samples.
(b) MCLs as published by the EPA Office of Water, Summer 2000.

TABLE 4.10
ANALYTICAL RESULTS - DETECTED CONSTITUENTS FOR GROUNDWATER (FILTERED) [(a)]
DUF6 CONVERSION FACILITY SITE CHARACTERIZATION
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY

Sample ID	UFSB01W025	UFSB02W020	UFSB04W029	UFSB05W027	UFSB05W027D	UFSB06W018	UFSB08W075	UFSB09W020	UFSB10W015	UFSB11W020	UFSB12W020
Sample Date	7/13/00	7/21/00	7/20/00	7/18/00	7/18/00	7/21/00	7/19/00	7/18/00	7/20/00	7/10/00	7/10/00
Inorganics (mg/L)											
Aluminum	**0.937 B J**		**1.42 X**								
Barium	0.089 J	0.176 X	0.048 X	0.213 =	0.213 =	0.12 X	0.156 X	0.331 X	0.3 X	0.403 X	0.12 X
Calcium	44.2 J	50.9 N X	22.8 N X	35.8 N =	36.6 N =	40.3 N X	35.3 N X	78.5 N X	50.3 N X	31.6 X	19.6 X
Radionuclides (pCi/L)											
Activity of U-235		42.4 X									
Alpha activity (pCi/ml)							**0.09 D X**				
Americium-241							56.9 X				
Beta activity (pCi/ml)							0.07 X			0.31 X	0.07 X
Plutonium-238	0.888 J						0.702 X				
Potassium-40										439 X	
Radium-226											**179 X**
Technetium-99				23.8 =	24 =						
Thorium-228								15.5 X		0.675 X	
Thorium-232										0.258 X	

(a) All constituents detected in filtered groundwater are listed. Result field consists of lab results followed by the result qualifier and validation qualifier, respectively.
See Tables 4.1 and 4.2 for explanation of qualifiers.
Blank cell indicates that result was below laboratory SQLs.
Shaded/bold result indicates exceedance of EPA MCL (published Summer 2000).

Inorganics/Metals—Unfiltered Samples

Thirteen inorganic/metal analytes were detected in the unfiltered groundwater samples collected during the DUF6 characterization investigation (see Table 4.7). Inorganic/metal analytes were detected at all 11 boring locations. Boring locations UFSB01 through UFSB11 had eight or more inorganic/metal analyte detections. Aluminum, barium, calcium, chromium, nickel, vanadium, and zinc were the most commonly detected inorganics/metals with 11 or more detections, including the duplicate (Table 4.7). Only alumimum, barium, and calcium were detected at boring location UFSB12; and no groundwater sample was collected at boring location UFSB05.

Six inorganic/metal analytes including aluminum (four locations), arsenic (four locations), barium (four locations), beryllium (seven locations), chromium (10 locations), and lead (four locations) were detected at concentrations that exceeded MCLs (Table 4.7). However, as previously noted, the high turbidity of the unfiltered groundwater samples suggests that inorganic/metal analyte concentrations are inflated due to the presence of suspended solids. Exceedance of the MCLs, therefore, is not considered conclusive evidence of groundwater contamination.

Inorganics/Metals—Filtered Samples

Three inorganic/metal analytes, aluminum, barium, and calcium, were detected in the filtered groundwater samples collected during the DUF6 characterization investigation (see Table 4.9). Barium and calcium were detected at all 11 boring locations; aluminum was detected only at boring locations UFSB01 and -04.

Aluminum at two locations was the only metal analyte to exceed MCLs. Calcium, considered by EPA to be an essential nutrient, does not have an MCL or secondary drinking water standard.

Radionuclides

Eight radionuclides and both alpha and beta activity were detected in perched groundwater (filtered and unfiltered samples) at the site (see Tables 4.7 and 4.9). The radionuclide ^{228}Th had seven detections, ^{40}K and ^{226}Ra had six detections each, and the remaining radionuclides had four or fewer detections. The groundwater sample and the duplicate from UFSB05 had the highest number of radionuclides detected with five detections. The maximum activity detected in the perched groundwater was 1270 pCi/L of ^{40}K at UFSB09 in the unfiltered samples. Unfiltered groundwater at UFSB01 had both the highest alpha activity (1.26 pCi/mL) and beta activity (1.14 pCi/mL). Only alpha activity and combined ^{226}Ra and ^{228}Ra have published MCL values. Considering both the filtered and unfiltered samples, the alpha activity MCL was exceeded at three boring locations (UFSB01, -08, and -09) and the activity of ^{226}Ra exceeded the combined ^{226}Ra and ^{228}Ra MCL at six boring locations (UFSB01, -06, -07, -08, -09, and -12).

