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MAY 14 2009

Ms. Jennifer Tufts
U.S. Environmental Protection Agency, Region 4
Federal Facilities Branch
61 Forsyth Street
Atlanta, Georgia 30303

PPPO-02-448-09

Mr. Edward Winner, FFA Manager
Kentucky Department for Environmental Protection
Division of Waste Management
200 Fair Oaks Lane, 2nd Floor
Frankfort, Kentucky 40601

Dear Ms. Tufts and Mr. Winner:

RETRANSMITTAL OF THE SITE EVALUATION REPORT FOR ADDENDUM 2 SOIL PILES AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY (DOE/LX/07-0188&D1)

Reference: Letter from R. Knerr to T. Ballard and E. Winner, "Transmittal of the Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/LX/07-0188&D1)," (PPPO-02-323-09), dated April 3, 2009

Please find enclosed the D1 *Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/LX/07-0188&D1). This document was previously submitted on April 3, 2009 (reference) without the "cleared for public release" stamp on the cover although the review for public release was performed on February 13, 2009. Please note that there are no changes to the contents of the document. The only difference between the two submittals is the addition of the "cleared for public release" stamp on the document cover.

If you have any questions or require additional information, please contact David Dollins at (270) 441-6819.

Sincerely,

Reinhard Knerr
Paducah Site Lead
Portsmouth/Paducah Project Office

Enclosure:
D1 SER Addendum 2 Soil Piles

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CERTIFICATION

Document Identification: ***Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** **(DOE/LX/07-0188&D1)**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Paducah Remediation Services LLC

Myrna Redfield
Deputy Environmental Restoration/Monitoring Director

5/4/09
Date Signed

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

U.S. Department of Energy (DOE)

Reinhard Knerr, Paducah Site Lead

5/4/09
Date Signed

DOE/LX/07-0188&D1
Primary Document

Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

This document is approved for public release per review by:

[signature] 2.13.09
Paducah Classification and Control Office — Date
Swift and Staley Team

DOE/LX/07-0188&D1
Primary Document

Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—April 2009

Prepared for the
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
PADUCAH REMEDIATION SERVICES, LLC
managing the
Environmental Remediation Activities at the
Paducah Gaseous Diffusion Plant
under contract DE-AC30-06EW05001

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PREFACE

This *Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0188&D1, (SER) was prepared as a result of implementing the *Sampling and Analysis Plan for Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015&D2/R1, (DOE 2007a) and associated *Addendum 2 to the Sampling and Analysis Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015/A2&D2.

This SER is the second of four to address soil and rubble pile areas in the vicinity of the Paducah Gaseous Diffusion Plant, as identified in the Notification Letter submitted to U.S. Environmental Protection Agency and Kentucky Department for Public Protection, dated February 16, 2007. This SER addresses soil sampling at soil piles located west of the Paducah Gaseous Diffusion Plant along Bayou Creek. It was developed in accordance with the requirement in Section IX of the Federal Facility Agreement for submittal of an integrated removal/remedial Site Evaluation and Solid Waste Management Unit Assessment Report.

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CONTENTS

FIGURES

TABLES

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ACRONYMS

AL	action level
AOC	area of concern
ASER	Annual Site Environmental Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COPC	chemical of potential concern
CSM	conceptual site model
DOE	U.S. Department of Energy
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
ISOCS	*In Situ* Object Counting System
KPDES	Kentucky Pollutant Discharge Elimination System
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
NA	not applicable
NAL	no action level
NCP	National Contingency Plan
NIST	National Institute of Standards and Technology
ORPS	Occurrence Reporting and Processing System
PAH	polyaromatic hydrocarbon
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
PPPO	Portsmouth/Paducah Project Office
PSS	plant shift superintendent
QC	quality control
RCRA	Resource Conservation and Recovery Act
RGA	Regional Gravel Aquifer
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SER	Site Evaluation Report
SRM	standard reference material
SWMU	solid waste management unit
SWOU	Surface Water Operable Unit
TCE	trichloroethene
VOC	volatile organic compound
WKWMA	West Kentucky Wildlife Management Area
XRF	X-ray fluorescence

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EXECUTIVE SUMMARY

This Site Evaluation Report (SER) presents the results of the comprehensive sampling effort completed for Addendum 2 Soil Piles along Bayou Creek. Sampling and analysis were completed in accordance with the following agency-approved secondary documents:

- *Sampling and Analysis Plan for Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015&D2/R1, (SAP) 2007; and

- *Addendum 2 to the Sampling and Analysis Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015/A2/&D2, 2008.

In December 2006, soil sampling was completed at Addendum 2 Soil Piles 14 and 15, which are located off DOE property, to assess further site conditions. The results of this sampling effort indicated levels below detection or at background for radionuclides, metals, and polychlorinated biphenyls (PCBs). Addendum 2 Soil Piles, distributed across approximately 88 acres, represents over one-half of the total number of soil piles identified in the February 2007 notification letter. The 54 piles that comprise the Addendum 2 soil piles are located along Bayou Creek west of the Paducah Gaseous Diffusion Plant (PGDP) vary in size and shape, ranging from approximately 3 to 450 ft in length and from 2 to 8 ft in height. The field investigation was conducted between August and September 2008.

PROJECT OBJECTIVES

The study was designed to obtain sufficient data of known quality to support the following objectives:

- Establish the nature and extent of contamination of soils in Addendum 2 Soil Piles and adjacent soils.
- Establish the mean concentrations of contaminants in soils.
- Determine if soils pose imminent risks to human health.
- Determine if soils contamination exceeds regulatory thresholds.

INVESTIGATION SUMMARY

The following provides the planned sampling activities for Addendum 2 Soil Piles and an accounting of the actual number and types of samples collected. Addendum 2 to the PGDP Soil Piles SAP specified the collection and analysis of these samples:

- Fifty-four surface samples (24 small piles, 30 large piles) to undergo field measurements and fixed laboratory analysis

- One hundred seven surface samples (24 small pile locations, 83 large pile locations) to undergo field measurements only

- Sixty subsurface samples (25 small pile locations, 35 large pile locations), where subsurface is defined as soil taken at a depth below 1 ft, to undergo field measurements and fixed laboratory analysis

- Two hundred ten subsurface samples (31 small pile locations, 179 large pile locations) to undergo field measurements only

- A number of contingency samples (no more than 40), if contamination was identified

During execution of Addendum 2, the total number of soil samples collected was as follows:

- Fifty-four surface samples underwent field measurements and fixed laboratory analysis
- Fifty-five surface samples underwent field measurements only
- Fifty-six subsurface samples underwent field measurements and fixed laboratory analysis
- One hundred eleven subsurface samples underwent field measurements only
- No contingency samples were collected

The differences between planned and actual sample numbers resulted from three factors.

First, the observed differences in subsurface samples result entirely from variations in soil pile height. Because the soil pile height, on average, was less than 5 ft, a fewer number of samples than that estimated in the Addendum 2 to the SAP were required to reach the natural grade.

Second, many of the large soil piles were smaller than planned in the Addendum 2 SAP, resulting in less area to be sampled.

Third, the concentration of analytes (i.e., chemicals of potential concern) in samples was less than the screening criteria in the Addendum 2 SAP; therefore, no contingency samples were required.

INVESTIGATION FINDINGS

Sample results indicate no PCBs detected. Generally, metals results were statistically the same as background, based upon the results being below the 95^{th} percentile of the generic statewide ambient background values. Polyaromatic hydrocarbons (PAHs) were detected (benzoanthracene, pyrene, anthracene, chrysene, and fluoranthene between 0.72 and 2.1 ppm) in two samples collected from the 54 Addendum 2 soil piles. The PAHs detected are considered outliers and not indicative of contamination. Cesium-137 and plutonium-239/240 radionuclides were detected at or below background and are considered the result of fallout. As a result, these chemicals are not considered site related contaminants.

SUMMARY OF INVESTIGATION CONCLUSIONS

Nature and Extent of Contamination

Data of known quality were acquired in sufficient quantities to allow decision makers to formulate an informed decision as to the need for an action at any of the Addendum 2 Soil Piles, if warranted. Samples were collected from 54 soil piles and, as noted, were not significantly different from background. No clear evidence of contamination was identified (Section 6) and no documentation was found as a result of the historical document review to demonstrate the presence of wastes. Accordingly, the available information indicates that the piles do not meet the regulatory definition of a solid waste management unit (SWMU) or area of concern (AOC). As defined in the Federal Facility Agreement, a SWMU “means any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which routine and systematic releases of hazardous wastes or hazardous constituents has occurred.” AOCs “shall include any area having a probable or known release of a hazardous waste, hazardous constituent or hazardous substance which is not from a solid waste management unit and which poses a current or potential threat to human health or the environment."

It should be noted that the February 16, 2007, Notification indicated that 102 of the 122 soil and rubble areas (including Addendum 2 54 soil piles) are being designated as a SWMU and/or AOC. It also states that DOE will be "evaluating whether the areas are SWMUs or AOCs.…" The Addendum 2 SER is the second of four SERs being provided as part of the evaluation and, as stated and detailed within the document, provides documentation to support the conclusion that Addendum 2 piles do not meet the definition of a SWMU or AOC.

Assessment of Human Health Risks

The results of the background screening for metals indicate concentrations used to quantify risks and hazards were at background levels for all 54 soil piles. No PCBs were detected. For uranium, the concentrations are below the individual recreational user screening level for a 1 mrem/year dose and, therefore, below the "walk away" level in the PGDP Risk Methods Document.

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1. INTRODUCTION

This Site Evaluation Report (SER) has been developed in accordance with the requirement in Section IX of the Paducah Gaseous Diffusion Plant (PGDP) Federal Facility Agreement (FFA) for the submittal of an integrated removal/remedial SER/Solid Waste Management Unit (SWMU) Assessment Report. The report is organized as follows:

- Project Scope, Objectives, and Background
- Area Description
- Field and Analytical Methods
- Quality Assurance/Quality Control (QC)
- Discussion and Results
- Data Screening
- Conclusions
- Recommendations

1.1 PROJECT SCOPE

During November, 2006, soil piles were discovered by the U.S. Department of Energy (DOE) and the Commonwealth of Kentucky along Bayou and Little Bayou Creek, outside of the PGDP industrialized area. Initial field radiation surveys of some Little Bayou Creek soil piles indicated elevated levels of radioactivity. However, surveys of piles along Bayou Creek, west of PGDP did not indicate levels of radioactivity above background. Based on these initial field results, DOE planned to determine if any of the piles posed an immediate threat to human health or public safety. A sampling plan to evaluate Addendum 2 Soil Piles was developed and approved by the regulatory agencies. The provisions for this program are contained in two DOE secondary documents:

- *Sampling and Analysis Plan for the Soil Piles at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015&D2/R1, (SAP) 2007; and

- *Addendum 2 to the Sampling and Analysis Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015/A2/&D2, 2008.

Addendum 2 field work was implemented at the soil piles between August and September 2008. This SER presents the results of that effort and includes the data generated from field activities, an evaluation of project data quality and usability, assessment of the potential risks to human health, and conclusions. See Figure 1 for Addendum 2 Soil Pile locations along Bayou Creek.

As noted in both the SAP and Addendum 2, the focus of the investigation was to evaluate conditions in the soil piles along Bayou Creek and adjacent soils. The scope of the project was to examine conditions, evaluate potential human health risks, and compare soil pile contaminant concentrations [to background and action levels (ALs)] to support future decisions.

1.2 PROJECT OBJECTIVES

The principal study objective of the Addendum 2 Soil Piles sampling effort was to determine if contamination is present and, if so, determine the nature and extent of soil contamination in soil piles and adjoining soils. The data quality objectives (DQOs) include the following:

- Establish the nature and extent of contamination in Addendum 2 Soil Piles and adjacent soils.
- Establish the mean concentrations of contaminants in soils.
- Determine if soils pose imminent risks to human health.
- Determine if soils contamination exceeds regulatory thresholds.

1.3 REGULATORY OVERVIEW

PGDP was placed on the National Priorities List on May 31, 1994. In accordance with Section 120 of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), DOE entered into an FFA with the U.S. Environmental Protection Agency (EPA) Region 4 and Kentucky. The FFA established one set of consistent requirements for achieving comprehensive site remediation in accordance with CERCLA and Resource Conservation and Recovery Act (RCRA), including stakeholder involvement.

The DOE Portsmouth/Paducah Project Office (PPPO) is responsible for environmental management activities associated with PGDP (CERCLIS# KY8-890-008-982) and serves as the lead agency for response actions at PGDP. EPA Region 4 and Kentucky Department for Environmental Protection serve as the regulatory oversight agencies for the facility.

Addendum 2 Soil Piles are identified in the notification letter dated February 16, 2007.

1.4 PROJECT BACKGROUND

Following the November 2, 2006, discovery and notifications to the regulators of contamination found in a soil pile located along Little Bayou Creek, field efforts were initiated to identify other piles. Once a pile was identified, the initial effort included a preliminary radiological survey of soil piles and adjoining soils. Initial reconnaissance and subsequent surveys noted no elevated radioactivity in Addendum 2 soil piles.

In December 2006, soil sampling was completed at Addendum 2 Soil Piles 14 and 15 (Figure 1), which are located off DOE property, to further assess site conditions. The results of this sampling effort indicated levels below detection or at background for radionuclides, metals, and polychlorinated biphenyls (PCBs).

A complete gamma walkover survey was performed for Addendum 2 Soil Piles during 2008. The results of this survey confirmed those of the initial survey and found no elevated radioactivity for any of the 54 Addendum 2 Soil Piles along Bayou Creek.

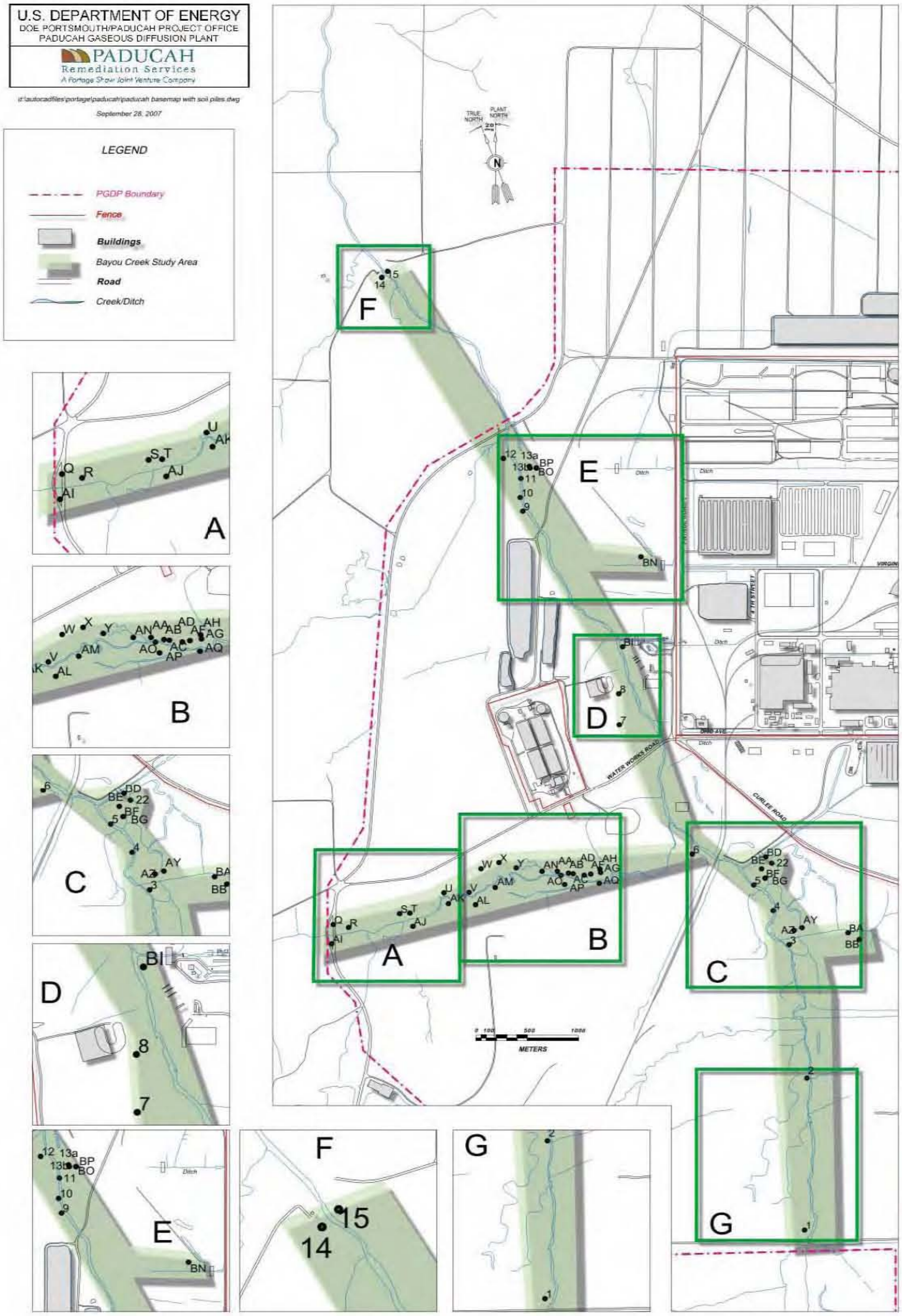

Figure 1. Addendum 2 Soil Piles

Historical research was performed to attempt to determine the origin of the piles and in response to EPA's previous request for soil and rubble area information pursuant to RCRA 3007 (2007). The origin of the Addendum 2 Soil Piles remains unknown; however, available information indicates that many of the PGDP-related soil piles may have originated from excavations associated with the creation, periodic dredging, and cleanout of the outfalls, ditches, and creeks that comprise the PGDP surface water management system. The Addendum 2 Soil Piles are not operational.

2. AREA DESCRIPTION

2.1 ADDENDUM 2 SOIL PILES

Field reconnaissance of Addendum 2 Soil Piles identified 54 piles along Bayou Creek. The majority of the soil piles are located west of PGDP industrialized area and are on DOE-owned property. Two soil piles, 14 and 15, are located on West Kentucky Wildlife Management Area (WKWMA) property just off DOE property, on the banks of Bayou Creek, west of PGDP. The soil piles are distributed across approximately 88 acres and generally are bounded by PGDP industrialized area to the east, the WKWMA/DOE boundary to the west, and the DOE boundary to the north and south. See Figure 1 in Section 1 for a map of the piles.

The Addendum 2 Soil Piles vary in size and shape, ranging from approximately 3 to 450 ft in length and from 2 to 8 ft in height. The soil piles are widely dispersed and often occur as clusters. Vegetative re-growth on and adjacent to the piles is very dense, indicating the soil piles have been in their present locations for years. Improvements that may have supported the creation of soil piles (e.g., road improvements) are not visible along the Addendum 2 Soil Piles.

2.2 GEOLOGY AND SOILS

The PGDP and Addendum 2 Soil Piles are located in the Jackson Purchase Region of Western Kentucky, which represents the northern tip of the Mississippi Embayment portion of the Coastal Plain. 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.

Relative to the shallow groundwater flow system in the vicinity of the PGDP, the continental deposits and the overlying loess and alluvium are of key importance. The continental deposits locally consist of an upper silt member, with lesser sand and gravel interbeds, and a thick, basal sand and gravel member, which fills a buried river valley. A subcrop of the Porters Creek Clay, located beneath and immediately south of the PGDP marks the south extent of the buried river valley. Fine sand and clay of the McNairy Formation directly underlie the continental deposits. These continental deposits are continuous from beneath PGDP to beyond the present course of the Ohio River.

The general soil map for Ballard and McCracken counties indicates that three soil associations are found within the vicinity of the PGDP (USDA 1976): the Rosebloom-Wheeling-Dubbs association, the Grenada-Calloway association, and the Calloway-Henry association. The predominant soil association in the vicinity of the PGDP is the Calloway-Henry association, which consists of nearly level, somewhat poorly drained, medium-textured soils on upland positions.

Although the soil over most of the PGDP may be Henry silt loam with a transition to Calloway, Falaya-Collins, and Vicksburg away from the site, many of the characteristics of the original soil have been lost due to industrial activity that has occurred over the past 50+ years. Activities that have disrupted the original soil classifications include filling, mixing, and grading.

2.3 HYDROGEOLOGY

PGDP and Addendum 2 Soil Piles are located in the western portion of the Ohio River drainage basin, approximately 15 miles downstream of the confluence of the Ohio River with the Tennessee River and approximately 35 miles upstream of the confluence of the Ohio River with the Mississippi River. Locally, the PGDP is within the drainage areas of the Ohio River, Bayou Creek, and Little Bayou Creek.

The PGDP is situated on the divide between the two creeks. Surface flow is east-northeast toward Little Bayou Creek and west-northwest toward Bayou Creek. Bayou Creek is a perennial stream on the western boundary of the plant that flows generally northward, from approximately 2.5 miles south of the plant site to the Ohio River. Little Bayou Creek becomes a perennial stream at the east outfalls of PGDP. The Little Bayou Creek drainage originates within WKWMA and extends northward and joins Bayou Creek near the Ohio River. The drainage basins for both creeks are located in rural areas; however, they receive surface drainage from numerous swales that drain residential and commercial properties, including WKWMA, PGDP, and Tennessee Valley Authority Shawnee Steam Plant. The confluence of the two creeks is approximately 4.8 km (3 miles) north of the plant site, just upstream of the location at which the combined flow of the creeks discharges into the Ohio River (DOE 2006a).

Most of the flow within Bayou and Little Bayou Creeks is from process effluents or surface water runoff from the PGDP. Contributions from PGDP comprise approximately 85% of flow within Bayou Creek and near 100% of flow within Little Bayou Creek. A network of ditches discharges effluent and surface water runoff from PGDP to the creeks. Plant discharges are monitored at the Kentucky Pollutant Discharge Elimination System (KPDES) outfalls prior to discharge into the creeks.

The local groundwater flow system at the PGDP site occurs within the sands of the Cretaceous McNairy Formation, Pliocene Terrace Gravel, Plio-Pleistocene lower continental gravel deposits and upper continental deposits, and Holocene alluvium. The primary local aquifer is the Regional Gravel Aquifer (RGA). The RGA consists of the Quaternary sand and gravel facies of the lower continental deposits and Holocene alluvium found adjacent to the Ohio River and is of sufficient thickness and saturation to constitute an aquifer. These deposits have an average thickness of 9.1 m (30 ft), and range up to 15.24 m (50 ft) along an axis that trends east–west through the plant site. Groundwater flow is predominantly north toward the Ohio River (DOE 2006a).

2.4 POTENTIAL SOURCES OF CONTAMINATION

The following provides an evaluation of potential transport mechanisms for contaminants found at PGDP. Figure 2 provides an overview of the PGDP industrial complex and the associated surface water management system.

2.4.1 Contaminant Transport Mechanisms

Transport mechanisms likely include both dissolved constituents and sediment in storm water runoff.

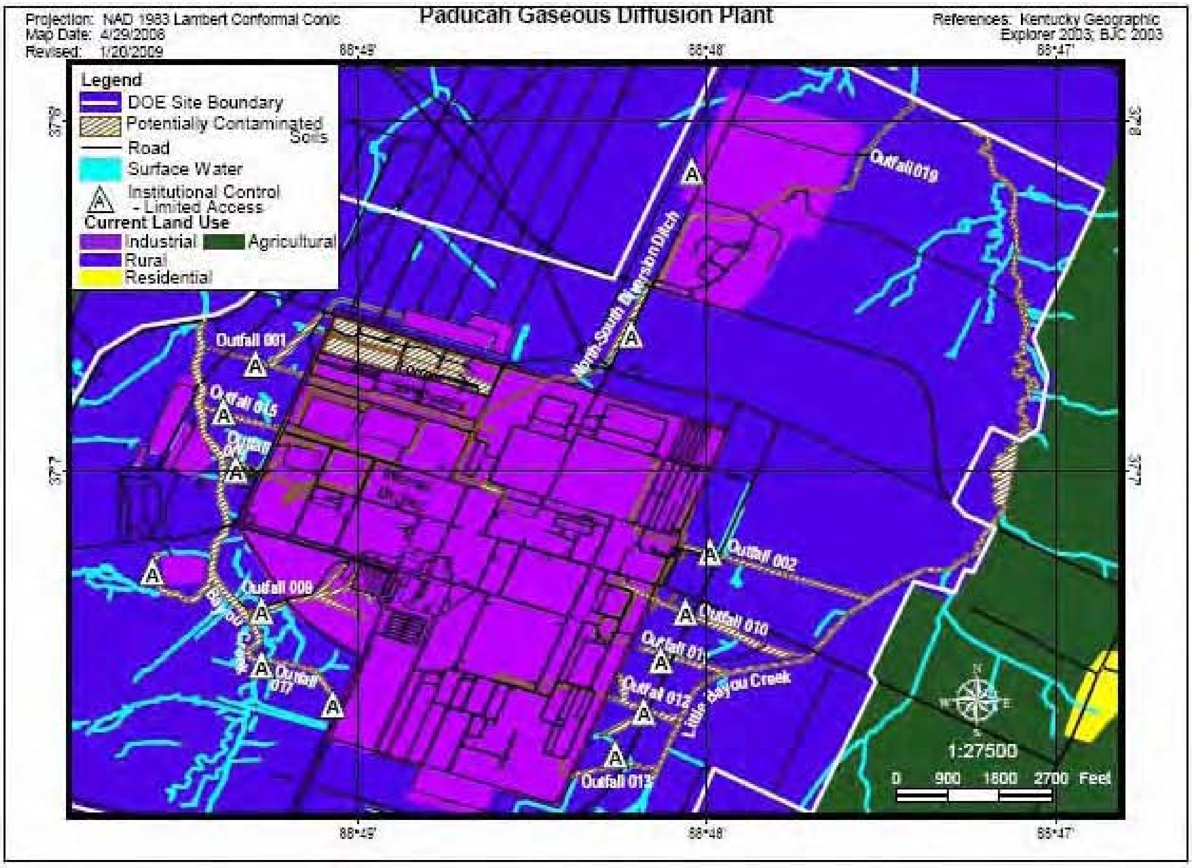

Figure 2. PGDP Outfall Locations

The PGDP surface water management system discharges to Bayou Creek through several outfalls.

Figure 2 illustrates where outfalls discharge relative to PGDP. An investigation was conducted for on-site areas for the Surface Water Operable Unit (SWOU). Transport modeling of contaminated sediment found in Outfalls 001, 008, and 015 completed as part of the SWOU on-site investigation concluded that migration through surface water would not result in unacceptable risk to recreational users of Bayou Creek. Ongoing monitoring supports this conclusion.

2.4.2 Documented Releases/Spills

Possible contaminant sources to Bayou Creek may include releases resulting from surface water runoff, originating at spill or release sites inside the PGDP industrial complex, prior to their remediation. These include releases documented in the following reports or logs:

- Occurrence Reporting and Processing System (ORPS) spanning from approximately 1990 to the present,
- Plant shift superintendent (PSS) logs spanning from 1984 through 1990, and
- Annual Site Environmental Reports (ASERs) from 1984 through 2006.

The 3007 information request, occurrence reports and document summary forms from the PSS logs provide a description of the spills and releases and contain pertinent information such as the date and time of release, known or suspected contaminants, estimated quantities of material(s) released, and a description of the actions taken.

The types of chemicals involved in historical spills and releases contained in the ORPS include PCBs, recirculated cooling water containing chromium, chilled chromated water, landfill leachate, gasoline and diesel fuel, and various oils. The types of spills and releases documented in the PSS logs include PCBs, recirculated cooling water, trichloroethene (TCE), sanitary waste water, chromated water, paint pigment, gasoline, diesel, miscellaneous oil, uranium, technetium-99, and observed oil sheens in the outfall discharges. Spills and releases reported in the ASERs include recirculated cooling water, chilled water, TCE, battery acid, transformer oil, diesel fuel, soda ash, and landfill leachate.

2.5 SUMMARY OF RECENT ENVIRONMENTAL MONITORING RESULTS

Bayou Creek is subject to routine environmental monitoring under DOE Order 450.1 (previously DOE Order 5400.1). The KPDES Permit and DOE Orders identify the monitoring and discharge limits for surface water. Monitoring data indicate there have been no recent (2000 to present) releases that could result in unacceptable risk to human health and the environment through the PGDP surface water drainage system and that surface water and sediment transport presently are not acting as a source of contamination to Bayou Creek.

3. FIELD AND ANALYTICAL METHODS

3.1 ADDENDUM 2 SOIL PILES SAMPLING APPROACH

The Addendum 2 Soil Piles sampling approach was designed to accomplish the project objectives. This approach is detailed in the DOE-, EPA-, and Commonwealth of Kentucky-approved SAP and Addendum 2. A summary of the sampling approach and other field activities is provided in the following sections.

3.1.1 Systematic Sampling

The Addendum 2 Soil Piles were divided into two groups: small and large. Soil piles whose length and width are less than or equal to 30 ft were classified as small; soil piles whose length or width are greater than 30 ft were classified as large. A systematic sampling approach was implemented for small soil piles, and a systematic random sampling approach was implemented for large soil piles. These approaches were designed to ensure sampling results were sufficient to determine the concentration and distribution of constituents throughout the study area.

Each small soil pile was sampled at a single location from the tallest portion of the pile. Each large pile was sampled using a grid with 50-ft spacing. For both small and large piles, surface samples were collected from 0-1 ft followed by subsurface samples collected vertically at 3-ft intervals, starting at the 1 ft level (1–4, 4–7, if required) and extending down to the interface with natural grade.

For all piles, all samples underwent field analyses, and a minimum of one surface, and one subsurface sample per pile was sent to the fixed laboratory analyses. Additionally, if more than 10 samples were collected from a pile, then, at a minimum, 10% of the samples underwent fixed-base laboratory analyses. The samples undergoing fixed-base laboratory analyses subject to this 10% rule were randomly selected from all samples collected.

Field methods included Resource Conservation and Recovery Act metals and uranium analysis by *ex situ* X-ray fluorescence (XRF), *ex situ* radioactivity measurements using *In Situ* Object Counting System (ISOCS), PCBs using immunoassay/colorimetric test kits, and a demonstration of polynuclear aromatic hydrocarbons (PAHs) test kits, which also employ immunoassay/colorimetric techniques.[1] The analyte list for fixed-base laboratory analyses includes the metals and radionuclides on the list of significant chemicals of potential concern (COPCs) in the PGDP Risk Methods Document (DOE 2001), PCBs, and PAHs.[2,3]

3.1.2 Contingency Sampling

The Addendum 2 Soil Piles sampling approach also included provisions for contingency sampling (up to 40 samples) to allow for the collection of data for unexpected field conditions or to augment project data based on field method results. Based upon the data results, contingency samples were not required and therefore not collected.

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[1] Field PAH analyses were completed on only those samples submitted for fixed laboratory analyses to determine their efficacy for deployment at PGDP on future projects.

[2] PAHs were analyzed in samples sent to the fixed-base laboratory to allow comparison with results from field test kits. The results of the PAH analyses will be used to support the use of field methods in future PGDP projects.

[3] VOCs are not included in the analyte list for the fixed-base laboratory because VOCs were not detected in Soil Pile I samples at concentrations above no action risk-based screening values. Additionally, neither trichloroethene nor trichloroethane was detected in samples collected at Soil Pile I.

3.1.3 Sampling Summary and Deviations from the SAP

The following provides the planned sampling activities for Addendum 2 Soil Piles and an accounting of the actual number and types of samples collected. Addendum 2 to the PGDP Soil Piles SAP specified the collection and analysis of these samples:

- Fifty-four surface samples (24 small piles, 30 large piles) to undergo field measurements and fixed laboratory analysis
- One hundred seven surface samples (24 small pile locations, 83 large pile locations) to undergo field measurements only
- Sixty subsurface samples (25 small pile locations, 35 large pile locations), where subsurface is defined as soil taken at a depth below 1 ft, to undergo field measurements and fixed laboratory analysis
- Two hundred ten subsurface samples (31 small pile locations, 179 large pile locations) to undergo field measurements only
- A number of contingency samples (no more than 40), if contamination was identified

During execution of Addendum 2, the total number of soil samples collected was as follows:

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- Fifty-five surface samples underwent field measurements only
- Fifty-six subsurface samples underwent field measurements and fixed laboratory analysis
- One hundred eleven subsurface samples underwent field measurements only
- No contingency samples were collected

The differences between planned and actual sample numbers resulted from three factors.

First, the observed differences in subsurface samples result entirely from variations in soil pile height. Because the soil pile height, on average, was less than 5 ft, a fewer number of samples than that estimated in the Addendum 2 to the SAP were required to reach the natural grade.

Second, many of the large soil piles were smaller than planned in the Addendum 2 SAP, resulting in less area to be sampled.

Third, the concentration of analytes (i.e., COPCs) in samples was less than the screening criteria in the Addendum 2 SAP; therefore, no contingency samples were required.

Additional deviations from the SAP Addendum 2 include one less fixed laboratory field blank and one less fixed laboratory equipment rinseate were collected (only one of each was collected compared to the requirement of 2 each as noted in the SAP Addendum). This was an inadvertent oversight by the field crew. There is minimal impact to the data assessment as these samples were collected to identify cross-contamination that could be introduced between samples. Because contamination was not found, there was no impact to collecting fewer QC samples. Also, 39 of the 110 PAH test kit sample analyses exceeded their holding times due to reagent solutions from the manufacturer not received within the 14-day time frame after sample collection. The order was placed early during project implementation; however, the manufacturer backlogged the order. PAH fixed-base laboratory analyses for the 110 samples (no holding time exceedances) and the PAH test kit data was collected to determine utility for future projects. The exceedance of holding times on the 39 field samples does not negatively impact the characterization of the Addendum 2 soil piles.

3.1.4 Fixed Laboratory Analysis

As noted, a total of 54 surface soil samples and 56 subsurface soil samples underwent fixed laboratory analysis. Each was analyzed in accordance with the method requirements outlined in Table 1 with the exception that six samples were randomly selected for waste characterization (ignitability, reactivity, corrosivity, paint filter, and moisture) in case a removal action was required.

Table 1. Fixed Laboratory Analysis Requirements for Soils

CHARACTERIZATION PARAMETERS	ANALYTICAL METHOD
PAHs	EPA 8270
PCBs (Aroclors/Total)	EPA 3540/8082
Inorganic Target Analyte List (Total Metals)	EPA 6010 or EPA 6020
^{241}Americium	DOE EML HASL-300, Am-05-RC
^{137}Cesium	EML HASL 300, 4.5.2.3
^{237}Neptunium	DOE EML HASL 300
^{238}Plutonium	DOE EML HASL-300, Pu-11-RC
$^{239/240}$Plutonium	DOE EML HASL-300, Pu-11-RC
^{99}Technetium	DOE EML HASL-300, Tc-02-RC
^{228}Thorium	DOE EML HASL-300, Th-01-RC
$^{230/232}$Thorium	DOE EML HASL-300, Th-01-RC
Total Uranium	DOE EML HASL-300, U-02-RC
^{234}Uranium	DOE EML HASL-300, U-02-RC
^{235}Uranium radioactivity	DOE EML HASL-300, U-02-RC
^{238}Uranium	DOE EML HASL-300, U-02-RC
Arsenic	EPA 1311/6010 or 6020[1]
Barium	EPA 1311/6010 or 6020[1]
Cadmium	EPA 1311/6010 or 6020[1]
Chromium	EPA 1311/6010 or 6020[1]
Lead	EPA 1311/6010 or 6020[1]
Mercury	EPA 1311/7470[1]
Selenium	EPA 1311/6010 or 6020[1]
Silver	EPA 1311/6010 or 6020[1]
Ignitability	EPA 1030[1]
Reactivity Cyanide	EPA 9014[1]
Reactivity Sulfide	EPA 9034[1]
Corrosivity to Steel	EPA 1110
Paint Filter Test	EPA 9095B
%Moisture/%Solid	ASTM D2216

ASTM = American Society for Testing and Materials
EPA = U.S. Environmental Protection Agency
PAH = polyaromatic hydrocarbon
PCB = polychlorinated biphenyl
[1] Toxicity Characteristic Leaching Procedure (TCLP) analyses will be performed only if Underlying Hazardous Constituents (UHC) exceed 20 times the TCLP limit as specified in 40 *CFR* § 261.24.

3.1.5 Field Analysis

All of the surface and subsurface samples collected for Addendum 2 Soil Piles underwent field analysis. The total field analysis included 109 surface samples and 167 subsurface samples. Field measurements included the following:

- RCRA metals and uranium using a XRF spectrometer
- Gamma radionuclides using a Canberra® ISOCS
- PCBs using Hach® immunoassay sample extraction and colorimetric analysis methods
- PAHs using Hach® immunoassay sample extraction and colorimetric analysis methods

Both fixed laboratory and field results for the Addendum 2 Soil Piles Investigation are provided on a CD.

4. QUALITY ASSURANCE/QUALITY CONTROL

4.1 DATA QUALITY/DATA USABILITY

The following sections summarize the results of data verification, data validation, reconciliation of measurement quality objectives, and the comparisons of field and laboratory data obtained from the Addendum 2 Soil Piles investigation.

4.1.1 Precision

Precision is the measure of agreement or reproducibility between individual measurements for the same property under the same analytical conditions.

Precision for Addendum 2 Soil Piles data was measured based on the performance of field and laboratory duplicate samples and laboratory matrix spike (MS) and matrix spike duplicate (MSD) pairs.

NOTE: Precision does not affect the quality or usability of organic analyses whose precision is measured by MS/MSD pairs. As the SAP notes, precision results do not impact on PCBs, semivolatile organic compounds, or volatile organic compounds (VOCs) in terms of data quality/data usability. Where performance criteria for precision are exceeded, there is less confidence in the reported result because of error introduced from sampling or analysis caused by unequal representation of target compounds or analytes between the two sample pairs.

The SAP required that a minimum of 9 of 10 samples (90%) for each analysis type meet method prescribed precision criteria. Based on the data received from the fixed base laboratory, each analysis met this goal.

4.1.2 Accuracy

Accuracy is the comparison of a known quantity of a reference standard to the value measured during analysis. Accuracy for Addendum 2 Soil Piles data was assessed by evaluating the performance of the following QC standards designed to monitor accuracy during sample preparation and analysis:

- Laboratory control samples
- Radioactive tracers
- MS
- MSDs
- Surrogate compounds

The SAP required that a minimum of 9 of 10 samples (90%) for each analysis type meet method/PGDP prescribed accuracy criteria. Based on the data received from the fixed base laboratory, each analysis type met this goal.

4.1.3 Completeness

Completeness is defined as the number of valid data points obtained from a sampling effort, compared with the total number of data points obtained. Valid data are those generated when analytical systems and the resulting analytical data meet all of the quantitative measurement objectives for the project.

The SAP required that a minimum of 9 of 10 samples (90%) for each analysis type meet completeness criteria. Based on the data received from the fixed base laboratory, each analysis type met this goal.

4.1.4 Detection Limits

To ensure the fixed laboratory data acquired from Addendum 2 Soil Piles supports the DQOs, method detection limits (MDLs) were pre-established for each analysis type and defined in the laboratory SOW. The MDLs were designed to ensure that sufficiently sensitive data were obtained from the contract laboratories, so non-detect results will not impact the evaluation of human health risks.

For field analytical methods, method sensitivity was a variable determined during the project. Field MDLs were determined in accordance with manufacturer analytical protocols. The field analytical methods do not achieve the same level of sensitivity as fixed-base laboratory methods. However, sufficient sensitivity was achieved for each method to support/direct field activities should actions be necessary at Addendum 2 Soil Piles.

Reporting limits were met as specified in the SAP.

4.1.5 Comparability

Comparability is the degree to which one data set can be compared to another, when both are obtained from the same sample population. Comparability can be achieved only through the use of consistent sampling procedures, experienced sampling personnel, the same or comparable analytical methods, standard field and laboratory documentation, and traceable laboratory standards.

Because the samples were collected from the nearly identical locations, samplers employed similar sampling techniques, and similar analytical methods. As a result, the data are comparable.

4.1.6 Representativeness

Representativeness is a measure of the degree to which data accurately and precisely represents the characteristics of a population at a sampling point, process condition, or environmental condition. Representativeness is a qualitative term evaluated to determine if sample measurements and physical sample locations result in data that appropriately reflects the population parameter of interest in the media and phenomenon measured or studied.

The data provides a good representation of the environmental conditions of Addendum 2 soil piles based upon data verification, validation, and assessment. The investigation has successfully determined that there is no contamination that warrants immediate action at soil piles along Bayou Creek.

4.1.7 Field Quality Control Summary

Field QC samples are independently generated samples from a pre-defined sampling scheme, designed to monitor the reproducibility, cleanliness, and accuracy of the sampling and analytical process. The following are the field QC samples prescribed for the Addendum 2 Soil Piles investigation:

- Field duplicates
- Field blanks
- Trip blanks

- Equipment rinseate blanks

QC samples were required for Addendum 2 at a frequency of 1 QC sample for every 20 samples collected or 5%. The collection frequency for QC samples applied to all samples whether undergoing field analysis or fixed laboratory analysis.

Field duplicates were collected and analyzed to evaluate the reproducibility (precision) of sampling techniques, laboratory methods, and to monitor the natural variability of the sample matrix. Field duplicates were co-located with the sample locations they were intended to mimic and were submitted as separate blind samples, with separate field identification numbers to the contract laboratory. The prescribed collection frequency was met with field duplicates collected and analyzed at a frequency of 5% for the investigation. Field duplicate precision was met for the investigation.

Field blanks were collected and analyzed to evaluate any cross contamination attributable to field methods including sample container handling. As noted previously, one less field blank was collected compared to the SAP Addendum requirement (two were planned, however, one collected).

Field rinseate blanks were collected and analyzed where subsurface samples were collected and sampling equipment was decontaminated and reused. Field rinseate blanks provide a measure of cross-contamination attributable to field equipment decontamination procedures. As noted previously, one less rinseate blank was collected compared to the SAP Addendum requirement (two were planned, however, one collected).

In summary, field, trip, and rinseate blanks were analyzed to verify the cleanliness of the sampling, decontamination, and the overall analytical process. Each is designed to monitor at least one aspect of the process, with all providing meaningful information as to the reliability of low-level contaminant results.

4.1.8 Data Quality Summary/Fixed Laboratory Data

As stated, the DQOs for the Addendum 2 Soil Piles investigation were to acquire sufficient data of known quality to support decision making. Experience and properly trained field personnel were utilized to execute the sampling and operating procedures. Project samples were collected, preserved, handled, and shipped in accordance with the SAP and industry and PGDP standard procedures. A reputable analytical laboratory using industry standard analytical procedures was utilized to generate sample data that complies with the requirements of the laboratory statements(s) of work and specified protocols.

Project data underwent 10% Level C validation, with all data undergoing verification. Precision, accuracy, and completeness criteria were met for all fixed-base laboratory data indicating the data set will support decision making.

4.1.9 Data Quality Summary/Field Analytical Data

Each of the field techniques employed for the Addendum 2 Soil Piles investigation utilized QC measures to monitor the accuracy, precision, and drift of the method during use. The following summarizes the results of QC analysis.

4.1.9.1 XRF

To support field XRF analysis, three types of QC samples were analyzed with each batch of 20 samples. These included (1) blanks, (2) duplicates, and (3) standard reference materials (SRMs). The XRF blank was vendor-provided, consisting of silica-certified clean for use as a blank.

Blank results for XRF analysis showed no positive detections during execution of the investigation for those parameters such as uranium. Precision for XRF duplicates was < 35% relative percent difference (RPD) for all field-laboratory duplicates.

Three SRMs were analyzed daily to monitor XRF accuracy. They represent low [National Institute of Standards and Technology (NIST) 2709], moderate (NIST 2711), and high (NIST 2710) level standards for soil analysis for metals. SRM performance was mixed for the three standards, with the low-level standard performing well for lead and barium, and moderately well for arsenic. The low concentrations for the remaining metals were outside the operating range of the XRF (below the MDL).[4] The mid-range standard performed well for barium and lead, with moderate performance for arsenic, zinc, and cadmium. The high-end standard performed very well for arsenic, barium, uranium,[5] and lead. The remaining metals concentrations were below the MDL for the XRF.

4.1.9.2 Field PCBs

To support field PCB analysis, three types of QC samples were analyzed with each batch of 20 samples: (1) blanks, (2) duplicates, and (3) calibration verification standards. The following summarizes QC performance.

- No positive detections were noted in any of the PCB method blanks.
- Precision for PCB duplicates was < 35% RPD for all field-laboratory duplicates.
- All calibration verifications had recoveries within 90–110%.

4.1.9.3 ISOCS

To support field ISOCS analysis, two types of QC samples were analyzed daily. Daily checks included (1) a background and (2) a NIST traceable calibration/check source.

Background results for ISOCS analysis were all within acceptable limits (i.e., two sigma of weekly background). In addition to daily QC checks, a chamber background count was performed weekly for a predetermined count time. The predetermined background count time was equal to or greater than the sample count time. The weekly background count is used for background subtraction in the activity calculation. An accurate representation of the background for the detector is necessary to produce high quality sample results.

[4] Selenium was not added to any of the standards.
[5] Chromium and uranium levels for the NIST SRMs are not certified values.

The NIST traceable calibration/check source consists of a mixed radionuclide with gamma peaks that cover the range (i.e., low, mid, high) of detections, generally 59 keV to 2,000 keV. All daily check source results for ISOCS analysis were within acceptable limits (i.e., 2 sigma).

4.1.10 PAH Summary

Correlation between laboratory and field PAH results were consistent as most all results were below the detection limits. A better comparison of data is recommended as a result of Addendum 1-B soil pile investigation due to the nondetects obtained from the Addendum 2 soil piles investigation.

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5. DISCUSSION AND RESULTS

The following section presents and evaluates the results for the Addendum 2 Soil Piles investigation. It includes a discussion of the conceptual site model (CSM) as it was defined for investigation planning and a discussion of findings. This section also provides data screening versus PGDP decision levels.