4.1.5 Surface Water

Three surface water samples and one duplicate were collected from three locations, UFSW1, UFSW2, and UFSW3 (see Fig. 2.1). Sample UFSW02W000D is the duplicate sample from UFSW2. All of the surface water samples were collected from the drainage ditch that flows from east to west at the open field within SWMU 194. At the time of sample collection, only nonflowing pools of water were present in the ditch. Surface water samples were analyzed for VOCs, SVOCs, inorganics/metals, PCBs, and radionuclides. The analytical results of all surface water samples collected during the DUF6 site characterization are provided in Appendix G. Table 4.11 summarizes the statistical analysis of the data. Commonwealth of Kentucky allowable instream concentrations based on protection of aquatic life from

TABLE 4.11
SUMMARY OF SURFACE WATER ANALYTICAL RESULTS
DUF6 CONVERSION FACILITY SITE CHARACTERIZATION
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY

PARAMETER	FREQUENCY OF DETECTIONS [a]	MAXIMUM	MINIMUM NON DETECTS	MAXIMUM NON DETECTS	KENTUCKY[b] SURFACE WATER	EXCEEDENCE YES/NO
Inorganics (mg/L)						
Aluminum	3/4	0.409	0.2	0.2	NA	NA
Barium	4/4	0.152			NA	NA
Cadmium	3/4	0.028	0.02	0.02	0.00143	Yes
Calcium	4/4	144			NA	NA
Nickel	2/4	0.052	0.025	0.025	0.029	Yes
Radionuclides (pCi/g)						
Technetium-99	3/4	38.1	9.86	9.86	NA	NA

NA - Criteria not available.
(a) Frequency of detections includes duplicate samples.
(b) Kentucky surface water values are the allowable instream concentrations based on protecting aquatic habitat from chronic affects (published in Kentucky Administrative Record 5:031, Section 4, Table 2). A water hardness of 50 mg/L was assumed for the calculation of these values.

chronic affects are also presented in Table 4.11. The analytical results for all constituents detected in surface water samples are provided in Table 4.12; results that exceeded the Kentucky screening levels are indicated in the table.

Volatile Organic Compounds

There were no surface water samples with VOC concentrations above SQLs.

Semivolatile Organic Compounds

There were no surface water samples with SVOC concentrations above SQLs.

Polychlorinated Biphenyls

There were no surface water samples with PCB concentrations above SQLs.

Inorganics

Aluminum, barium, cadmium, calcium, and nickel were detected in surface water samples. The surface water sample and its duplicate at UFSW02 had positive detections for all five inorganic/metal analytes. Aluminum, barium, and calcium were detected at UFSW01. Barium, cadmium, and calcium were detected at UFSW03. Concentrations of both cadmium (locations UFSW02 and -03) and nickel (location UFSW02) exceeded the instream concentrations that are protective of warm water aquatic life (see Table 4.11); screening levels are not available for aluminum, barium, and calcium. Because of the industrial nature of the site and the intermittent nature of flow in the ditch in which the surface water samples were collected, it is unlikely that significant exposure of ecological receptors exists. The intermittent nature of flow in the ditch also indicates that surface water would not be used for domestic purposes.

Radionuclides

The only radionuclide detected in surface water was ^{99}Tc at boring locations UFSW02 and -03 in the drainage ditch. The maximum activity detected was 38.1 pCi/L at location UFSW02 (see Table 4.12).