5.1 CONCEPTUAL SITE MODEL

The following description of the CSM is taken from the PGDP soil piles SAP (DOE 2007a). It summarizes the expected receptors and exposures for Soil Pile I, however, also applies to others including Addendum 2 soil piles. See Figure 3 for the CSM representation.

Recreational activities known to take place in and near to some of the PGDP soil piles include the following:

- Bow hunting
- Field trials (horses and dogs)
- Other recreational uses (e.g., hiking)

Recreational user exposure to surface soils is the primary exposure pathway. The recreational user could be exposed to contaminants through contact with surface soils through the following exposure routes:

- External exposure to ionizing radiation
- Dermal contact
- Incidental ingestion
- Inhalation

Recreational user exposure to surface soils through the dermal contact, incidental ingestion, and inhalation is likely limited given that most soil piles and soils in the adjoining areas are covered by continuous vegetation. Industrial worker exposure would be similar for nonintrusive activities.

Addendum 2 Soil Piles are located adjacent to Bayou Creek. This proximity to surface water drainage areas could have resulted in potential secondary exposure routes that could impact human health and the environment. The majority of the secondary routes assume the soils or contaminants they contain have been released to adjacent waterways or moved through the food chain.

Precipitation could result in contaminant migration from the soil piles if contaminated; however, PGDP historical monitoring data indicate little if any migration is occurring. Further, data presented in this SER indicate contaminants do not exist and are not migrating away from Addendum 2 Soil Piles.

The majority of the contaminants analyzed for samples collected at Addendum 2 Soil Piles do not bioaccumulate in plants to a great degree. As a result, plant uptake and corresponding accumulation in animal tissue is unlikely, but soil ingestion as part of normal feeding activities is likely a complete pathway. Ecological receptors also may be exposed to on-site contaminants; however, the primary focus of the characterization effort is to determine risks to human health.

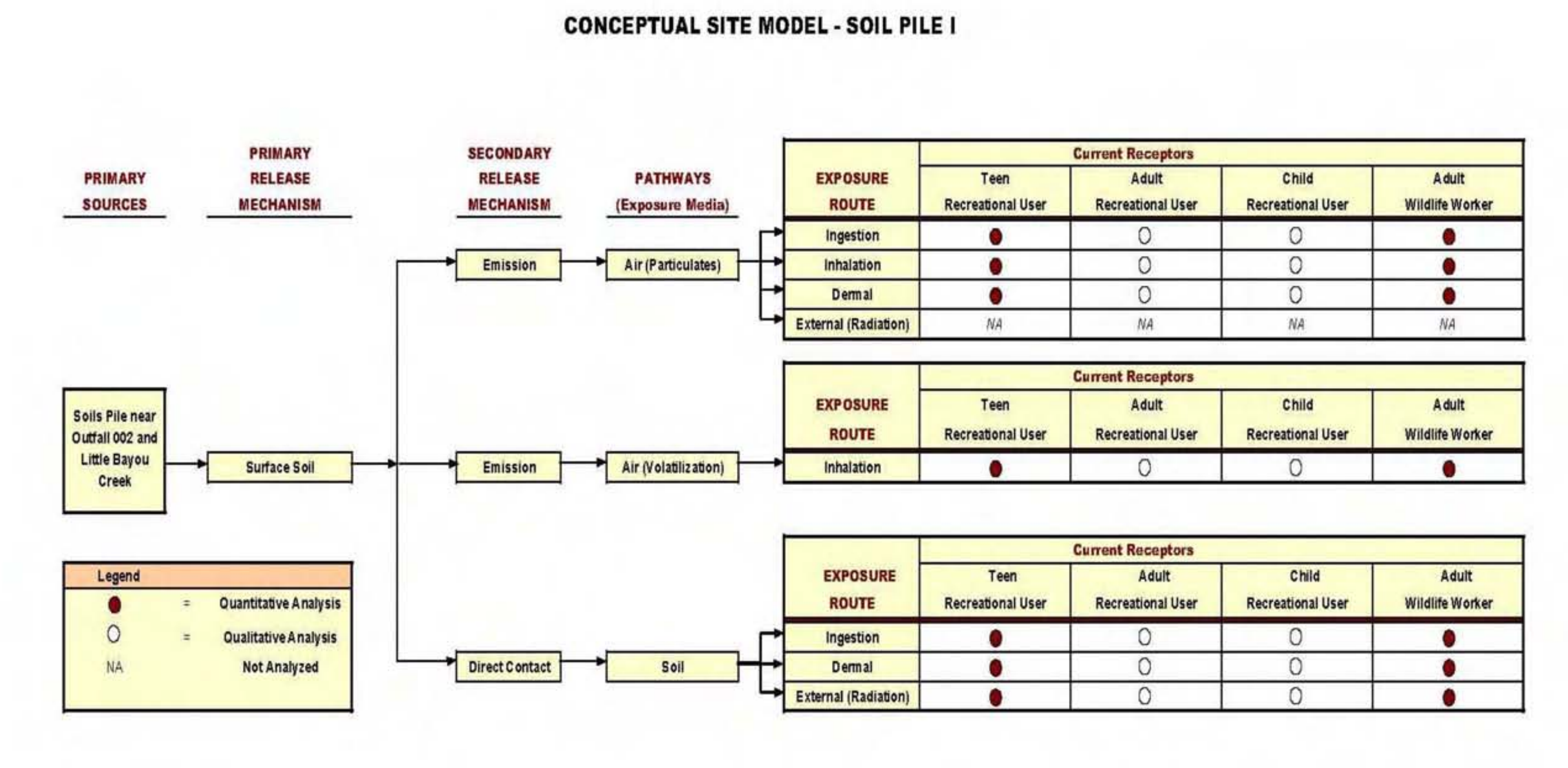

Figure 3. Conceptual Site Model for Soil Piles

5.2 EXAMINATION OF SAMPLE POPULATIONS

As part of project planning, the Addendum 2 Soil Piles operating hypothesis for investigative purposes was that each pile likely represents a unique population, in terms of contaminant type, concentrations, and distribution. To examine this hypothesis, the data from each pile was examined to determine if individual sample populations were present. Following this examination, each pile was compared with all the other piles to determine if any/all were the same population.

The comparison indicates piles 1–54 are similar to one another and can be considered one population.

5.3 SURFACE DISTRIBUTION OF CONTAMINANTS

The first step in examining project data from Addendum 2 Soil Piles was to perform a data screening to establish which constituents will be retained for further consideration as COPCs. The data screening steps employed for Addendum 2 Soil Piles include the following:

- Comparison of maximum contaminant concentrations to PGDP background levels for soils;
- Comparison of contaminant concentrations to established teen recreational user no action levels (NALs); [6]
- Evaluation of frequency of detection for each contaminant.

See Section 6 for further discussion of the data screening. As constituents detected were near background ranges, no migration of contamination is occurring.

[6] No Action Levels were taken from the PGDP Risk Methods Document (DOE 2001).

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6. DATA SCREENING

This data screening used data collected in the summer 2008 from Addendum 2 Soil Piles. The principal objective of this screening is to inform risk managers in support of decision making for the site. Key considerations include the following:

- Determine whether all or portions of the study area may be eliminated from concern.
- Identify where risk characterization suggest actions may be needed.
- Determine whether additional data gathering and/or risk assessments are warranted.

The data screening provides information to the stakeholders based on the Commonwealth of Kentucky and nationally accepted risk assessment methods. These objectives are consistent with the goals, objectives, and requirements identified in the *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant Paducah, Kentucky, Volume 1, Human Health* (DOE 2001).

The scope of the Addendum 2 Soil Piles data screening is to assess risks to human receptors who, through use of the Addendum 2 Soil Piles area, may be exposed to chemicals or radionuclides through normal use of the site. This data screening does not examine ecological risks.

6.1 METHODOLOGY

The following describes the process used to develop the data screening activity.

6.1.1 Data Screening

Following background comparisons, those contaminants retained were evaluated for comparison to other criteria as described below.

As part of the data screening process, maximum concentrations were compared to the PGDP Risk Methods Document and site-specific health guidelines. The site-specific comparison involved examination of site-specific exposure conditions and comparison of site-specific maximum concentrations with established risk-based values versus the more generic values noted in the PGDP Risk Methods Document. To complete this evaluation, NALs for the teen recreational use scenario listed in Table A-17 of the Risk Methods Document (DOE 2001) were used for comparisons with maximum concentrations.

Following health guideline comparison, those constituents that (1) exceeded PGDP background concentrations, and (2) exhibited concentrations in excess of the NALs, were to be considered as COPCs for future quantitative risk assessment in subsequent investigative activities. See Tables 2–4 for the NALs that were used to compare data.

Table 2. Comparison of Teen Recreational Site-Specific and PGDP NALs

Contaminants	Units	Site-Specific Teen Recreational User NALs Hazard	Carcinogen	NAL	PGDP Risk Methods Document Teen Recreational User NALs Hazard	Carcinogen	NAL
Aluminum	mg/kg	100,000		100,000	3,010		3,010
Antimony	mg/kg	26.4		26.4	0.242		0.242
Arsenic	mg/kg	13.8	1.79	1.79	5.98	0.346	0.346
Barium	mg/kg	40,707		40,707	148		148
Beryllium	mg/kg	67.9	466,490	67.9	0.606	60,200	0.606
Iron	mg/kg	100,000		100,000	1,350		1,350
Lead	mg/kg	NA	NA	1,420			400
Manganese	mg/kg	17,263		17,263	29.0		29.0
Uranium	mg/kg	529		529	14.7		14.7
Vanadium	mg/kg	4,036		4,036	2.12		2.12
Total PCB	mg/kg	0.436	0.636	0.436	0.191	0.127	0.127
Total PAH	mg/kg		0.066	0.066		0.0133	0.0133
Cesium-137	pCi/g		1.19	1.19		0.178	0.178
Plutonium-239	pCi/g		237	237		30.3	30.3
Thorium-230	pCi/g		302	302		39.0	39.0
Uranium-234	pCi/g		407	407		52.2	52.2
Uranium-235	pCi/g		5.53	5.53		0.826	0.826
Uranium-238	pCi/g		24.6	24.6		3.64	3.64

[1]No action level (NAl) values are based on a risk of 1E-6 and a hazard index of 0.1.

[2]The value for lead is a regulatory value provided by the Commonwealth of Kentucky Risk Assessment Branch.

Table 3. Comparison of Site-Specific Action Levels and PGDP Risk Methods Action Levels

Contaminants	Units	Site-Specific Teen Recreational User ALs Hazard	Carcinogen	Action	PGDP Risk Methods Document Teen Recreational User ALs Hazard	Carcinogen	Action
Aluminum	mg/kg	100,000		100,000	100,000		100,000
Antimony	mg/kg	793		793	344		344
Arsenic	mg/kg	413	179	179	2,590	314	314
Barium	mg/kg	100,000		100,000	100,000		100,000
Beryllium	mg/kg	2,036	46,649,028	2,036	884	100,000	884
Iron	mg/kg	100,000		100,000	100,000		100,000
Lead	mg/kg			400			400
Manganese	mg/kg	100,000		100,000	39,100		39,100
Uranium	mg/kg	15,877			6,830		6,830
Vanadium	mg/kg	121,076		121,076	3,090		3,090
Total PCB	mg/kg	13.1	63.3	13.1	2.02	10.5	2.02
Total PAH	mg/kg		6.60	6.60		4.24	4.24
Cesium-137	pCi/g		119	119		1.28	1.28
Plutonium-239	pCi/g		23,724	23,724		222	222
Thorium-230	pCi/g		30,237	30,237		285	285

Table 3. Comparison of Site-Specific Action Levels and PGDP Risk Methods Action Levels (Continued)

		Site-Specific Teen Recreational User ALs			PGDP Risk Methods Document Teen Recreational User ALs		
Contaminants	Units	Hazard	Carcinogen	Action	Hazard	Carcinogen	Action
Uranium-234	pCi/g		40,716	40,716		381	381
Uranium-235	pCi/g		553	553		5.91	5.91
Uranium-238	pCi/g		2,461	2,461		26.1	26.1

[1]The action levels (Als) are based on a risk of 1E-4 and a hazard index of 3.
[2]The value for lead is a regulatory value provided by the Commonwealth of Kentucky Risk Assessment Branch.
[3]Toxicity values for radionuclides account for short-lived daughter products, where applicable.

Table 4. Site-Specific NALs for the Wildlife Worker

		Site-Specific Wildlife Worker NALs		
Contaminants	Units	Hazard	Carcinogen	NAL
Aluminum	mg/kg	100,000		100,000
Antimony	mg/kg	98.0		98.0
Arsenic	mg/kg	64.3	8.22	8.22
Barium	mg/kg	62,819		62,819
Beryllium	mg/kg	374	976,375	374
Iron	mg/kg	100,000		100,000
Lead	mg/kg			50
Manganese	mg/kg	40,173		40,173
Uranium	mg/kg	211		211
Vanadium	mg/kg	3,057		3,057
Total PCB	mg/kg	11,789	3.24	3.24
Total PAH	mg/kg		0.368	0.368
Cesium-137	pCi/g		1.53	1.53
Plutonium-239	pCi/g		103	103
Thorium-230	pCi/g		137	137
Uranium-234	pCi/g		179	179
Uranium-235	pCi/g		6.93	6.93
Uranium-238	pCi/g		29.3	29.3

NAL = no action level

6.1.2 Addendum 2 Soil Piles Receptors

Addendum 2 Soil Piles are part of the WKWMA. Access to the portion of the WKWMA adjoining PGDP is controlled to the public throughout the year. In order to legally access the site, members of the public must check in with the United States Enrichment Corporation security force at the main guard outpost to PGDP. Known uses of DOE lands included in the WKWMA are defined in the CSM and include a) recreational users and b) wildlife workers.[7]

[7] The receptors for Addendum 2 soil piles are current use receptors only.

Known recreational uses of Addendum 2 Soil Piles include field trials, which incorporate horseback riding and dog trials, bow hunting, and similar outdoor activities. Generally, the defined recreational uses will be engaged in by teens and adults.

The soil piles CSM, as defined in the SAP, details the routes of exposure (as included in the derivation of the NALs and ALs shown in the previous tables) to be considered in a risk assessment and includes the following:

- Incidental ingestion of soil
- Inhalation of soil particles (i.e., dust)
- Inhalation of vapors emitted from soil
- Dermal contact with soil
- External exposure to ionizing radiation

6.1.3 Chemicals of Potential Concern

The results indicate the detects are statistically at background based upon the results being below the 95th percentile of the generic statewide ambient background values; therefore, they are not indicative of contamination, but are indigenous to soils in the region. NALs for specific parameters were exceeded; however, the parameters are not recommended for further evaluation as COPCs in regard to risk due to their existence being inherent to soils in this area. See Table 5 for data screening results and Table 6 for chemicals exceeding background. As noted previously, the exceedances are below the 95th percentile of the generic statewide ambient background values and, as a result, are not considered contaminants. Also see Appendix B, Screening of Detected Chemicals Exceeding Background.

6.1.4 Radiation Dose Comparison

The PGDP Risk Methods Document provides radionuclide screening concentrations derived for human health based target doses for 1, 15, and 25 mrem/year. Of the two known receptors (recreational user and wildlife worker) at Addendum 2 Soil Piles, screening concentrations for the recreational user are considered for this analysis because the recreational user's screening concentration is less than the wildlife worker's screening concentration at the same target risk and hazard levels. The target dose of 25 mrem/year is based on criteria in DOE Order 5400.5, Chapter II. The target dose of 15 mrem/year is based on the U.S. EPA memorandum dated August 22, 1997. The PGDP Risk Methods Document describes a screening level from the target dose of 1 mrem/year as the "walk away" level. See Table 5 for a comparison of radiological results to the human health based target doses.

The concentrations (range of concentration noted in Table 7) are from the fixed base laboratory data obtained as a result of all samples collected for Addendum 2 soil piles and are below the individual recreational user screening levels for a 1 mrem/year dose and, therefore, below the "walk away" level in the PGDP Risk Methods Document. Negative concentration data (as noted in Table 7) sometimes is reported for radionuclides when data represents activity below background.

Table 5. Data Screening Results

		Detected Results					Exceedances of No Action Levels			
Analysis	**Units**	**Minimum**	**Maximum**	**Average**	**Frequency of Detection**	**Exceeds Background[1]**	**Site-Specific Teen Recreational User**	**PGDP-Specific Teen Recreational User**	**Site-Specific Wildlife Worker**	**Detection Limit Range**
Aluminum	mg/kg	1.95E+03	1.31E+04	6.75E+03	110/110	2/110	0/110	108/110	0/110	17 - 194
Antimony	mg/kg				0/110	0/110	0/110	0/110	0/110	6.6 - 9.97
Arsenic	mg/kg	1.96E+00	1.02E+01	4.28E+00	110/110	3/110	110/110	110/110	4/110	0.849 - 1
Barium	mg/kg	1.78E+01	1.35E+02	6.17E+01	110/110	0/110	0/110	0/110	0/110	2.12 - 2.5
Beryllium	mg/kg	4.44E-01	7.16E-01	5.59E-01	26/110	3/110	0/110	6/110	0/110	0.425 - 0.5
Cadmium	mg/kg	4.66E-01	6.74E-01	5.47E-01	14/110	14/110	N/A	0/110	N/A	0.425 - 0.5
Calcium	mg/kg	1.24E+02	6.62E+04	1.87E+03	108/110	2/110	N/A	N/A	N/A	84.9 - 898
Chromium	mg/kg	6.36E+00	5.46E+01	1.22E+01	110/110	6/110	N/A	0/110	N/A	2.12 - 2.5
Cobalt	mg/kg	2.93E+00	1.26E+01	5.29E+00	110/110	0/110	N/A	0/110	N/A	0.849 - 1
Copper	mg/kg	2.45E+00	1.71E+01	6.49E+00	110/110	0/110	N/A	0/110	N/A	2.12 - 2.5
Iron	mg/kg	5.55E+03	2.13E+04	1.03E+04	110/110	0/110	0/110	110/110	0/110	17 - 20
Lead	mg/kg	3.02E+00	2.88E+01	1.05E+01	110/110	1/110	0/110	0/110	0/110	0.849 - 4.82
Magnesium	mg/kg	1.30E+02	2.13E+03	7.37E+02	110/110	0/110	N/A	0/110	N/A	4.25 - 5
Manganese	mg/kg	8.51E+01	1.58E+03	4.91E+02	110/110	1/110	0/110	110/110	0/110	2.12 - 2.5
Mercury	mg/kg	1.30E-02	8.60E-02	2.66E-02	97/110	N/A	N/A	0/110	N/A	0.011 - 0.017
Molybdenum	mg/kg				0/110	N/A	N/A	0/110	N/A	4.25 - 5
Nickel	mg/kg	4.54E+00	1.15E+01	7.82E+00	75/110	0/110	N/A	0/110	N/A	4.25 - 5
Selenium	mg/kg				0/110	0/110	N/A	0/110	N/A	0.849 - 1
Silver	mg/kg				0/110	0/110	0/110	0/110	0/110	1.65 - 2.49
Sodium	mg/kg				0/110	0/110	0/110	0/110	0/110	170 - 200
Thallium	mg/kg				0/110	0/110	N/A	0/110	N/A	1.7 - 2
Uranium	mg/kg	9.48E-01	3.74E+00	1.38E+00	45/110	0/110	0/110	0/110	0/110	0.849 - 1
Vanadium	mg/kg	1.07E+01	3.77E+01	1.76E+01	110/110	1/110	0/110	110/110	0/110	2.12 - 2.5
Zinc	mg/kg	1.82E+01	5.82E+01	2.61E+01	70/110	0/110	N/A	0/110	N/A	17 - 20
Americium-241	pCi/g				0/110	N/A	N/A	0/110	N/A	0.0214 - 0.0259
Cesium-137	pCi/g	3.91E-02	9.79E-01	2.72E-01	75/110	15/110	0/110	41/110	0/110	0.0359 - 0.0747
Neptunium-237	pCi/g				0/110	0/110	N/A	0/110	N/A	0.0169 - 0.0554
Plutonium-238	pCi/g				0/110	0/110	N/A	0/110	N/A	0.0107 - 0.014
Plutonium-239/240	pCi/g	1.22E-02	3.53E-02	2.07E-02	15/110	3/110	0/110	0/110	0/110	0.00977 - 0.018
Technetium-99	pCi/g	6.83E-01	1.45E+00	9.42E-01	23/110	0/110	N/A	0/110	N/A	0.632 - 0.655
Thorium-228	pCi/g	1.41E-01	5.11E-01	3.06E-01	108/110	0/110	N/A	108/110	N/A	0.112 - 0.118
Thorium-230	pCi/g	1.30E-01	4.71E-01	2.34E-01	103/110	0/110	0/110	0/110	0/110	0.127 - 0.133
Thorium-232	pCi/g	1.19E-01	5.38E-01	3.33E-01	110/110	0/110	N/A	0/110	N/A	0.0739 - 0.0803
Uranium	pCi/g	2.32E-01	1.80E+00	5.64E-01	32/110	N/A	N/A	N/A	N/A	0.218 - 0.294
Uranium-234	pCi/g	1.22E-01	7.99E-01	2.24E-01	37/110	0/110	0/110	0/110	0/110	0.119 - 0.154
Uranium-235	pCi/g	1.49E-02	4.55E-02	2.54E-02	12/110	0/110	0/110	0/110	0/110	0.0117 - 0.0345
Uranium-238	pCi/g	8.90E-02	9.56E-01	2.47E-01	68/110	0/110	0/110	0/110	0/110	0.0859 - 0.118

[1] Background Values from DOE 2001. Samples whose bottom depth less than or equal to 1 screened against surface values; those with depth greater than 1 screened against subsurface values.
N/A = not applicable or not available.

Table 6. Chemicals Exceeding Background

Analysis	Depth	Frequency Exceeding Background[1, 2]
Aluminum	Subsurface	2/56
Arsenic	Subsurface	4/56
Beryllium	Surface	3/54
Cadmium	Surface Subsurface	6/54 8/56
Calcium	Subsurface	3/56
Chromium	Surface Subsurface	5/54 1/56
Lead	Subsurface	1/56
Manganese	Surface	1/54
Vanadium	Subsurface	1/56
Cesium-137	Surface Subsurface	6/54 9/56
Plutonium-239/240	Surface	3/54

[1] Background values taken from the provisional background values provided in DOE 2001.
[2]Eleven chemicals exceeded background. The results for nine chemicals were below the 95th percentile of the generic statewide ambient background values; therefore, they are not considered contaminants. Although cesium-137 and plutonium-239/240 exceed the site-specific background for the Paducah Site, the concentrations are below that associated with fallout. Cesium-137 and plutonium-239/240 are major contributors to global fallout due to atmospheric testing of nuclear weapons in the 1950s to the early 1960s. A summary from Argonne National Laboratory states that concentrations up to 1 pCi/g cesium-137 and 0.1 pCi/g plutonium-239/240 are expected from fallout. Detections noted were evaluated graphically to determine if detects were clustered or random and then compared from low to high. See Appendix B.

Table 7. Comparison of Addendum 2 Soil Piles Radionuclide Concentrations and Radiation Dose/Concentration Limits

Radionuclide	Range of Concentration (pCi/g)	Teen Recreator Screening Level (pCi/g)[b]			Residual Concentration Limit for Release of DOE Property (pCi/g)
		1 mrem/year	15 mrem/year	25 mrem/year	
Cesium-137	-0.0229 – 0.979	1.07E+01	1.60E+02	2.67E+02	
Thorium-230	-0.00525 – 0.471	1.38E+03	2.07E+04	3.44E+04	5/15[c]
Thorium-232	0.119 – 0.538	2.88E+02	4.33E+03	7.21E+03	5/15[c]
Uranium-234	-0.0357 – 0.799	2.72E+03	4.07E+04	6.79E+04	
Uranium-238	0.0112 – 0.956	2.44E+02	3.67E+03	6.11E+03	

[ab] From the PGDP Risk Methods Document. All Risk Methods Document values are presented for comparison purposes; however, not all of these values may be appropriate for response action decision making.
[c] 5 pCi/g, averaged over the first 15 cm of soil below the surface; 14 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface.

6.1.5 PCB Comparison

All piles sampled for Addendum 2 Soil Piles show no detection of PCBs; therefore, a comparison was not performed.

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7. CONCLUSIONS

The following provides a summary of the major findings and conclusions for the Addendum 2 soil piles evaluation. The following lists the objectives of the Addendum 2 soil piles investigation:

- Establish the nature and extent of contamination in Addendum 2 Soil Piles and adjacent soils.
- Establish the mean concentrations of contaminants in soils.
- Determine if soils pose imminent risks to human health.
- Determine if soils contamination exceeds regulatory thresholds.

Consistent with Section 40 *CFR* § 300.420(c)(5) of the National Contingency Plan (NCP), information on the nature of waste handling, known contaminants, pathways of migration of contaminants, human and environmental targets, and a recommendation on further action is contained in this report.

Consistent with Section 40 *CFR* § 300.415(b)(2) of the NCP, the factors that should be considered in determining the appropriateness of a removal action for Addendum 2 soil piles are discussed below.

(i) **Actual or potential exposure to nearby human populations, animals, or food chain from hazardous substances or pollutants or contaminants.**
The SLRA found no constituents that exceeded background. PCBs were not detected.

(ii) **Actual or potential contamination of drinking water supplies or sensitive ecosystem.**
There is no known use of groundwater for drinking water, feedstock watering, or crop irrigation from the Addendum 2 soil piles area.

(iii) **Hazardous substances or pollutants or contaminants in drums, barrels, banks, or other bulk storage containers that may pose a threat of release.**
There are no containers or tanks associated with the Addendum 2 soil piles.

(iv) **High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface that may migrate.**
Sampling results from Addendum 2 and PGDP historical monitoring data indicate no migration is occurring.

(v) **Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.**
Sampling results from Addendum 2 and PGDP historical monitoring data indicate no migration is occurring.

(vi) **Threat of fire or explosion.**
The Addendum 2 soil piles do not present a threat of fire or explosion.

(vii) **The availability of other appropriate federal or state response mechanisms to respond to the release.**
This factor is not applicable to the Addendum 2 soil piles.

(viii) **Other situations or factors that may pose threats to public health or welfare of the United States or the environment.**
There are no other situations or factors at Addendum 2 soil piles that would pose a threat to public health or the environment.

7.1 NATURE AND EXTENT OF CONTAMINATION

As expected, contamination was not found in field and fixed laboratory samples collected from the 54 soil pile samples. Data (see Appendix A) of known quality were acquired in sufficient quantities to allow decision makers to formulate an informed decision as to the need for an action at any of the Addendum 2 soil piles, if warranted. No evidence was found of a release of hazardous waste or hazardous constituents that would pose a current or potential threat to human health or the environment. Additionally, no indication was found of treatment, storage, or disposal of solid or hazardous waste.

7.2 HUMAN HEALTH RISKS

The results of the background screening for metals indicate concentrations used to quantify risks and hazards were near background levels for all 54 soil pile samples. Eleven chemicals exceeded site specific background; however, the results either were below the 95^{th} percentile of the generic statewide ambient background values or as a result of fallout; therefore, they are not considered contaminants, as noted in Section 6.

7.2.1 Radiation Dose Limits

Concentrations of radiological parameters detected in Addendum 2 soil piles are below recreational user screening levels for a 1 mrem/year dose and, therefore, below the “walk away” level in the PGDP Risk Methods Document.

7.2.2 PCB Remediation Waste

PCBs were not detected in any of the field and laboratory samples collected from the 54 soil piles.

8. RECOMMENDATIONS

The following provides recommendations for future activities at Addendum 2 Soil Piles. The recommendations are based on the findings of the investigation and lessons learned during the planning and execution of study efforts at Addendum 2 Soil Piles.

8.1 FUTURE ACTIVITIES

The following are recommendations and future actions to be taken based on the findings of the Addendum 2 Soil Piles:

- SWMU Assessment Reports are not required for any of the Addendum 2 piles as contamination was not identified and no documentation exists to indicate the presence of wastes.
- No further investigation is recommended for the 54 soil piles along Bayou Creek (Addendum 2 Soil Piles).
- The PAH test kit evaluation will be completed in the Addendum 1-B SER because most all results for Addendum 2 Soil Piles were below the detection limit for both field and fixed laboratory results.

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APPENDIX A

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SER ADDENDUM 2 DATA

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APPENDIX B

SCREENING OF DETECTED CHEMICALS EXCEEDING BACKGROUND

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Background Exceedances for Addendum 2 Soil Pile Sampling

Eleven chemicals exceeded Paducah Gaseous Diffusion Plant (PGDP) background during the Addendum 2 sampling. Three of those chemicals exceeded background in both surface and subsurface sampling. The eleven chemicals are listed in Table 1.

Table 1. Addendum 2 Chemicals Exceeding Background

Analysis	Depth	Frequency Exceeding Background*
Aluminum	Subsurface	2/56
Arsenic	Subsurface	4/56
Beryllium	Surface	3/54
Cadmium	Surface	6/54
	Subsurface	8/56
Calcium	Subsurface	3/56
Chromium	Surface	5/54
	Subsurface	1/56
Lead	Subsurface	1/56
Manganese	Surface	1/54
Vanadium	Subsurface	1/56
Cesium-137	Surface	6/54
	Subsurface	9/56
Plutonium-239/240	Surface	3/54

*Background values for this analysis were taken from the provisional background values provided in DOE 2001. Material presented later in this section considers estimates of background concentrations from other sources.

Of the soil piles with results exceeding background, Soil Pile BP has the most background exceedances with 5 [2 surface exceedances (cadmium and chromium) and 3 subsurface exceedances (cadmium, lead, cesium-137)]. The next highest ranking soil piles have 4 background exceedances each: Soil Piles AG and W. [Soil Pile AG has 1 surface exceedance (cadmium) and 3 subsurface exceedances (aluminum, cadmium, calcium). Soil Pile W has 4 surface exceedances (beryllium, manganese, cesium-137, plutonium-239/240).] Soil Piles AH, AB, and X have 3 background exceedances each. Several other soil piles have 1 or 2 background exceedances.

The following soil piles have no background exceedances:

2	5	10	15	AD	AK	BD	BO	U
3	7	12	13A	AI	AN	BF	Q	V
4	8	14	13B	AJ	AY	BN	R	Y

The following text describes and illustrates the spatial distribution of these background exceedances with accompanying charts of results compared to background and other screening values. Other screening values used for comparison are the revised site background values for PGDP published for review in 2008 and the generic statewide ambient background value available in Kentucky Energy and Environment Cabinet guidance (KEEC 2004). To apply the guidance established by the KEEC, the criteria were used as listed here:

1. The mean site concentration for inorganic constituents must be below the 95% upper confidence limit (UCL) of the mean concentrations of background for inorganic constituents.

2. At least half of the data points should be less than the 60th percentile.

3. No data points should be above the upper bound value (95th percentile).

Aluminum–Subsurface. Aluminum values in subsurface soil samples exceed the background value of 12,000 mg/kg in 2 of 56 samples. The two exceeding values are 12,300 and 13,000 mg/kg. The locations from which the exceeding samples were collected are from different soil piles and are not related. Further, several other samples were collected near these two and did not exceed background. The criteria for applying ambient background values established by KEEC were met. Both of these values are well below the 95th percentile of the generic statewide ambient background value (21,000 mg/kg) (KEEC 2004); therefore, aluminum is not present in the Addendum 2 soil piles as a contaminant.

Figure 1 graphically shows the results with the background value and other comparison values. Figure 2 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

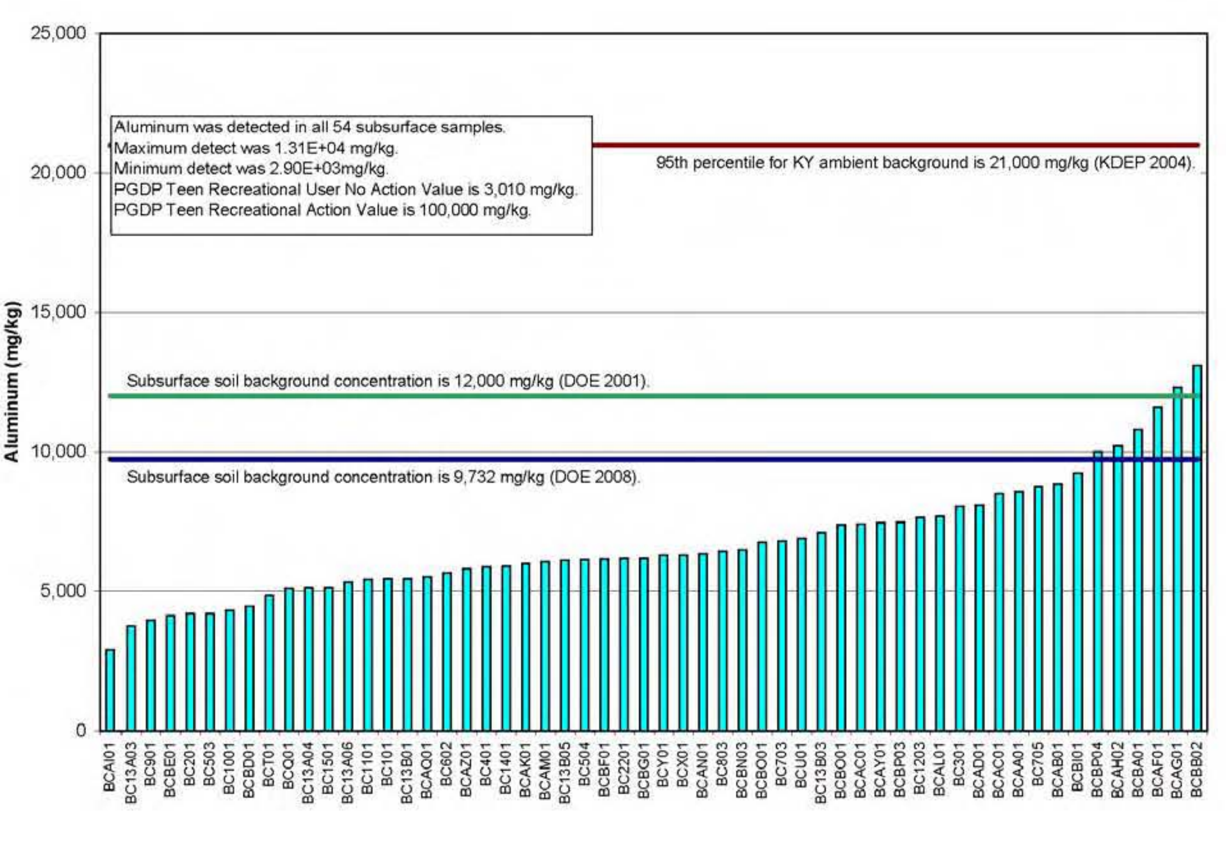

Figure 1. Comparison between Aluminum Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

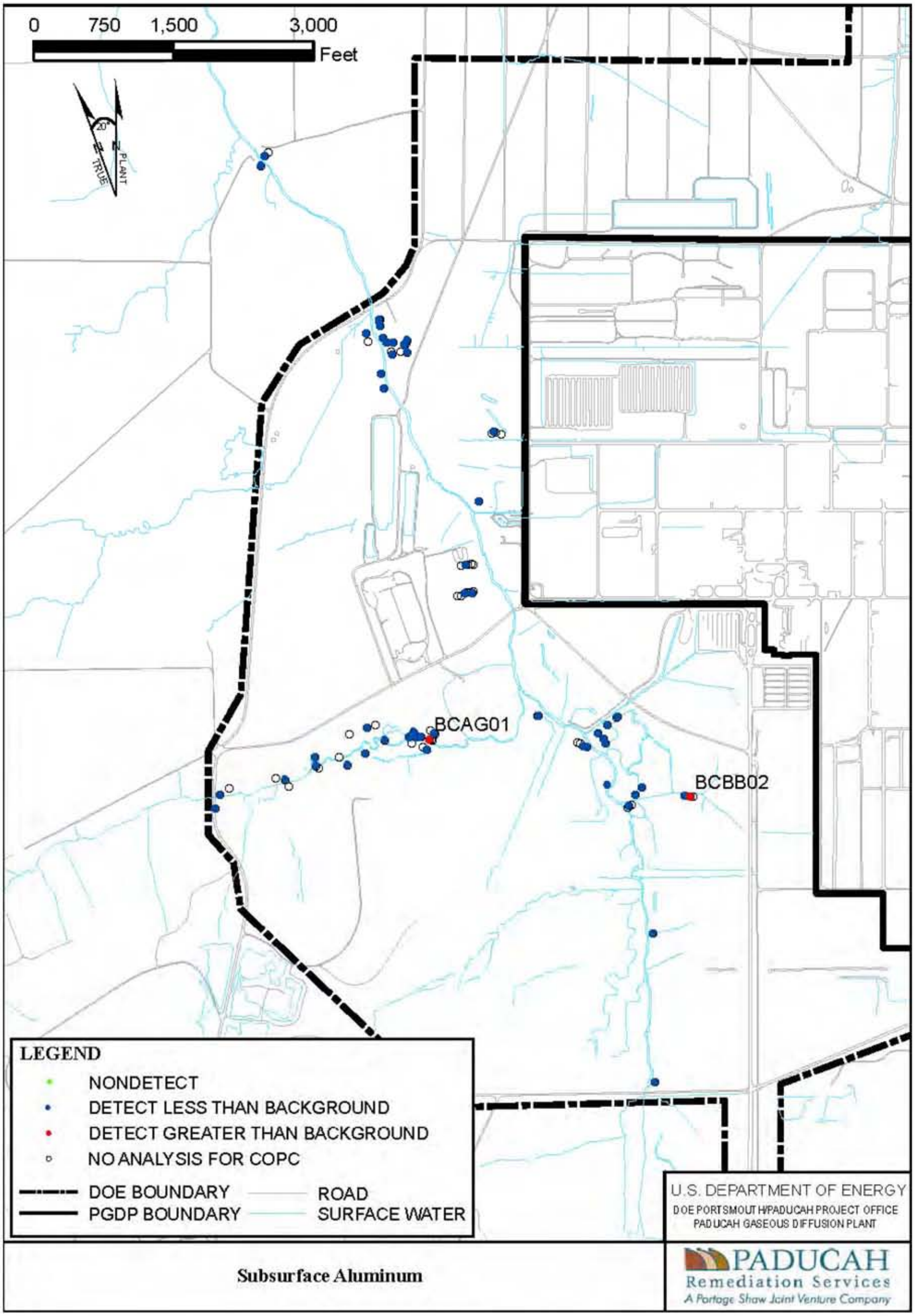

Figure 2. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Aluminum in the Subsurface

Arsenic–Subsurface. Arsenic values in subsurface soil samples exceed the background value of 7.9 mg/kg in 4 of 56 samples. The four exceeding values are 7.94, 8.3, 8.85, and 9 mg/kg. The soil piles from which the samples were collected are not related spatially. Further, several other samples were collected near these four, and the concentrations in these samples did not exceed background. The criteria for applying ambient background values established by KEEC were met. These values are well below the 95th percentile of the generic statewide ambient background value (21.2 mg/kg) (KEEC 2004); therefore, arsenic is not present in the Addendum 2 soil piles as a contaminant.

Figure 3 graphically shows the results with the background value and other comparison values. Figure 4 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

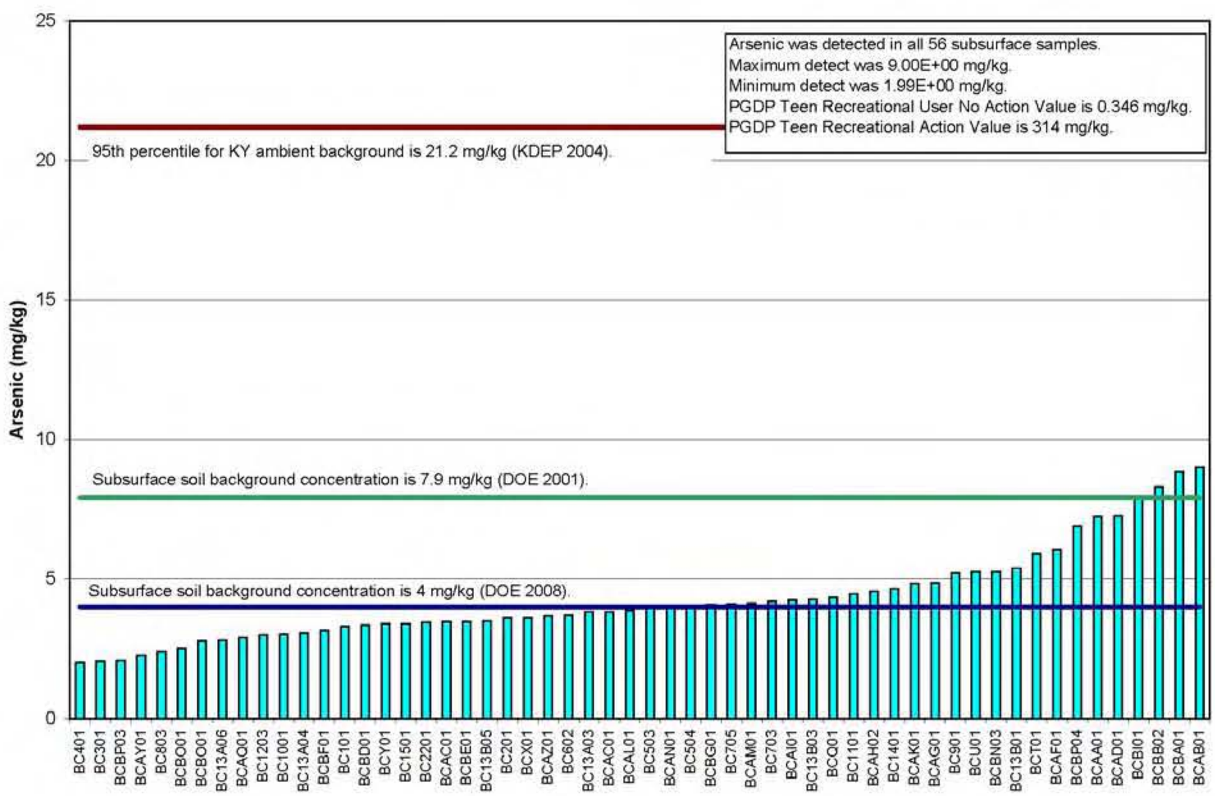

Figure 3. Comparison between Arsenic Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

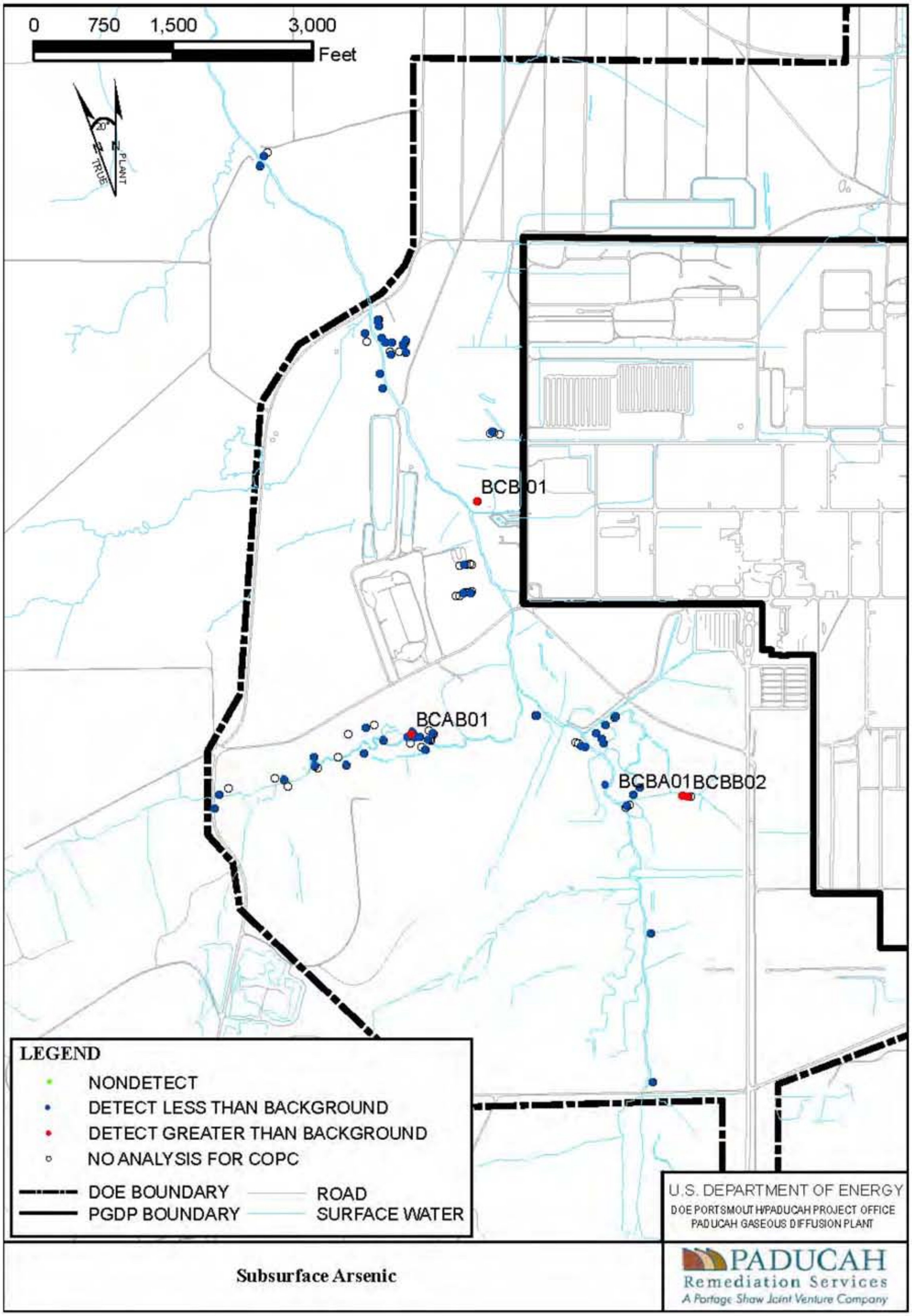

Figure 4. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Arsenic in the Subsurface

Beryllium–Surface. Beryllium values in surface soil samples exceed the background value of 0.67 mg/kg in 3 of 54 samples. The three exceeding values are 0.676, 0.686, and 0.716 mg/kg. The soil piles from which the samples were collected are not related spatially. Further, several other samples were collected near these three locations and did not exceed background. The criteria for applying ambient background values established by KEEC were met. These values are well below the 95th percentile of the generic statewide ambient background value (1.8 mg/kg) (KEEC 2004); therefore, beryllium is not present in the Addendum 2 soil piles as a contaminant.