4.1.6 Sediment

Four sediment samples and one duplicate were collected from four locations, UFSS1, UFSS2, UFSS3, and UFSS4 (see Fig. 2.1). Sample UFSS03W000D is the duplicate sample from UFSS3. Three sediment samples at locations UFSS1, UFSS2, and UFSS3 were collected from the drainage ditch that flows from east to west across the open field within SWMU 194. The sediment sample at location UFSS4 was collected from the eastern part of the wooded area of the site. Sediment samples were analyzed for VOCs, SVOCs, inorganics/metals, PCBs, and radionuclides. The analytical results of all sediment samples collected during the DUF6 characterization report are shown in Appendix G. Table 4.13 summarizes the statistical analysis of the data. The PGDP surface soil background levels are also presented in Table 4.13 for comparison with the sediment results. The analytical results of all constituents detected in sediment samples are shown in Table 4.14; results that exceeded the PGDP surface soil background are identified in the table.

The following PAHs were positively identified at estimated concentrations below the SQLs at location UFSS3: benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and pyrene.

TABLE 4.12

ANALYTICAL RESULTS - DETECTED CONSTITUENTS FOR SURFACE WATER [(a)]

DUF6 CONVERSION FACILITY SITE CHARACTERIZATION

PADUCAH GASEOUS DIFFUSION PLANT

PADCAH, KY

Sample ID	UFSW01W000	UFSW02W000	UFSW02W000D	UFSW03W000
Sample Date	**7/17/00**	**7/17/00**	**7/17/00**	**7/17/00**
Inorganics (mg/L)				
Aluminum	0.256 N =	0.315 N =	0.409 N =	
Barium	0.152 =	0.085 =	0.118 =	0.148 =
Cadmium		**0.026 =**	**0.028 =**	**0.021 =**
Calcium	68.3 N =	67.4 N =	92.7 N =	144 N =
Nickel		**0.052 =**	**0.05 =**	
Radionuclides (pCi/L)				
Technetium-99		38.1 =	28.9 =	29.5 =

(a) All constituents detected in surface water are listed. Result field consists of lab results followed by the result qualifier and validation qualifier, respectively.

See Tables 4.1 and 4.2 for explanation of qualifiers.

Blank cell indicates that result was below laboratory SQLs.

Shaded/bold result indicates exceedance of Kentucky allowable instream concentrations for protection of aquatic habitat from chronic affects (KAR 5:031, Section 4, Table 2).

TABLE 4.13
SUMMARY OF SEDIMENT ANALYTICAL RESULTS
DUF6 CONVERSION FACILITY SITE CHARACTERIZATION
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY

PARAMETER	FREQUENCY OF DETECTIONS [(a)]	MAXIMUM	MINIMUM NON DETECTS	MAXIMIM NON DETECTS	PGDP[(b)] BACKGROUND	EXCEEDENCE YES/NO
Inorganics (mg/kg)						
Aluminum	5/5	10800			13000	No
Barium	5/5	84.7			200	No
Beryllium	1/5	0.54	0.5	0.5	0.67	No
Calcium	5/5	74400			200000	No
Chromium	5/5	78			16	Yes
Copper	5/5	12.6			19	No
Lead	3/5	269	20	20	36	Yes
Nickel	5/5	13.5			21	No
Vanadium	5/5	29.1			38	No
Zinc	5/5	514			65	Yes
Radionuclides (pCi/g)						
Alpha activity	3/5	7.21	0.51	1.25	NA	NA
Beta activity	5/5	8.02			NA	NA
Cesium-137	3/5	0.42	-0.0177	0.00832	0.494	No
Potassium-40	5/5	8.44			16.031	No
Thorium-228	5/5	0.425			1.582	No
Thorium-230	5/5	0.395			1.452	No
Thorium-232	5/5	0.426			1.476	No
Semivolatiles (ug/kg)						
Di-n-butyl phthalate	1/5	12000	680	2600	NA	NA

NA - Criteria not available.
(a) Frequency of detections includes duplicate samples.
(b) PGDP background values for surface soil as published in DOE 1996 and 1997.