Figure 5 graphically shows the results with the background value and other comparison values. Figure 6 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

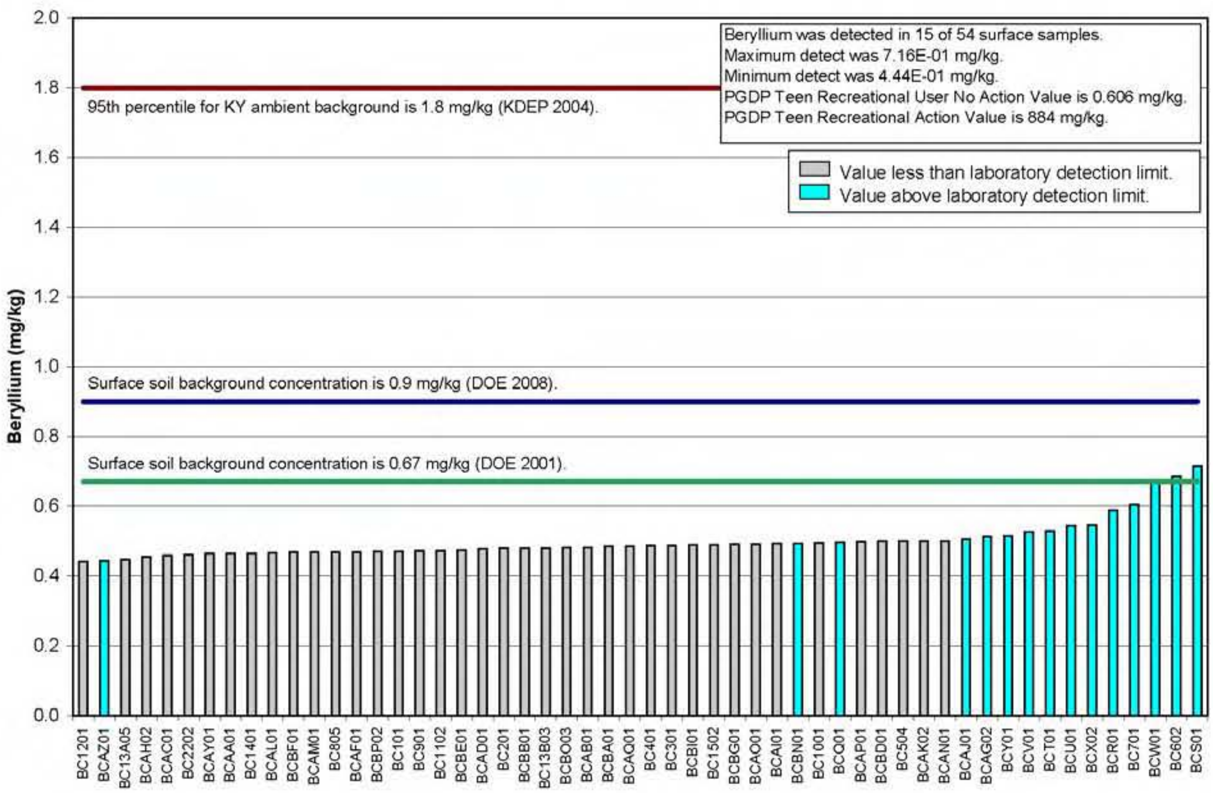

Figure 5. Comparison between Beryllium Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

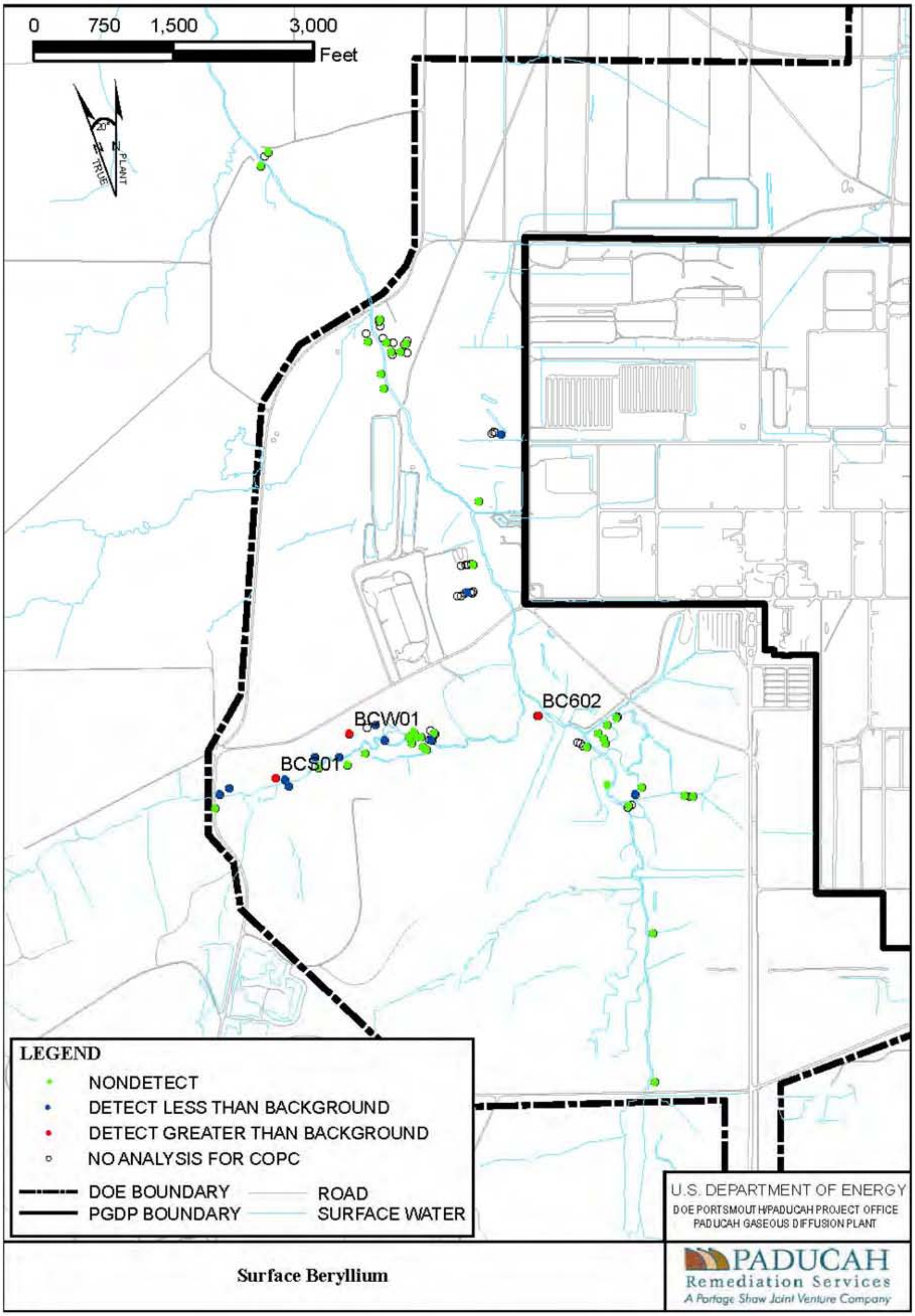

Figure 6. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Beryllium in the Surface

Cadmium–Surface. Cadmium values in surface soil samples exceed the background value of 0.21 mg/kg in 6 of 54 samples. The exceeding values were the only detects of cadmium in surface samples because the background value is lower than the detection limit for cadmium. Detected values in the samples range from 0.477 to 0.674 mg/kg. The criteria for applying ambient background values established by KEEC were met. All detected values, however, are below the 95th percentile of the generic statewide ambient background value (3.9 mg/kg) (KEEC 2004). Although detected values are primarily located within close proximity, their values are well below the statewide ambient background values and, as such, are not of consequence; therefore, cadmium is not present in the Addendum 2 soil piles as a contaminant in either the surface.

Figure 7 graphically shows the results with the background value and other comparison values. Figure 8 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

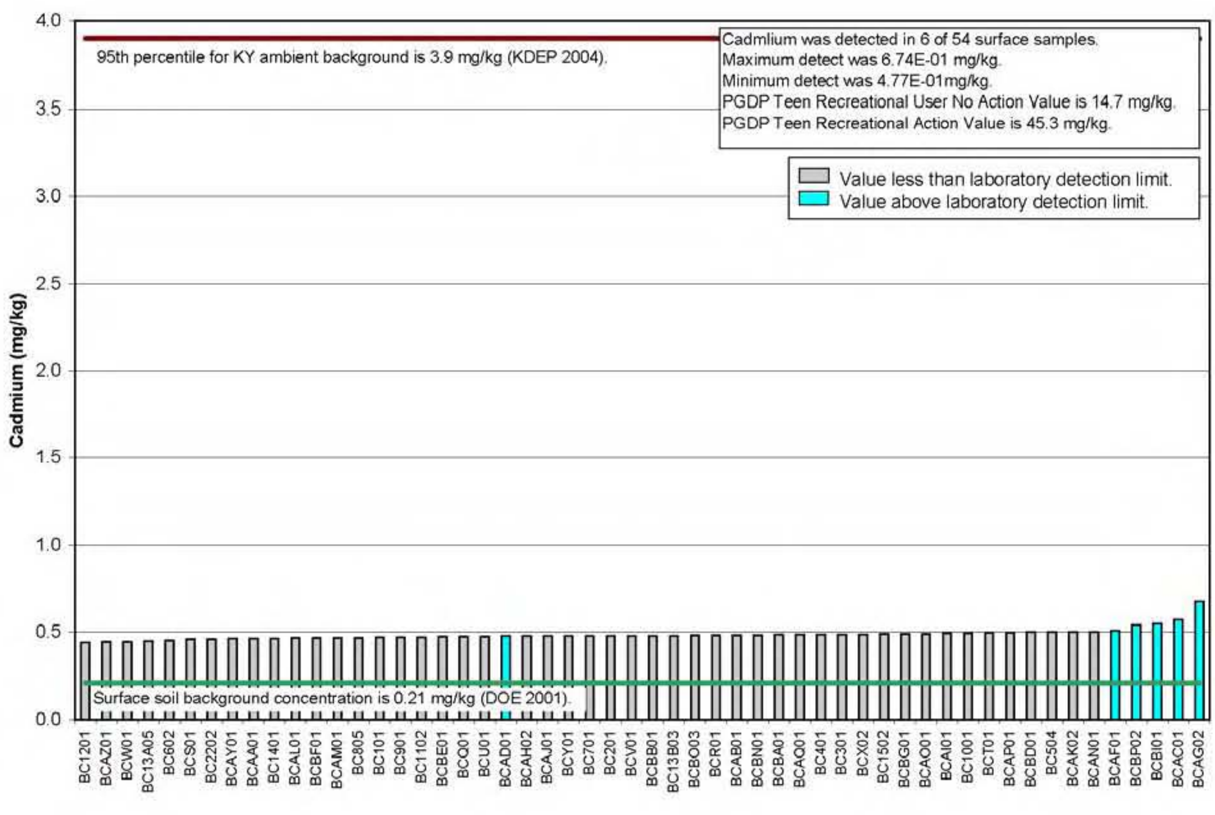

Figure 7. Comparison between Cadmium Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

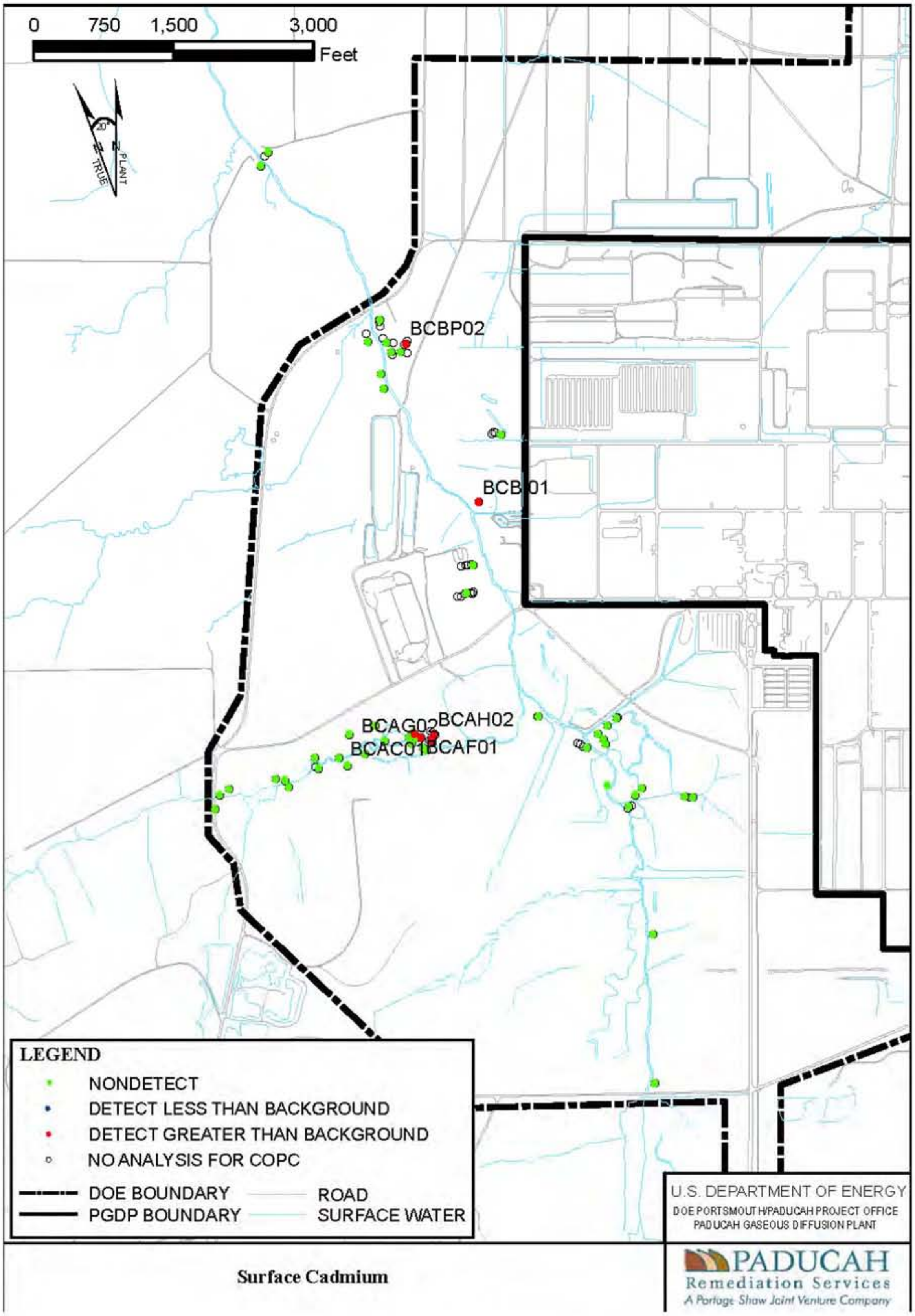

Figure 8. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cadmium in the Surface

Cadmium–Subsurface. Cadmium values in subsurface soil samples exceed the background value of 0.21 mg/kg in 8 of 56 samples. The exceeding values were the only detects of cadmium in the subsurface because the background value is lower than the detection limit for cadmium. Detected values in the samples range from 0.466 to 0.655 mg/kg. The criteria for applying ambient background values established by KEEC were met. All detected values, however, are below the 95^{th} percentile of the generic statewide ambient background value (3.9 mg/kg) (KEEC 2004). Although detected values are primarily located within close proximity, their values are well below the statewide ambient background values and as such, are not of consequence; therefore, cadmium is not present in the Addendum 2 soil piles as a contaminant in the subsurface.

Figure 9 graphically shows the results with the background value and other comparison values. Figure 10 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

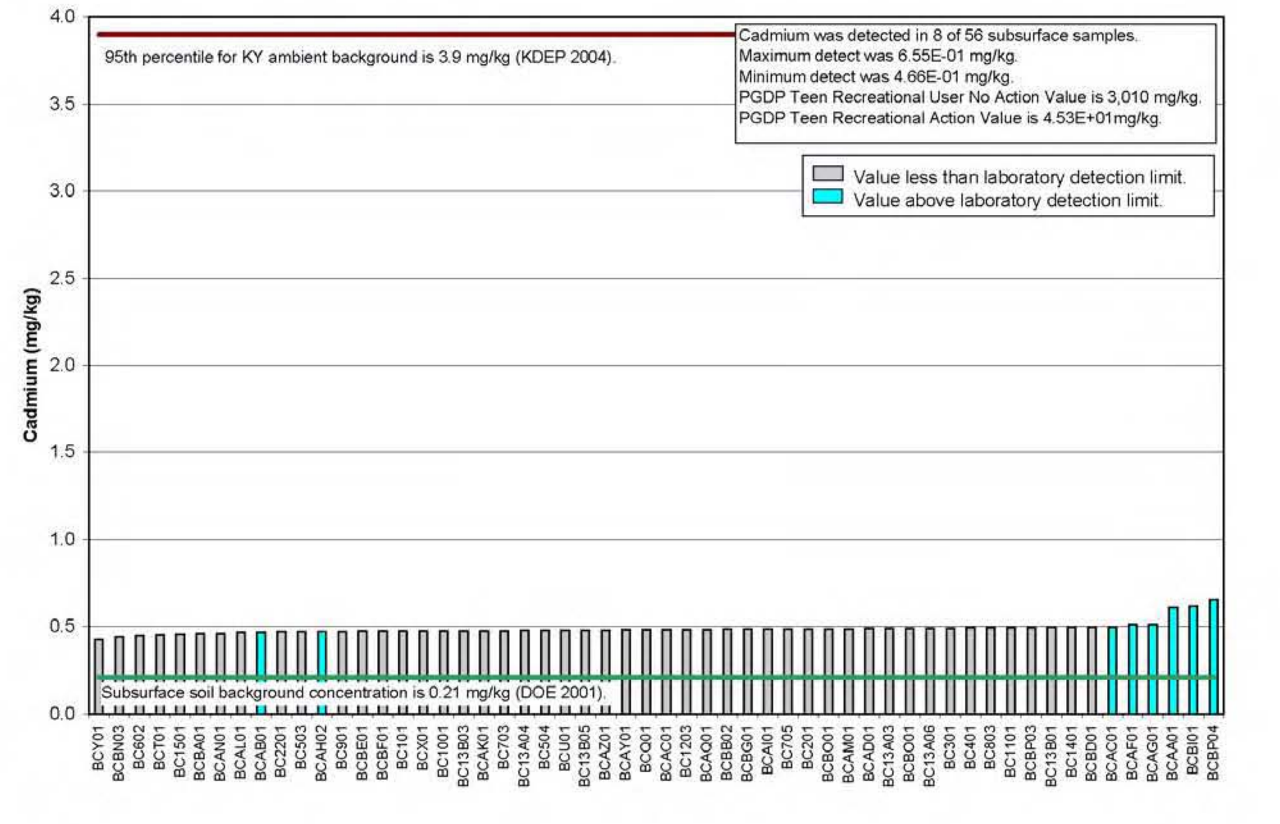

Figure 9. Comparison between Cadmium Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

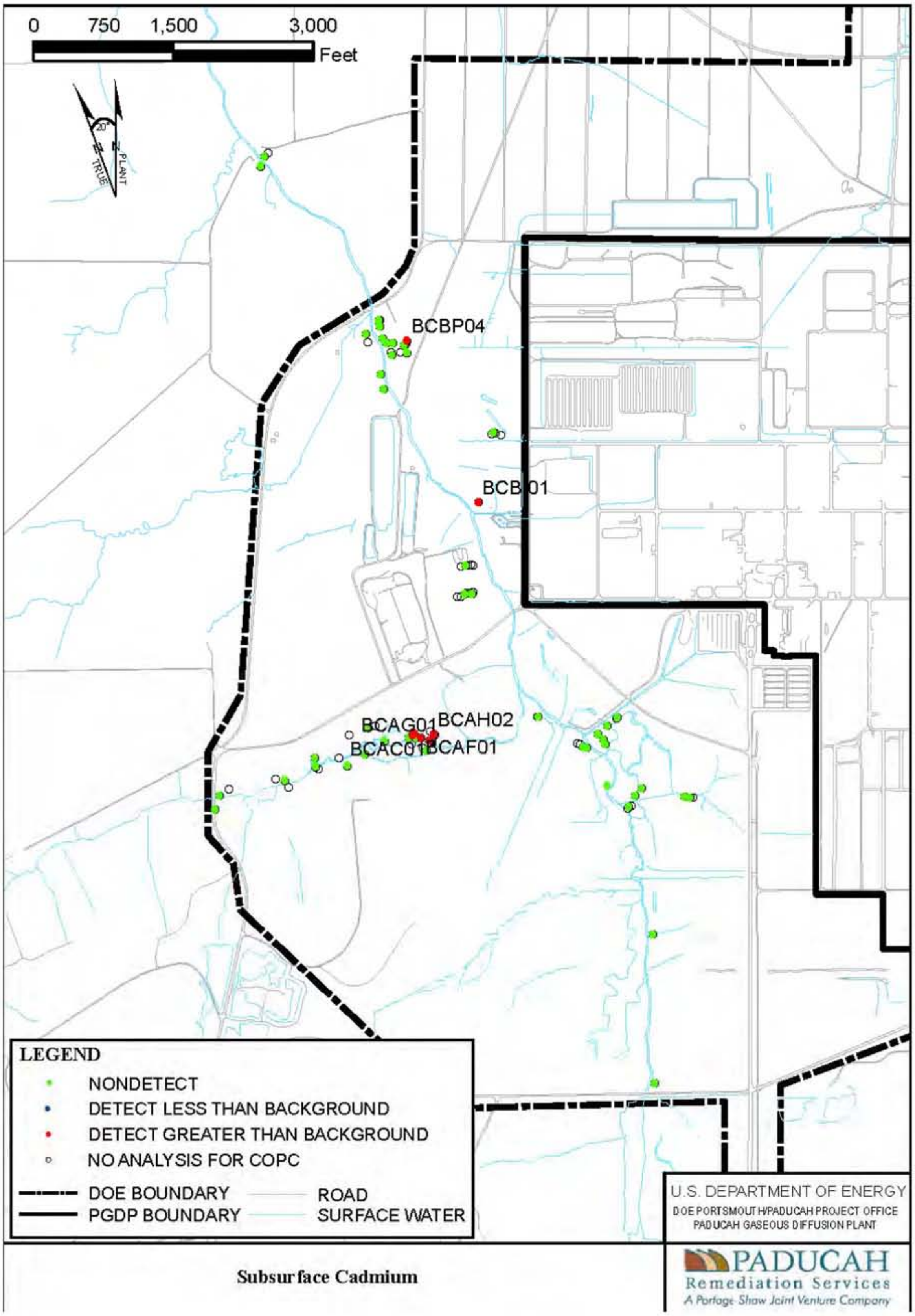

Figure 10. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cadmium in the Subsurface

Calcium–Subsurface. Calcium values in subsurface soil samples exceed the background value of 6,100 mg/kg in 3 of 56 samples. The three exceeding values are 9,750; 26,000; and 66,200 mg/kg. The locations from which the exceeding samples were collected are from the same area; however, several other samples were collected near these three locations that did not exceed background. Calcium is not listed with a generic statewide ambient background value, nor does the chemical have risk-based action and no-action levels because calcium is an essential element (DOE 2001); therefore, though calcium is present in the Addendum 2 soil piles above background, it is not considered a contaminant.

Figure 11 graphically shows the results with the background value and other comparison values. Figure 12 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

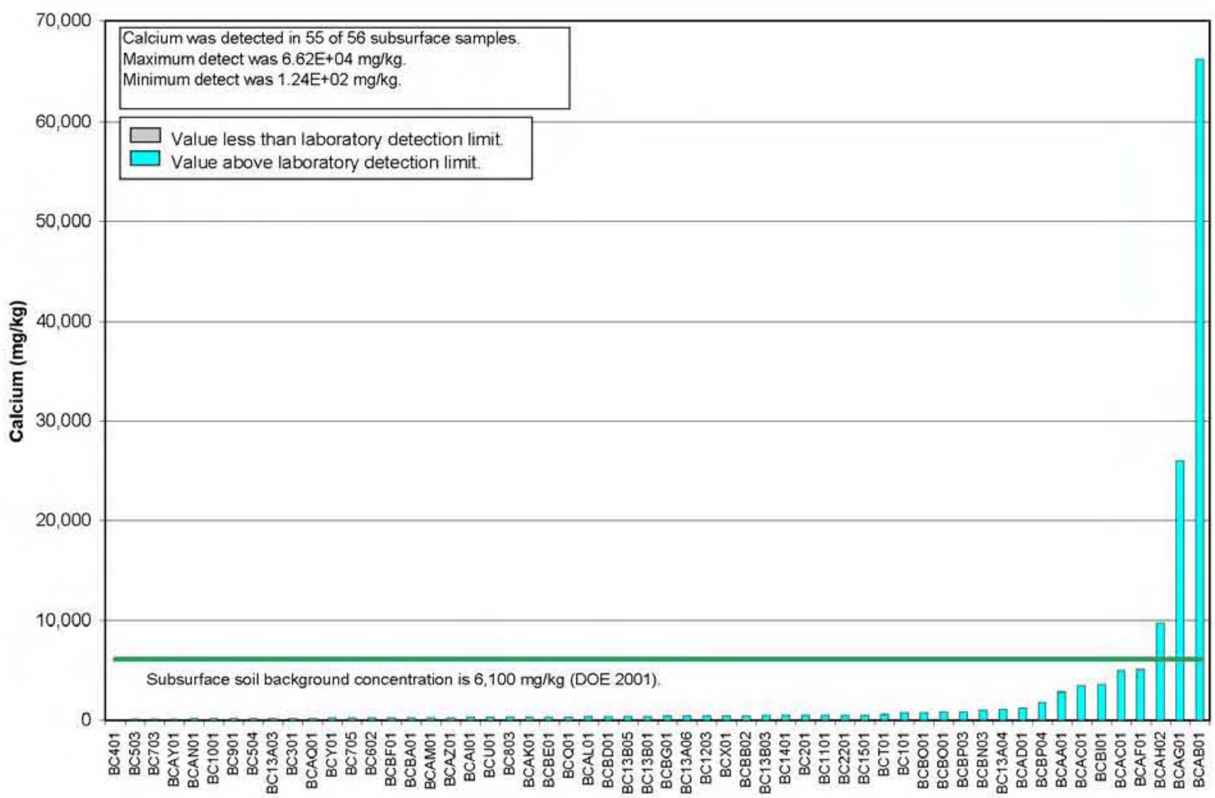

Figure 11. Comparison between Calcium Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

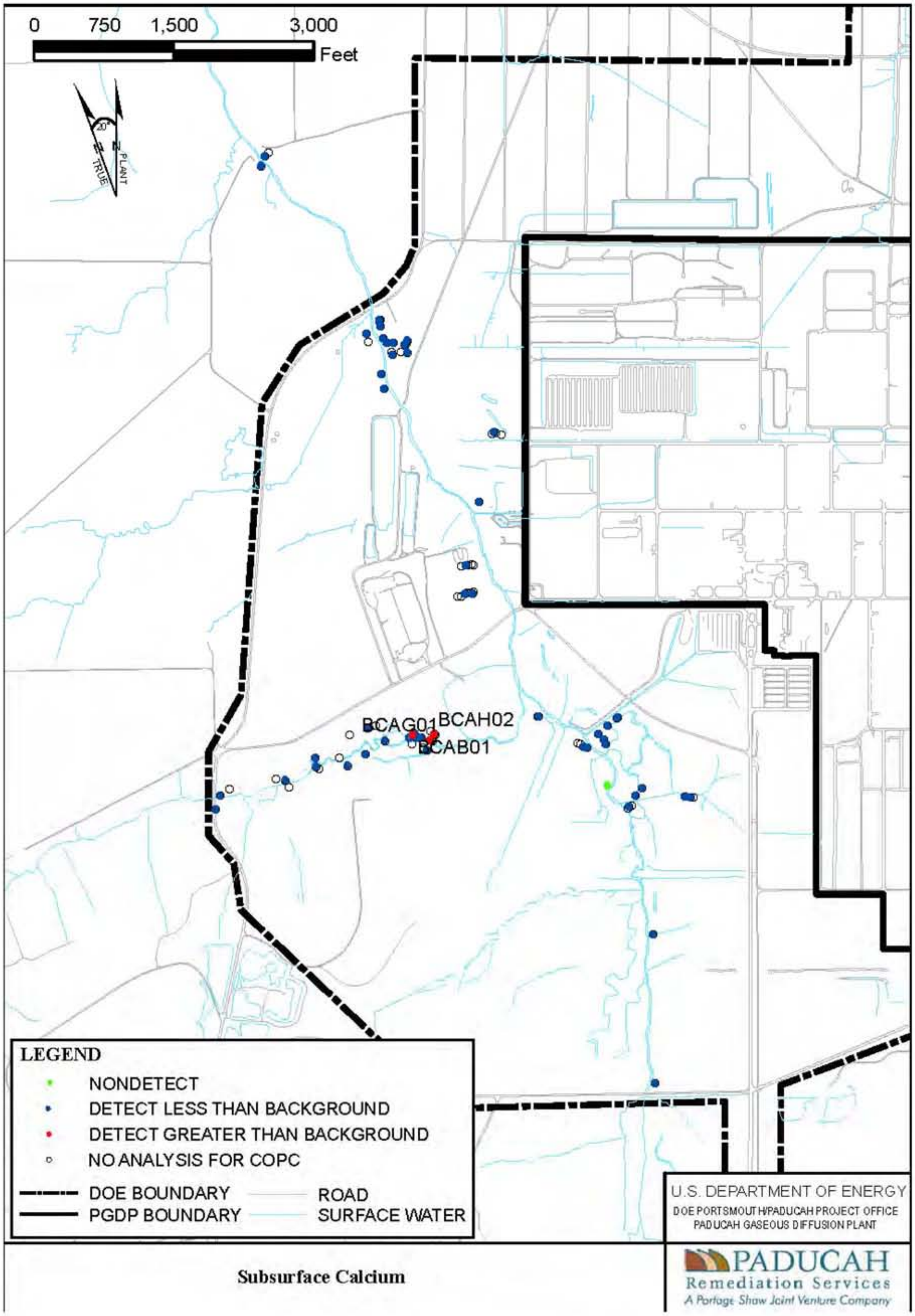

Figure 12. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Calcium in the Subsurface

Chromium–Surface. Chromium values in surface soil samples exceed the background value of 16 mg/kg in 5 of 54 samples. The samples exceeding background ranged from 16.7 to 29.7 mg/kg. The criteria for applying ambient background values established by KEEC were met. All values were well below the 95th percentile of the generic statewide ambient background value (40 mg/kg) (KEEC 2004); therefore, chromium is not present in the Addendum 2 soil piles as a contaminant in the surface.

Figure 13 graphically shows the results with the background value and other comparison values. Figure 14 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

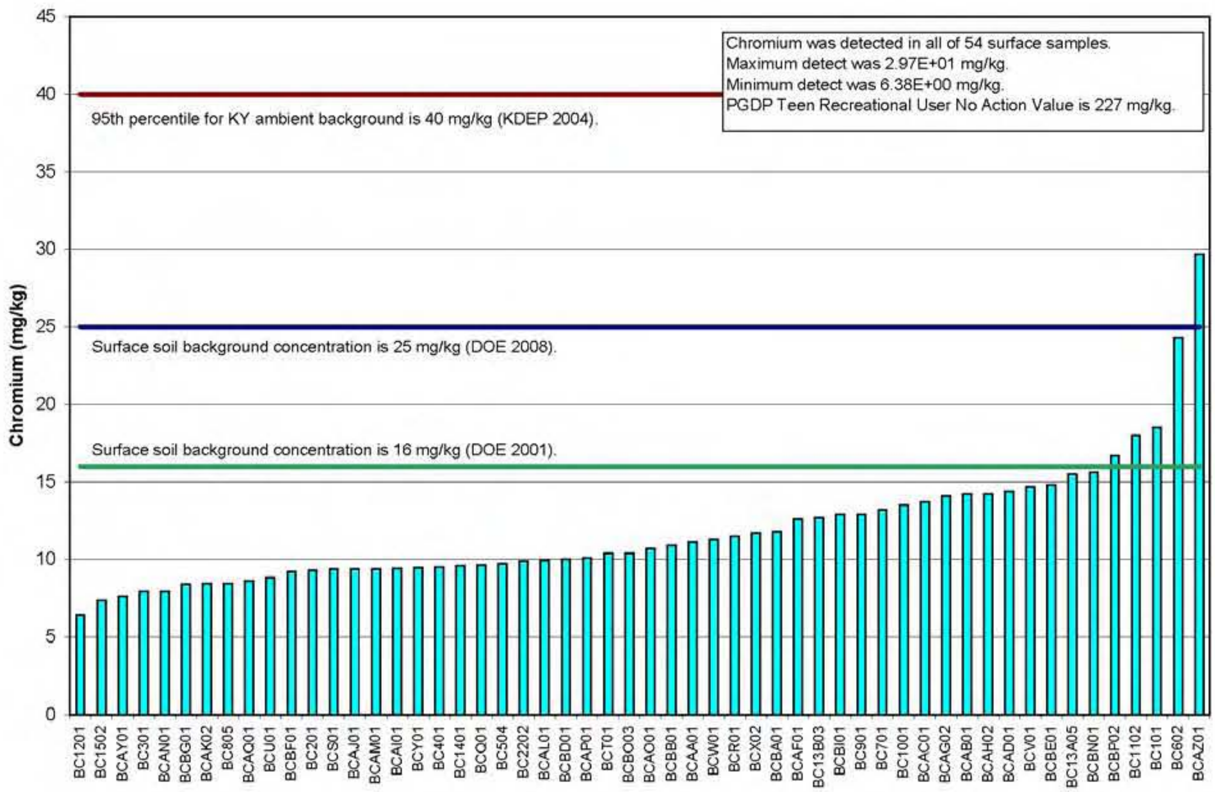

Figure 13. Comparison between Chromium Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

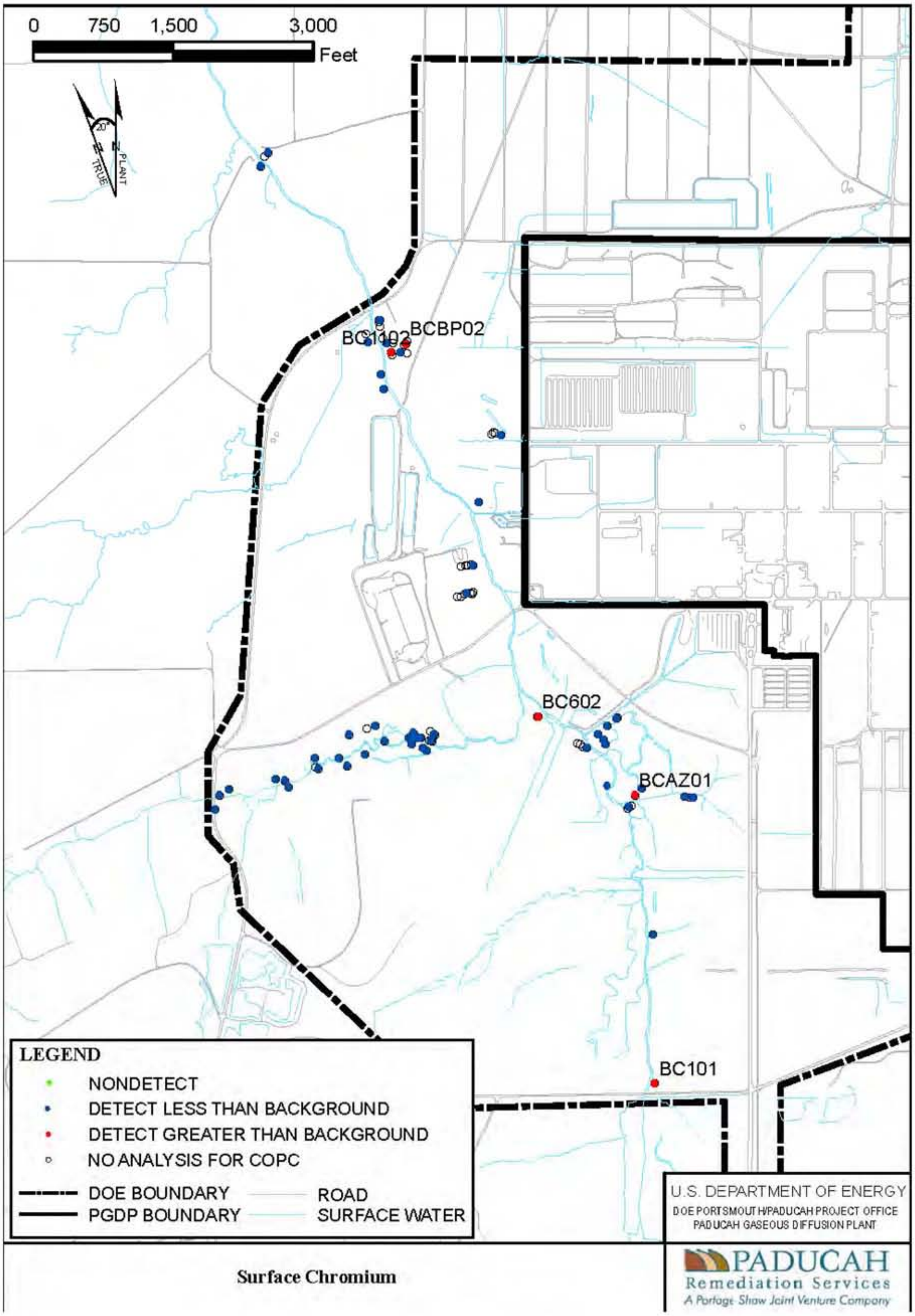

Figure 14. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Chromium in the Surface

Chromium–Subsurface. Chromium values in subsurface soil samples exceed the background value of 43 mg/kg in only 1 of 56 samples (54.6 mg/kg). This value is near other subsurface samples that are below the background value. Additionally, though this sample exceeds background, it is well below the screening criteria established for the soil piles. The teen recreational user no-action level for chromium is 227 mg/kg. Although chromium is present in the Addendum 2 soil piles above background, it is should not be considered a contaminant since it is well below the screening criteria.

Figure 15 graphically shows the results with the background value and other comparison values. Figure 16 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

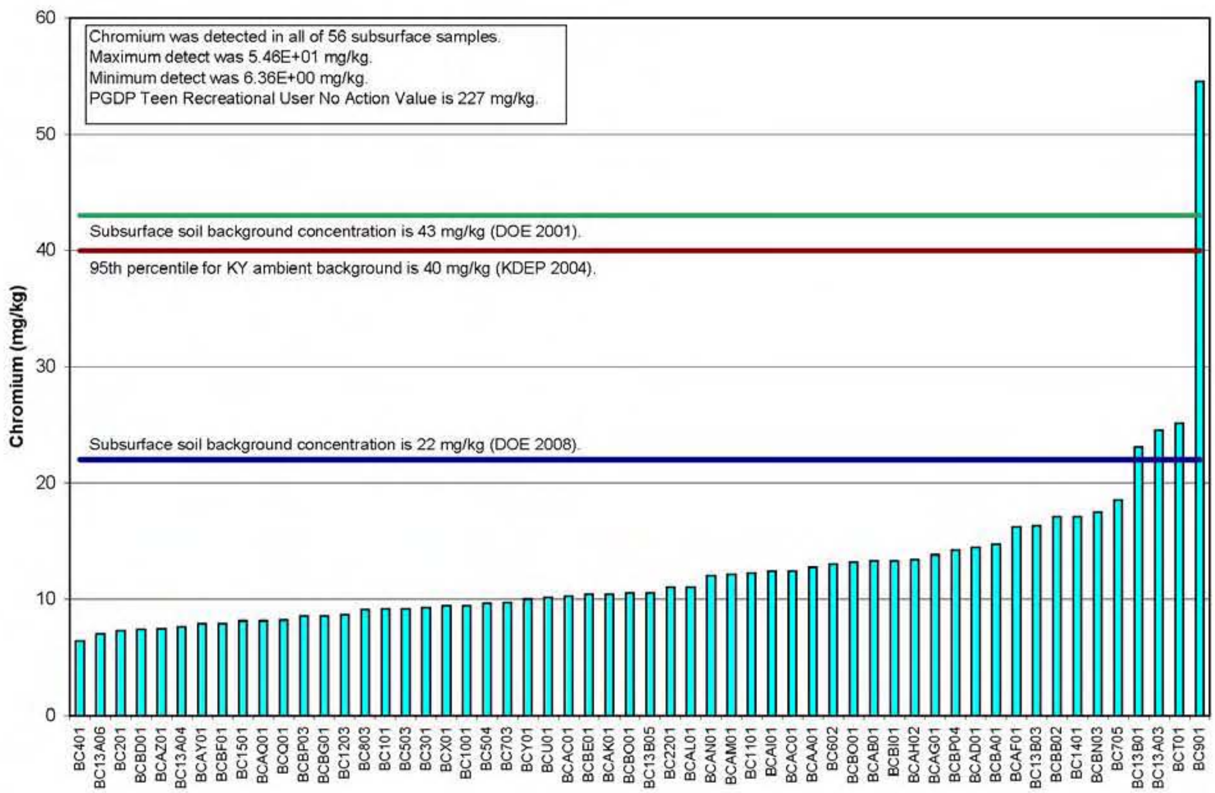

Figure 15. Comparison between Chromium Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

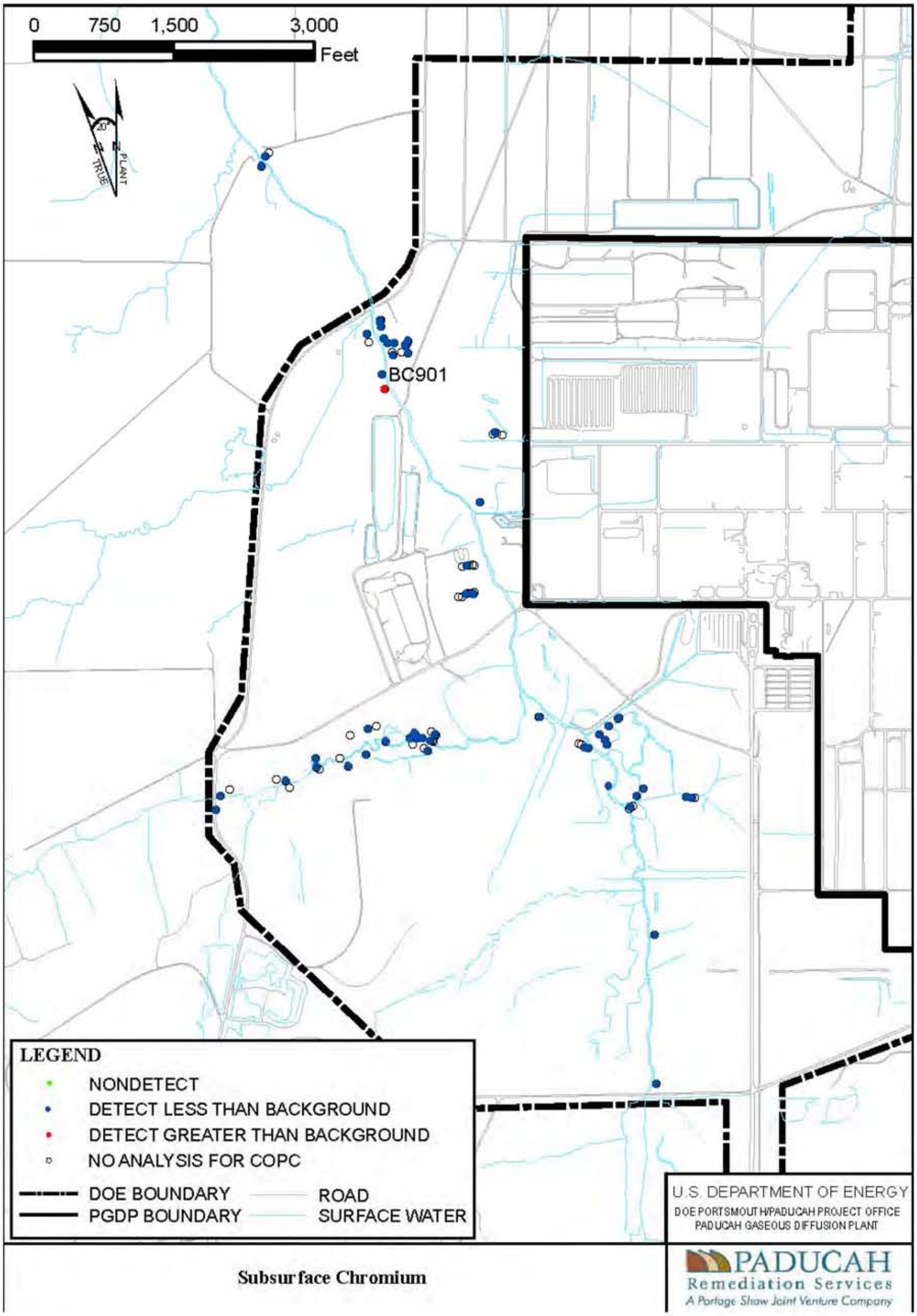

Figure 16. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Chromium in the Subsurface

Lead–Subsurface. Lead values in subsurface soil samples exceed the background value of 23 mg/kg in 1 of 56 samples (28.8 mg/kg). Several other samples were collected near this location and did not exceed background. The criteria for applying ambient background values established by KEEC were met. The exceedance is below the 95th percentile of the generic statewide ambient background value (84.6 mg/kg) (KEEC 2004); therefore, lead is not present in the Addendum 2 soil piles as a contaminant.