TABLE 4.14

ANALYTICAL RESULTS - DETECTED CONSTITUENTS FOR SEDIMENT [(a)]

DUF6 CONVERSION FACILITY SITE CHARACTERIZATION

PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH, KY

Sample ID Sample Date	UFSS01S000 7/17/00	UFSS02S000 7/17/00	UFSS03S000 7/17/00	UFSS03S000D 7/17/00	UFSS04S000 7/17/00
Inorganics (mg/kg)					
Aluminum	9240 *NW =	4380 *NW =	4350 *NW =	3610 *NW =	10800 *NW =
Barium	84.7 *N J	41.7 *N J	39.2 *N J	42.1 *N J	71.6 *N J
Beryllium	0.54 =				
Calcium	2040 *N J	2400 *N J	74400 *N J	66400 *N J	4380 *N J
Chromium	12.5 N J	8.26 N J	**38.2 N J**	**78 N J**	14.2 N J
Copper	10.6 =	6.47 =	10.2 =	11 =	12.6 =
Lead	21.2 =		**137 =**	**269 =**	
Nickel	13.5 =	7.41 =	11 =	9.43 =	12.7 =
Vanadium	29.1 W =	11.6 W =	13.3 W =	9.24 W =	22.3 W =
Zinc	44.5 N J	**134 N J**	**404 N J**	**514 N J**	**79.8 N J**
Radionuclides (pCi/g)					
Alpha activity	4.65 =	3.6 =			7.21 =
Beta activity	3.04 =	3.51 =	2.16 =	2.35 =	8.02 =
Cesium-137		0.0621 =		0.0356 =	0.42 =
Potassium-40	5.77 =	4.74 =	3.31 =	2.84 =	8.44 =
Thorium-228	0.248 =	0.161 =	0.081 =	0.0932 =	0.425 =
Thorium-230	0.236 =	0.149 =	0.285 =	0.263 =	0.395 =
Thorium-232	0.262 =	0.128 =	0.0654 =	0.0656 =	0.426 =
Semivolatiles (µg/kg)					
Di-n-butyl phthalate		12000 BE =			

(a) All constituents detected in sediments are listed. Result field consists of lab results followed by the result qualifier and validation qualifier, respectively. See Tables 4.1 and 4.2 for explanation of qualifiers.
Blank cell indicates that result was below laboratory SQLs.
Shaded/bold result indicates exceedance of PGDP background for surface soil, A horizon (DOE 1996, 1997).

Volatile Organic Compounds

There were no sediment samples with VOC concentrations above SQLs.

Semivolatile Organic Compounds

Di-n-butyl phthalate was the only SVOC with concentrations above SQLs and was found in all sediment samples including the duplicate. All detections of di-n-butyl phthalate were qualified (B qualifier) by the laboratory as occurring in associated blank samples, namely the laboratory method blank. The EPA also recognizes the phthalate esters as common laboratory contaminants. For these reasons, di-n-butyl phthalate is considered to be a laboratory artifact and not an SRC.

Polychlorinated Biphenyls

There were no sediment samples with PCB concentrations above analytical detection limits.

Inorganics

Ten inorganic/metals analytes were detected in sediments at the site. Aluminum, barium, calcium, chromium, copper, nickel, vanadium, and zinc were detected in all of the sediment samples. Beryllium was detected in only one sediment sample and lead was detected in three sediment samples. As indicated in Table 4.14, chromium, lead, and zinc were detected at concentrations that exceeded the PGDP background for surface soils. The exceedances occurred at sediment locations UFSS02, -03, and -04 (see Fig. 2.1). Similar to surface water, because of the industrial nature of the site and the intermittent flow of water in the ditch from which the sediment samples were collected, it is unlikely that a significant exposure to human or ecological receptors exists.

Radionuclides

Radionuclides detected in sediment included ^{137}Cs, ^{40}K, ^{228}Th, ^{230}Th, and ^{232}Th. Alpha and beta activities were also detected in sediment samples. The maximum radionuclide activity detected was 8.44 pCi/g of ^{40}K in sediment sample UFSS04 collected in the southern portion of the site in the wooded area. As seen in Table 4.13, none of the radionuclides exceeded the PGDP background for surface soils.