Figure 17 graphically shows the results with the background value and other comparison values. Figure 18 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

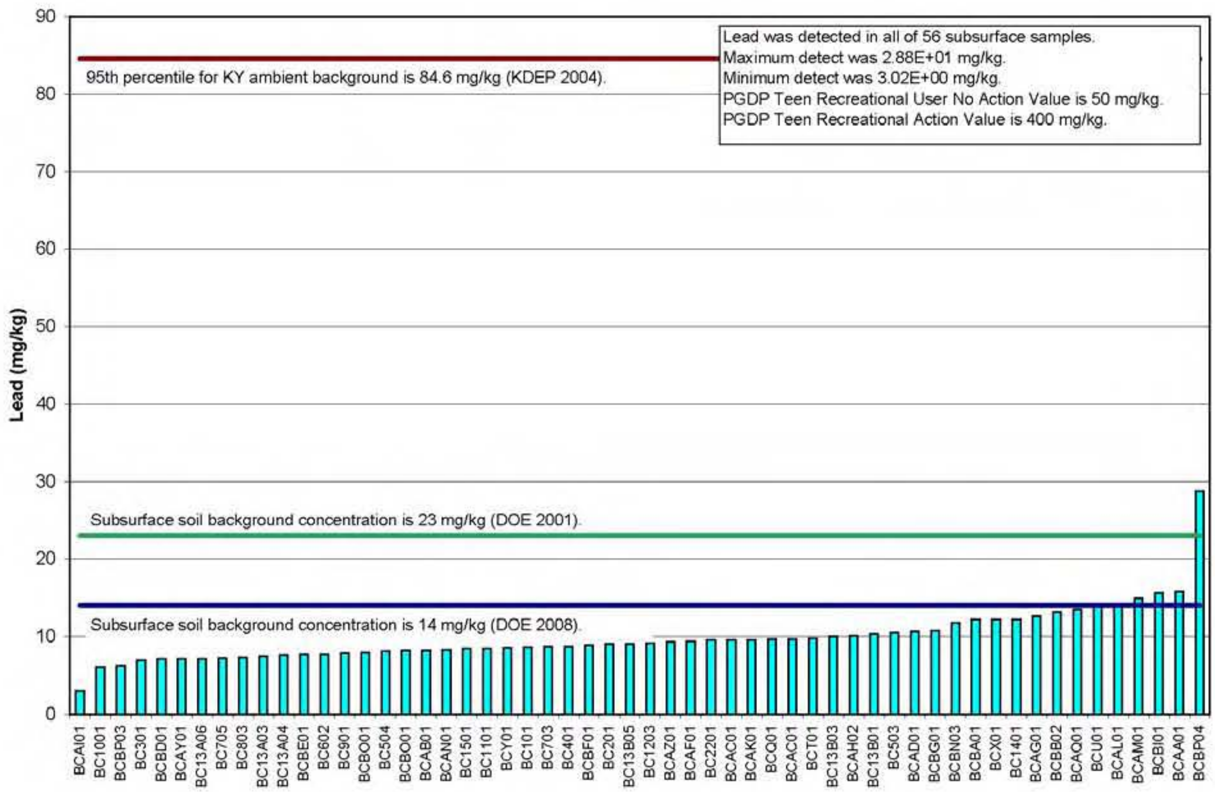

Figure 17. Comparison between Lead Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

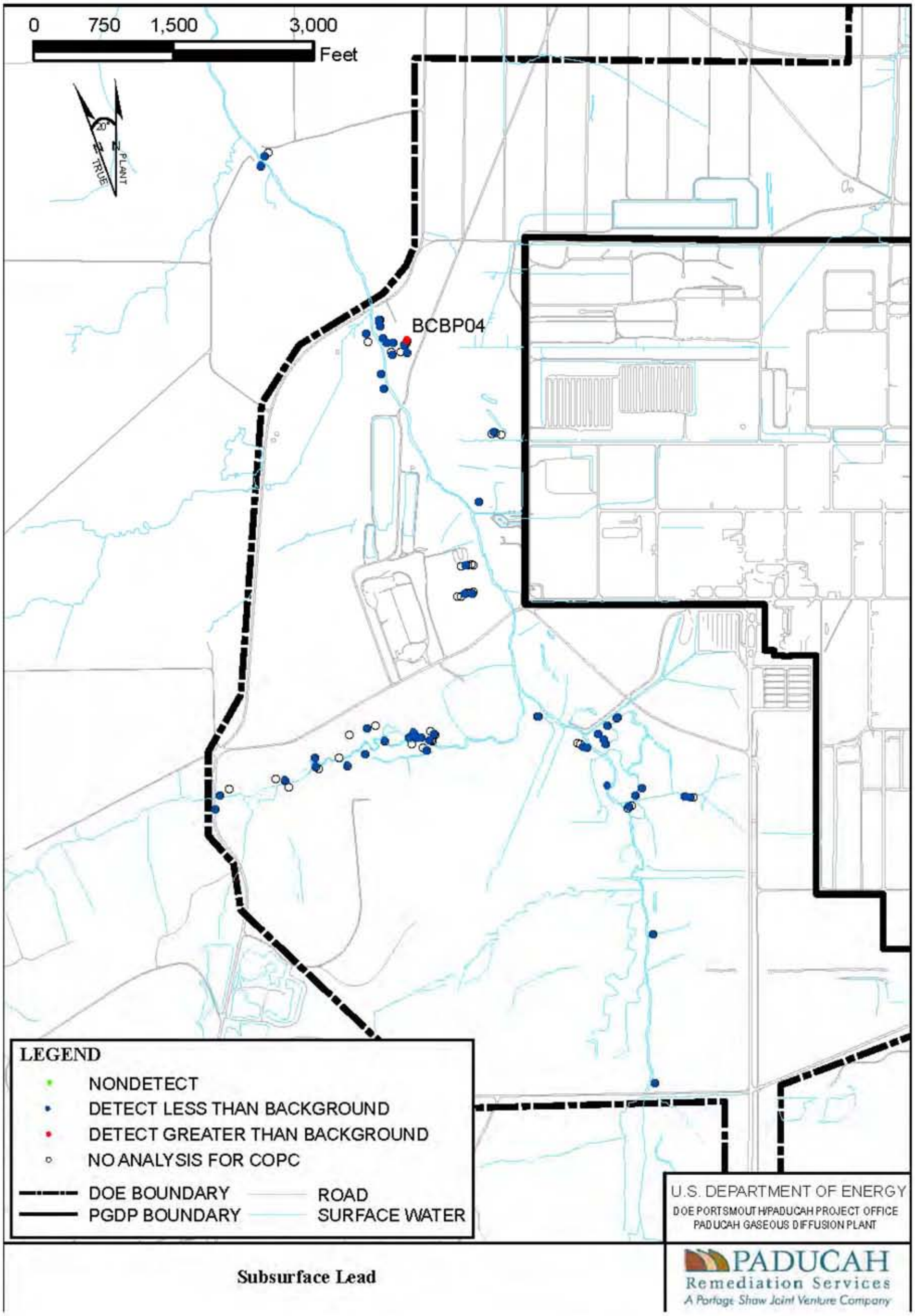

Figure 18. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Lead in the Subsurface

Manganese–Surface. Manganese values in surface soil samples exceed the background value of 1,500 mg/kg in only 1 of 54 samples (1,580 mg/kg). The criteria for applying ambient background values established by KEEC were met. The exceedance is below the 95th percentile of the generic statewide ambient background value (2,620 mg/kg) (KEEC 2004; therefore, manganese is not present in the Addendum 2 soil piles as a contaminant.

Figure 19 graphically shows the results with the background value and other comparison values. Figure 20 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

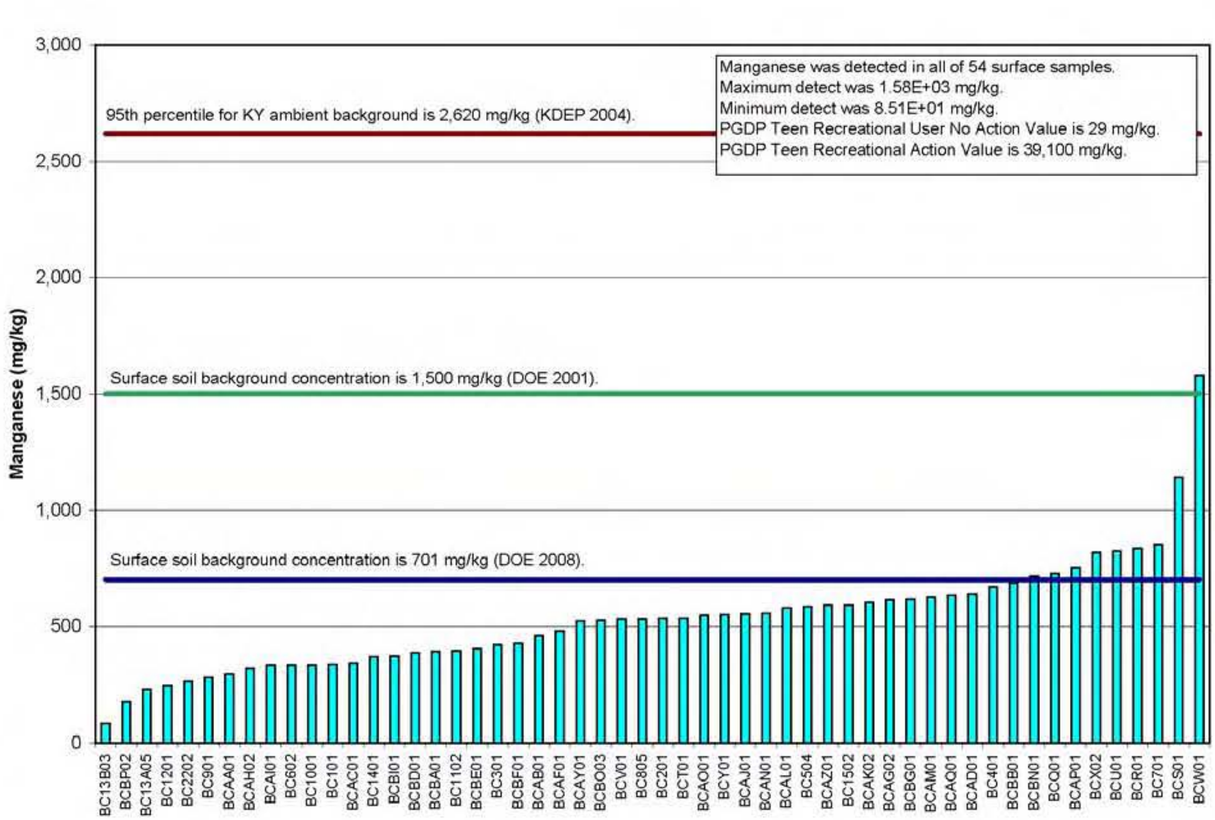

Figure 19. Comparison between Manganese Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

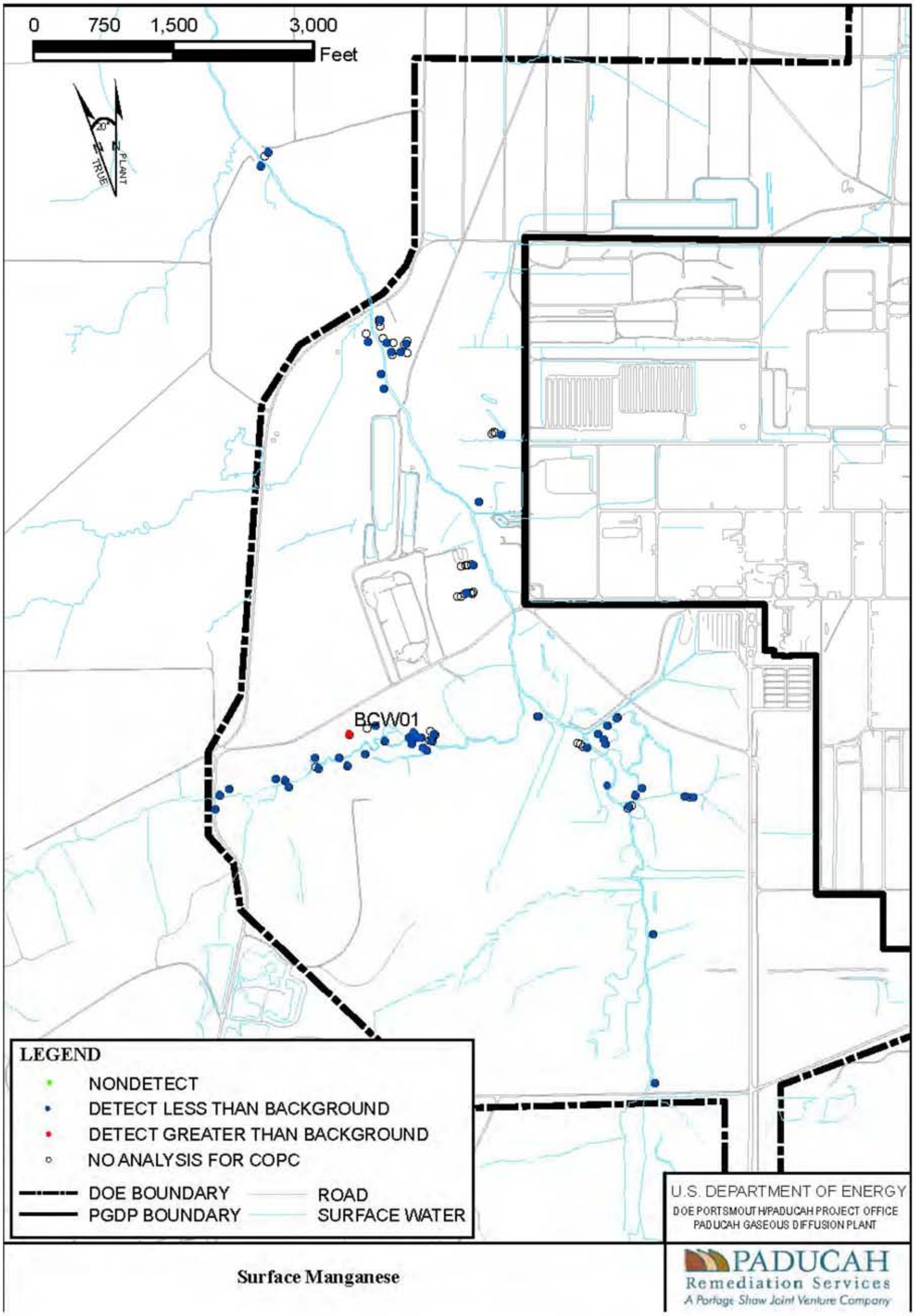

Figure 20. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Manganese in the Surface

Vanadium–Subsurface. Vanadium values in subsurface soil samples exceed the background value of 37 mg/kg in 1 of 56 samples (37.7 mg/kg). The criteria for applying ambient background values established by KEEC were met. This value is only slightly above site background and is well below the 95th percentile of the generic statewide ambient background value (48.6 mg/kg) (KEEC 2004); therefore, vanadium is not present in the Addendum 2 soil piles as a contaminant.

Figure 21 graphically shows the results with the background value and other comparison values. Figure 22 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

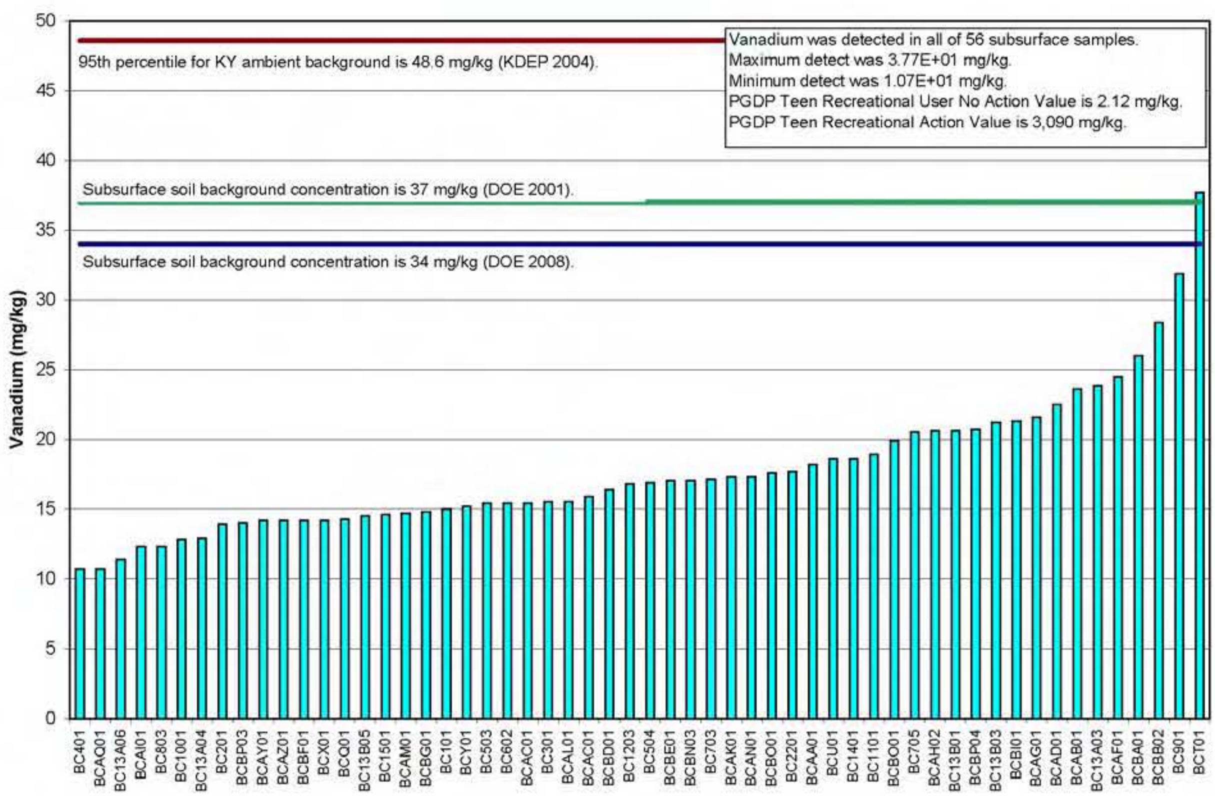

Figure 21. Comparison between Vanadium Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

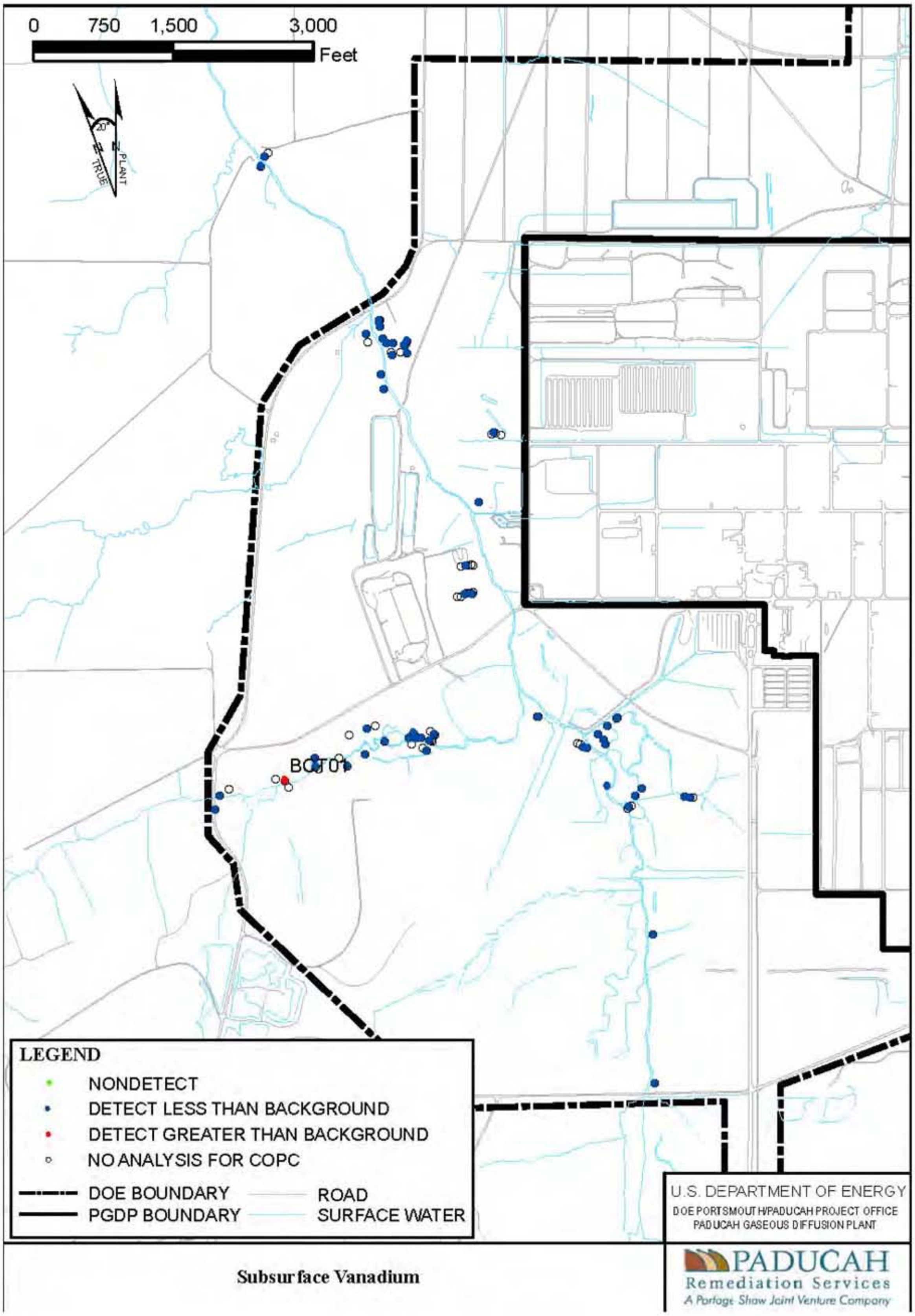

Figure 22. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Vanadium in the Subsurface

Cesium-137–Surface. Cesium-137 values in surface soil samples exceed the background value of 0.49 pCi/g in 6 of 54 samples. The samples exceeding background ranged from 0.724 to 0.883 pCi/g. Although the cesium-137 concentration exceeds the site-specific background for PGDP, the concentration of cesium-137 in samples exceeding background are below the concentrations associated with fall-out. Cesium-137 is a major contributor to global fall-out due to atmospheric testing of nuclear weapons in the 1950s to the early 1960s. A summary from Argonne National Lab (ANL 2007) states that concentrations up to 1 pCi/g are expected from fall-out. Further, earlier monitoring studies at PGDP (from 1988 to 1993) revealed background levels of cesium-137 ranging from 0.11 to 4.0 pCi/g (DOE 1997); therefore, cesium-137 should not be considered in the Addendum 2 soil piles as a contaminant.

Figure 23 graphically shows the results with the background value and other comparison values. Figure 24 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

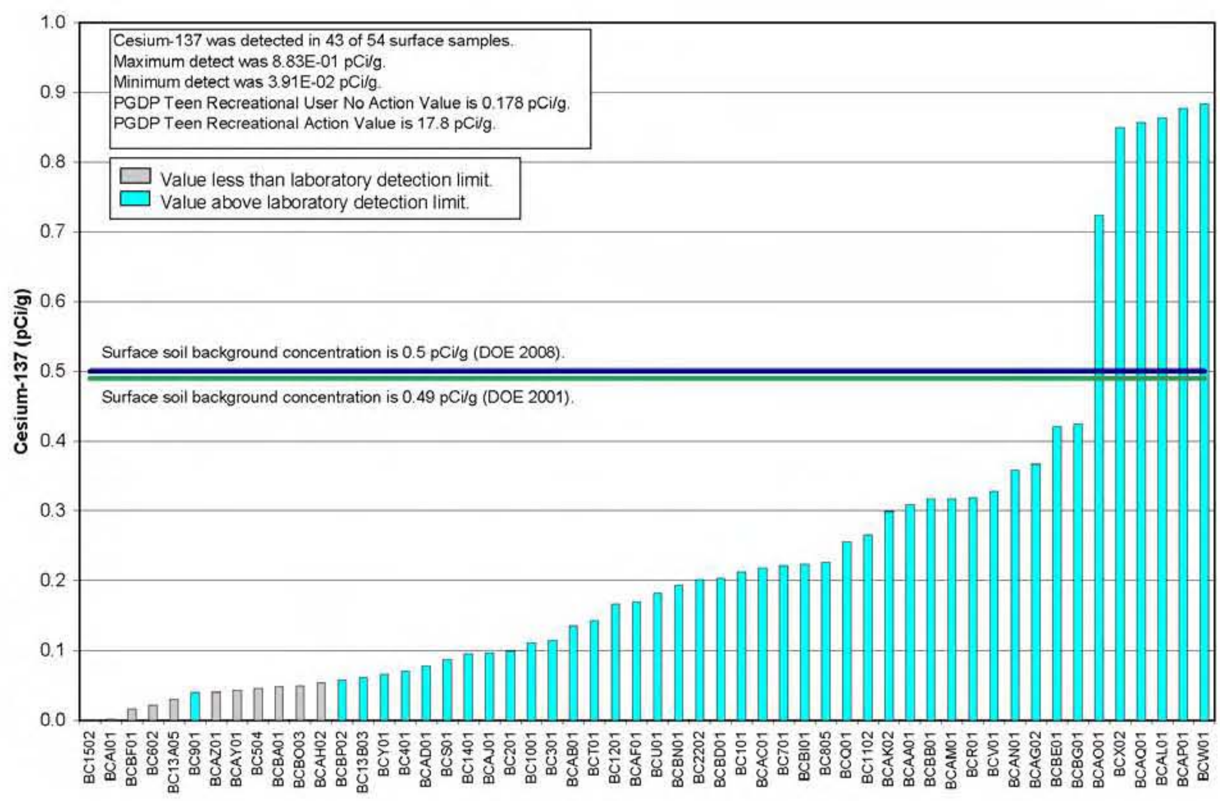

Figure 23. Comparison between Cesium-137 Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

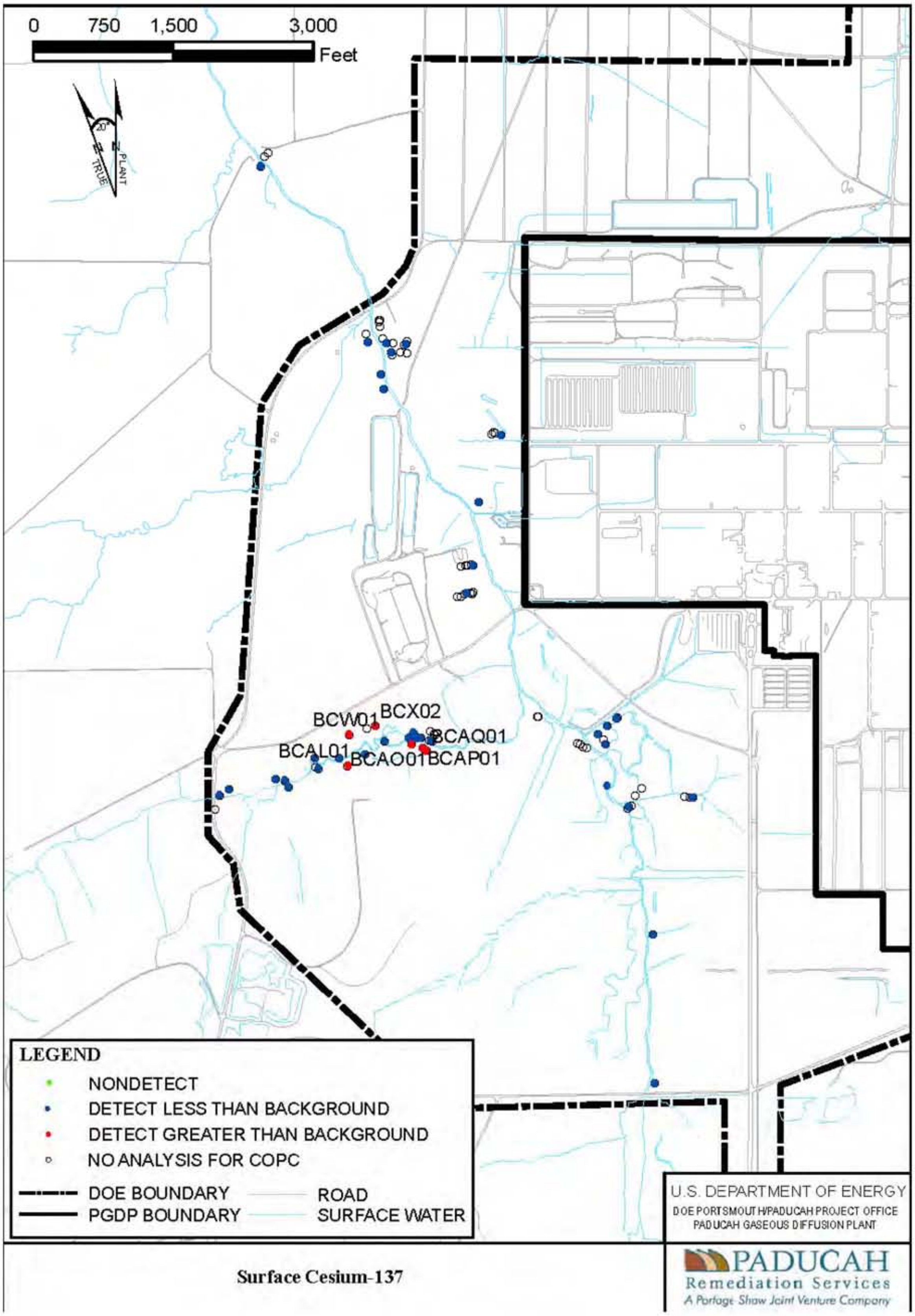

Figure 24. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cesium-137 in the Surface

Cesium-137–Subsurface. Cesium-137 values in subsurface soil samples exceed the background value of 0.28 pCi/g in 9 of 56 samples (ranging 0.342 to 0.979 pCi/g). Although the cesium-137 concentration exceeds the site-specific background for PGDP, the concentration of cesium-137 in samples exceeding background is below the concentrations associated with fall-out. Cesium-137 is a major contributor to global fall-out due to atmospheric testing of nuclear weapons in the 1950s to the early 1960s. A summary from Argonne National Lab (ANL 2007) states that concentrations up to 1 pCi/g are expected from fall-out. Further, earlier monitoring studies at PGDP (from 1988 to 1993) revealed background levels of cesium-137 ranging from 0.11 to 4.0 pCi/g (DOE 1997); therefore, cesium-137 should not be considered in the Addendum 2 soil piles as a contaminant.

Figure 25 graphically shows the results with the background value and other comparison values. Figure 26 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

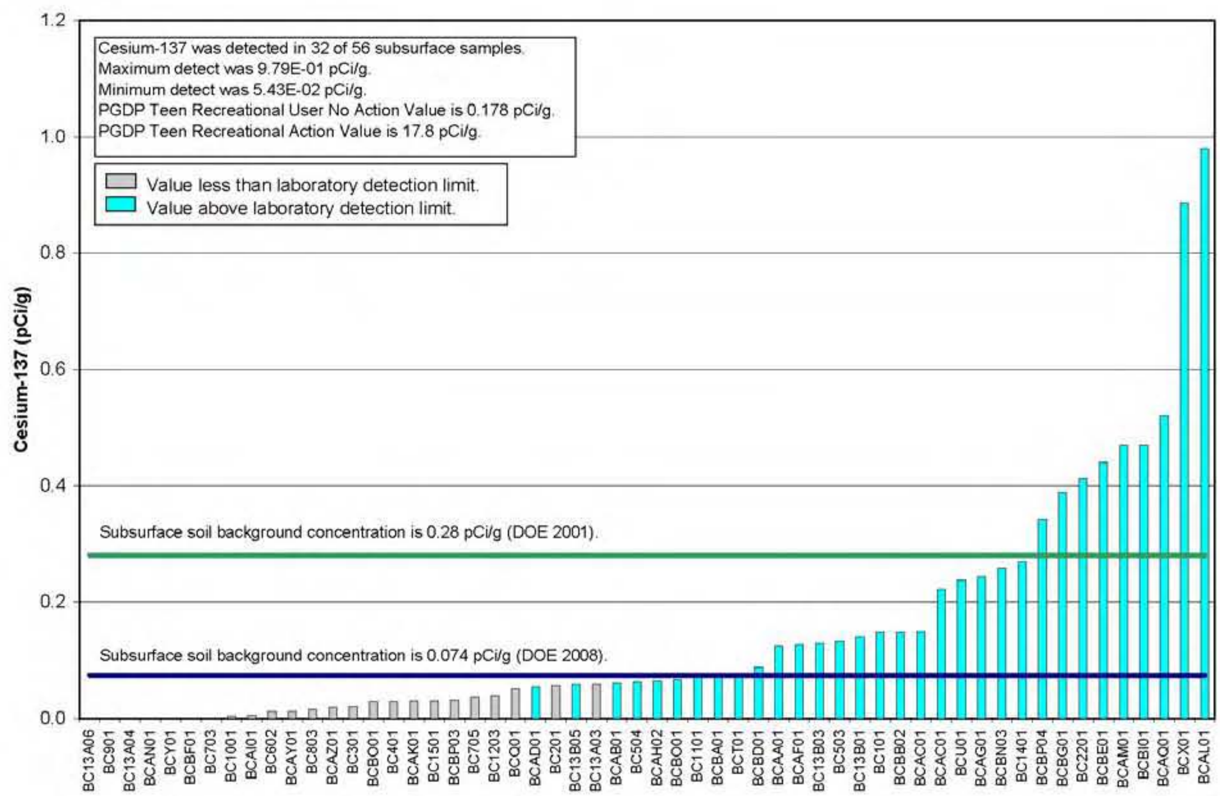

Figure 25. Comparison between Cesium-137 Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

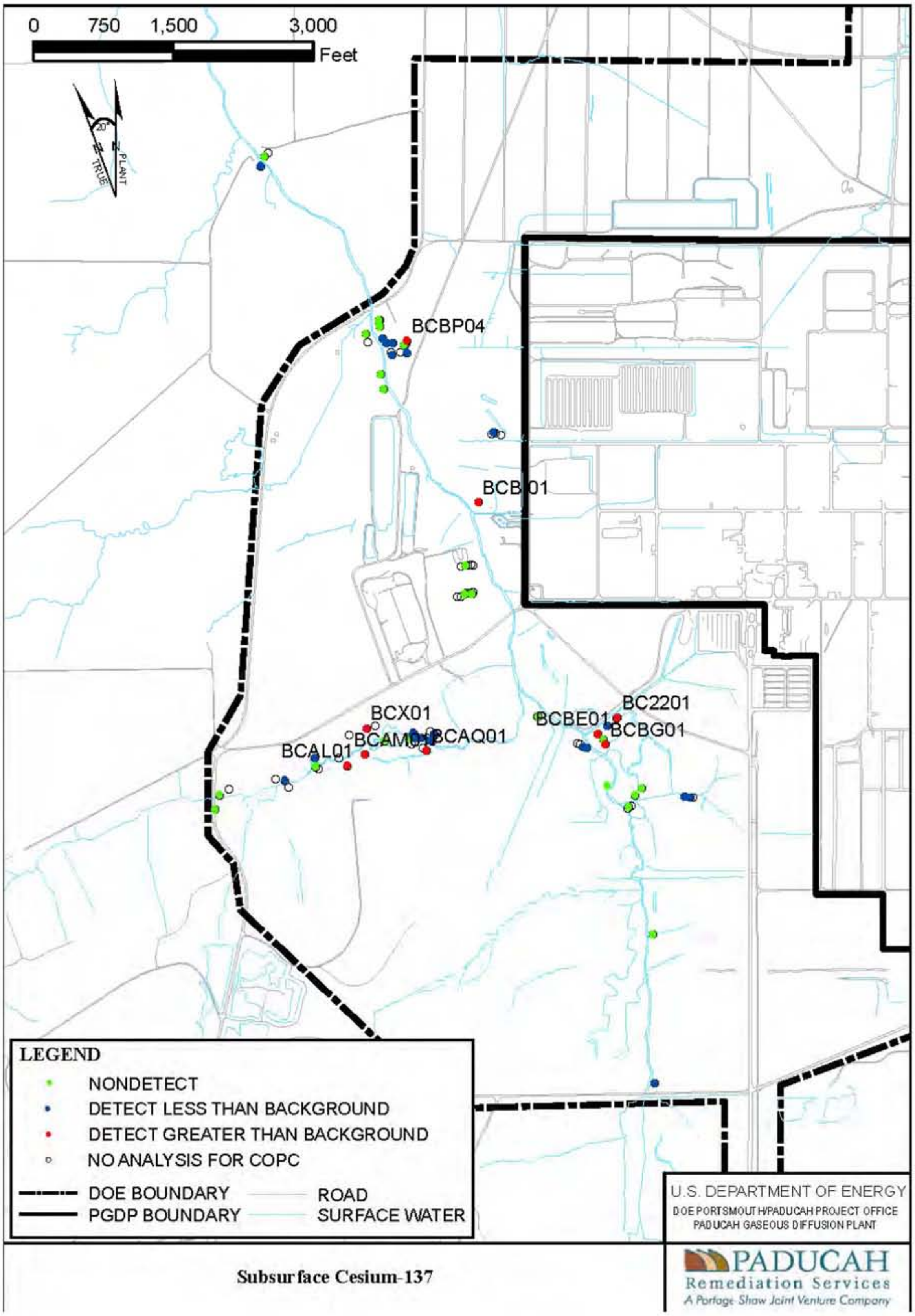

Figure 26. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cesium-137 in the Subsurface

Plutonium-239/240–Surface. Plutonium-239/240 values in surface soil samples exceed the background value of 0.025 pCi/g in 3 of 54 samples. The three exceeding values are 0.0264, 0.028, and 0.0353 pCi/g. Although the plutonium-239/240 concentration exceeds the site-specific background for PGDP, the concentration of plutonium-239/240 in samples exceeding background are below the concentrations associated with fall-out. Plutonium-239/240 is a major contributor to global fall-out due to atmospheric testing of nuclear weapons in the 1950s to the early 1960s. A summary from Argonne National Lab (ANL 2007) states that concentrations up to 0.1 pCi/g are expected from fall-out; therefore, plutonium-239/240 should not be considered in the Addendum 2 soil piles as a contaminant.

Figure 27 graphically shows the results with the background value and other comparison values. Figure 28 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

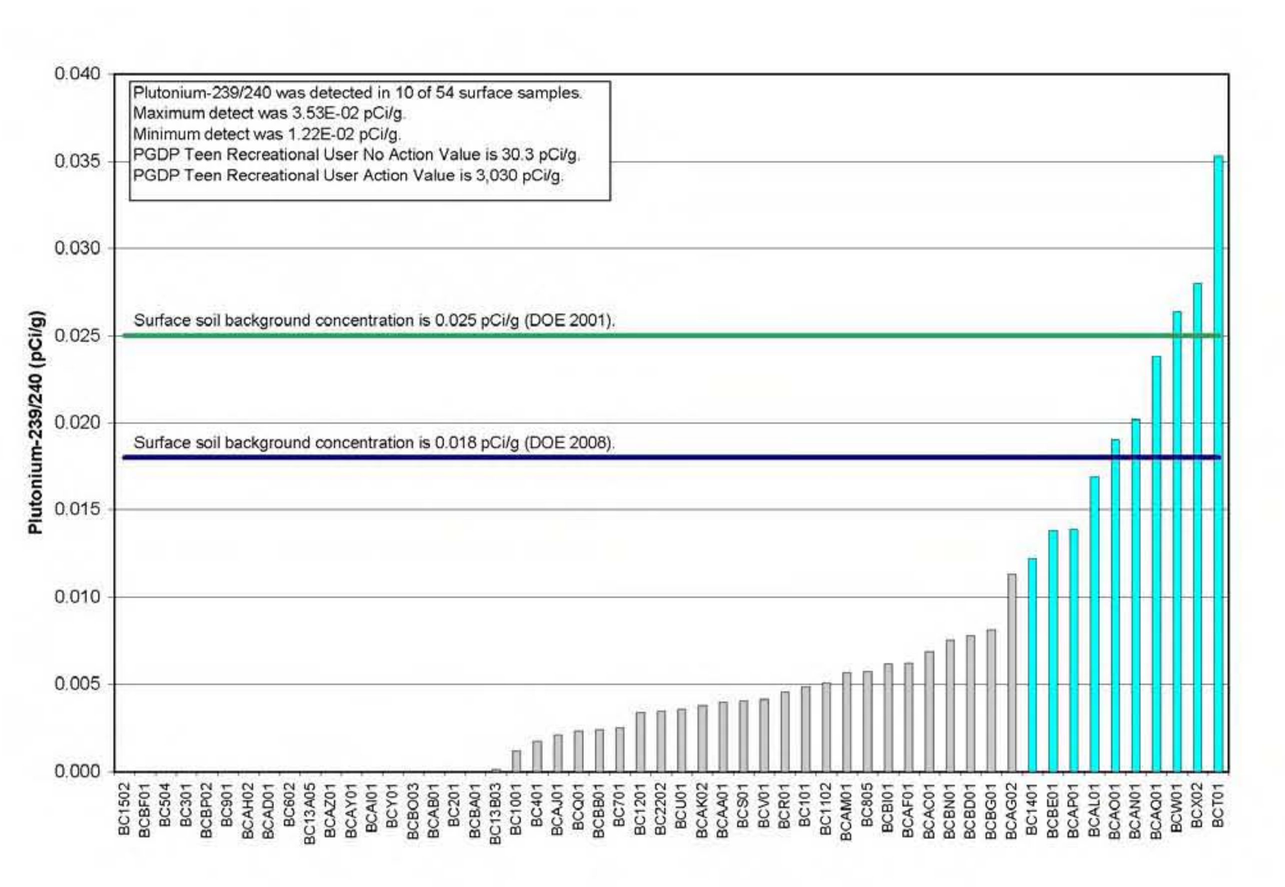

Figure 27. Comparison between Plutonium-239/240 Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

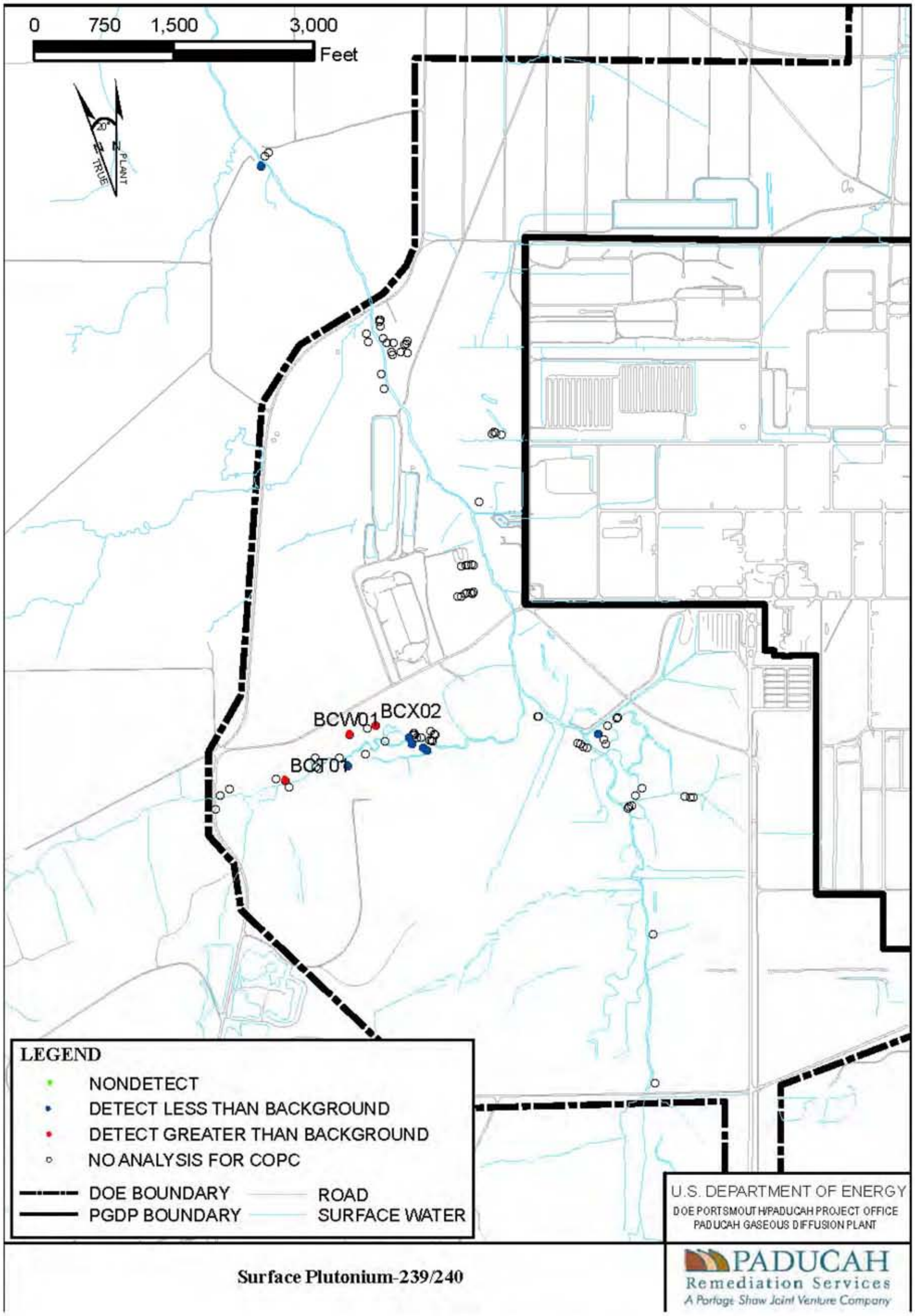

Figure 28. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Plutonium-239/240 on the Surface

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