4.2 GEOTECHNICAL RESULTS

Surface soil samples were collected and analyzed for both disturbed and nondisturbed geotechnical properties. Loose material was collected in 3 1/2-gal buckets for determining the California Bearing Ratio and the Optimum Moisture Content using Standard Proctor Effort. The California Bearing Ratio was determined for surface soils at soil borings SB-3, -10, and -14. Additional material was collected using Shelby Tubes to determine various in situ soil properties. Table 4.15 lists the types of geotechnical analyses by sample identification number. Samples were collected from three distinct soil strata which typically consist of a thin layer of fill material underlain by fine-grained inorganic clays over a layer of clay soils containing approximately 22% gravel. Table 4.16 lists the soil classification results for the two clay layers. The upper layer of fill material was not classified based on the minimal thickness (i.e., 12-18 in.) of material, which most likely would be removed during grading operations. Table 4.17 summarizes the particle size analysis completed for the proposed site, including a hydrometer analysis. The optimum moisture content was computed for each geotechnical sample using the Standard Proctor Method. Table 4.18 summarizes the results from each Standard Proctor test specimen. Table 4.19 lists the results from one-dimensional consolidation testing. The compression ratio for the mid-level soils (i.e., 5-10 ft) ranges from 0.17 to 0.24. Table 4.20 summarizes the shear strength of the in situ soils as determined by triaxial shear testing. Table 4.21 includes the Atterberg limits for soil samples.

Table 4.15. Geotechnical sample parameters

Sample ID No.	Sample depth (bgs)	D2216-92 Moisture content	D2435 Soil bearing capacity	D2487-90 Soil classification	D2850 Triaxial shear strength	D422-63 Particle size	D4318-95 Atterberg limits	D4767 Triaxial shear strength	D1883 California Bearing Ratio	D698-91 Standard Proctor Test
UFSB03003	1-3 ft								x	x
UFSB03008	6-8 ft	x	x	x	x	x	x	x		
UFSB03023	21-23 ft	x	x	x	x	x	x	x		
UFSB03006	4-6 ft	x	x	x	x	x	x	x		
UFSB03022	20-22 ft	x	x	x	x	x	x	x		
UFSB10S009	7-9 ft	x	x	x	x	x	x	x		x
UFSB14S007	5-7 ft	x	x	x	x	x	x	x		
UFSB10S007	5-7 ft	x	x	x	x	x	x	x		
UFSB10S003	1-3 ft								x	x
UFSB14S003	1-3 ft								x	x
UFSB14S009	7-9 ft	x	x	x	x	x	x	x		x

Table 4.16. Soil classification results

Sample ID No.	UFSB03006	UFSB03022	UFSB14S007	UFSB10S007
% Retained on #200 sieve	4.8	47.2	2.9	3.4
% Passing #200 sieve	95.2	52.8	97.1	96.6
% Gravel	0.6	22.3	0	0
% Sand	4.3	24.8	2.9	3.4
D60 (Diameter at 60% passing)	0.01932	0.21456	0.01629	0.01858
D30 (Diameter at 30% passing)	0.00571	0.01918	0.00146	0.00737
D10 (Diameter at 10% passing)	0.00061	0.00088	0.00042	0.00086
Cc	31.73	243.48	39.41	21.67
Cu	2.77	1.95	0.31	3.37
Liquid limit	35	33	43	26
Plastic index	11	20	27	7
Atterberg classification	ML	CL	CL	CL-ML

Table 4.17. Particle size analysis

Sample ID No.			UFSB03S006	UFSB03S022	UFSB10S007	UFSB14S007
Specific gravity			2.647	2.66	2.683	2.658
Moisture content			21.90%	11.80%	27.10%	2570.00%
	Sieve No.	**Diameter (mm)**	**Percent finer**			
Coarse	3 in.	75.000	100.0	100.0	100.0	100.0
	1.5 in.	37.500	100.0	100.0	100.0	100.0
	0.75 in.	19.000	100.0	91.5	100.0	100.0
	0.375 in.	9.500	100.0	82.9	100.0	100.0
	#4	4.750	99.5	77.7	10.0	100.0
	#10	2.000	98.9	74.9	99.8	100.0
Fine	#20	0.850	98.3	730.0	99.4	99.0
	#40	0.425	97.9	69.3	98.9	98.3
	#60	0.250	97.0	62.2	98.4	97.5
	#100	0.149	95.9	55.9	97.6	97.0
	#140	0.106	95.6	54.0	97.3	96.8
	#200	0.075	95.2	52.8	97.1	96.6
Hydrometer analysis		0.05541	88.3	47.2	90.3	89.2
		0.03993	84.4	45.0	86.5	84.5
		0.02951	75.8	40.6	79.0	77.0
		0.01994	61.4	31.2	65.8	61.9
		0.01228	44.1	26.1	50.8	43.2
		0.00898	35.5	21.8	45.1	33.8
		0.00638	30.7	18.9	39.5	27.2
		0.00454	28.8	17.4	37.6	22.5
		0.00319	24.0	16.7	35.7	18.8
		0.00129	21.1	15.2	29.2	15.0

Table 4.18. Standard Proctor and California Bearing Ratio results

Sample ID No.	UFSB03S003	UFSS10S003	UFSB10S009	UFSB14S003	UFSB14S009
Borehole	3	10	10	14	14
Sample depth	3 ft bgs	3 ft bgs	9 ft bgs	3 ft bgs	9 ft bgs
Maximum dry density	126.5 pcf	109.1 pcf	108.3 pcf	120.8 pcf	109.7 pcf
Optimum moisture content	9.60%	15.30%	16.00%	11.70%	14.80%
Specific gravity	2.70	2.67	2.70	2.68	2.66
%> 3/8 in.	31.30%	13.30%	0.04%	19.70%	2.54%
California Bearing Ratio @ 90%	6.73	1.72	N/A	2.17	N/A
California Bearing Ratio @ 95%	12.73	3.83	N/A	3.38	N/A

Table 4.19. One-dimensional consolidation results

Sample ID No.	UFSB03S006	UFSB03S022	UFSB10S007	UFSB14S007
Borehole	3	3	10	14
Sample depth	4-6 ft bgs	20-22 ft bgs	5-7 ft bgs	5-7 ft bgs
Natural saturation	96.8%	87.0%	105.5%	86.1%
Natural moisture	22.6%	15.3%	36.3%	27.9%
Dry density	101.8 pcf	114.1 pcf	86.6 pcf	91.1 pcf
Specific gravity	2.65	2.66	2.65	2.66
Compression index	0.19	0.15	0.24	0.17
Void ratio	0.6178	0.469	0.9108	0.8604

Table 4.20. Triaxial shear test results

Sample ID No.	UFSB03S006		UFSB03S022		UFSB10S007		UFSB14S009	
Type of test	CU		CU		CU		CU	
Sample type	Undisturbed		Undisturbed		Undisturbed		Undisturbed	
Description	ML – Silt		CL – Sandy lean clay w/gravel		CL – Lean clay		Silty clay	
	Total	**Effective**	**Total**	**Effective**	**Total**	**Effective**	**Total0**	**Effective**
Cohesion (c)	0.0	0.0	0.0	0.0	0.2	0.0	0.0	2.9
Angle of internal friction	31.8	35.1	22.6	33.6	19.7	28.0	18.8	18.5

Table 4.21. Atterberg Limits

Sample ID	Liquid Limit	Plastic Limit	Placticity Index	USCS Symbol
UFSB03S003	30	13	17	CL
UFSB03S008	48	18	30	CL
UFSB03S023	29	12	17	CL
UFSB10S003	33	18	15	CL
UFSB10S009	49	16	33	CL
UFSB14S003	34	18	16	CL
UFSB14S009	30	18	12	CL
UFSB10S009	36	11	25	CL
UFSB14S009	28	21	7	CL-ML
UFSB03S006	35	24	11	ML
UFSB03S022	33	13	20	CL
UFSB10S007	43	16	27	CL
UFSB14S007	28	21	7	CL-ML

5. SUMMARY

5.1 ENVIRONMENTAL DATA

The field characterization performed at the Paducah DUF6 Conversion Facility site indicated the presence of organic, inorganic/metal, and radionuclide SRCs. Metal and radionuclide SRCs above background are sporadic but widespread throughout the site; their presence is consistent with prior preliminary historical and field characterizations. SRCs were not only detected in the northern portion of the site where prior operations occurred but were also identified in the southern portion of the site which has been relatively undisturbed. SVOCs (i.e., PAHs) were also detected but are limited to surface soil contamination in the northern portion of the site and estimated concentrations below SQLs in sediment sample UFSS03. PCBs were detected in subsurface soils, but detection was infrequent at low concentrations. There was no indication of VOC SRCs at the site. Table 5.1 summarizes maximum concentrations where contaminants are present above background levels.

5.2 GEOTECHNICAL DATA

In general, the data indicate that the northern section of the site consists primarily of clayey soils overlain by a layer (± 24 in.) of fill material and organic soils. The southern portion of the site is primarily silty to gravelly clays covered by highly organic soils, which support a wetlands habitat, dense trees, and heavy vegetation. The clay soils extend down approximately 23 ft to a perched groundwater zone and displays favorable soil properties (i.e., low plasticity index, moderate to high bearing capacity) capable of supporting industrial facilities.

5.3 CONCLUSIONS

The environmental data provide a basis for evaluating the presence of potential contamination, managing soil removed from the site, determining appropriate health and safety approaches during construction activities, and for establishing a baseline for follow-on activities. Environmental data included in Sect. 4.1 should be used to supplement data collected as a part of the WAG 28 RI (SWMU 194 is one of the sites within WAG 28) performed in accordance with CERCLA regulations. The combined data can be used to update risk assessments that will determine remedial actions, administrative controls, and/or future use determinations for the WAG 28 sites.

The geotechnical results indicate that the site soil characteristics are suitable for constructing industrial facilities. Geotechnical data included in this report provide a basis for planning buildings, roads, and other structures that will be constructed on-site. The wetland habitat area identified in the report provides a basis for determining equivalent wetland replacement, if required.

Table 5.1. Summary of maximum constituent concentrations above background[a]

	Medium				
Constituent	**Surface soil**	**Subsurface soil**	**Sediment**	**Surface water**	**Filtered groundwater**
Inorganics/Metals	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/L)**	**(mg/L)**
Aluminum		15,500 (12,000)[b]			1.4 (0.2)[c]
Arsenic		13.4 (7.9)[b]			
Barium		1700 (170)[b]			
Beryllium	0.98 (0.67)[b]	1.33 (0.69)[b]			
Cadmium				0.028 (0.001)[d]	
Calcium	218,000 (200,000)[b]	132,000 (6100)[b]			
Chromium	67.5 (16)[b]	83.7 (43)[b]	78 (16)[b]		
Copper	38.6 (19)[b]	42.1 (25)[b]			
Lead	38.4 (36)[b]	32.2 (23)[b]	269 (36)[b]		
Nickel	83.7 (21)[b]	50.5 (22)[b]		0.052 (0.029)[d]	
Silver	4.6 (2.3)[b]				
Vanadium	63 (38)[b]	63.9 (37)[b]			
Zinc	273 (65)[b]	123 (60)[b]	514 (65)[b]		
Radionuclides	**(pCi/g)**	**(pCi/g)**			**(pCi/g)**
Activity of Uranium-235	0.77 (0.14)[b]	0.78 (0.14)[b]			
Alpha activity					90 (15)[c]
Cesium-137	1.06 (0.49)[b]				
Radium-226					179 (5)[c]
Technetium-99	4.1 (2.5)[b]	4.3 (2.8)[b]			
Uranium	34 (4.9)[b]	45.9 (4.6)[b]			
Uranium-234	15.1 (2.5)[b]	14.7 (2.4)[b]			
Uranium-238	18.2 (1.2)[b]	30.3 (1.2)[b]			
SVOCs (mg/kg)[e]	**(μg/kg)**	**(μg/kg)**			
Benz(a)anthracene	2200				
Benzo(a)pyrene	2200				
Benzo(b)fluoranthene	2800				
Benzo(g,h,i)perylene	1200				
Benzo(k)fluoranthene	1800				
Chrysene	2500				
Fluoranthene	4700				
Indeno(1,2,3,-cd)pyrene	1400				
Phenanthrene	2200				
Pyrene	3400				
PCBs[e]	**(mg/kg)**	**(mg/kg)**			
PCB-1242		0.3			
Polychlorinated biphenyl		0.3			

[a]Data omitted from table indicates that the constituent was below background or not detected.
[b]Exceeds PGDP background (shown in parentheses).
[c]Exceeds EPA MCLs (shown in parentheses).
[d]Exceeds Kentucky allowable instream concentrations for protection of aquatic habitat (shown in parentheses).
[e]Background concentrations used for SVOCs and PCBs is 0.

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