Remedial Investigation Report for J-Field, Aberdeen Proving Ground, Maryland

Volume 1: Remedial Investigation Results

Environmental Assessment Division
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Volume 1: Remedial Investigation Results

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FOREWORD

This document presents the results of a remedial investigation (RI) conducted at J-Field in the Edgewood Area of Aberdeen Proving Ground (APG), a U.S. Army installation located in Harford County, Maryland. The RI was carried out for the U.S. Army under the direction of the Environmental Conservation and Restoration Division, Directorate of Safety, Health, and Environment at APG, pursuant to the requirements outlined under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. This report comprises Volume 1 of a three-part series of documents that were prepared to describe the comprehensive evaluation of the site conditions, nature and extent of contamination, and risks to human health and the environment. Volume 2 of this series, prepared by ICF Kaiser Engineers, provides the results of the human health risk assessment. Volume 3, prepared by Argonne National Laboratory, provides the results of the ecological risk assessment. More information on the APG, including J-Field, may be obtained by visiting the APG Web site at www.apg.army.mil.

An earlier version of Volume 1 was released by the U.S. Army in 1998. This document has been reviewed by the U.S. Army (the project sponsor) and assigned the following:

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NOTATION

The following is a list of abbreviations and acronyms, chemicals, and units of measure used in this document. Some acronyms used only in tables are defined in those tables.

ABBREVIATIONS AND ACRONYMS

AAS	atomic absorption spectrophotometry or spectrophotometric
ACGIH	American Conference of Governmental Industrial Hygienists
AEC	U.S. Army Environmental Center
ANL	Argonne National Laboratory
AOC	area of concern
APG	Aberdeen Proving Ground
APGSCC	Aberdeen Proving Ground Superfund Citizens Coalition
AWQC	Ambient Water Quality Criteria
BTAG	Biological Technical Assistance Group (EPA)
CA	cost analysis
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
COC	contaminant of concern
COE	U.S. Army Corps of Engineers
COEC	contaminant of ecological concern
COMAR	*Code of Maryland Regulations*
CP	criteria pollutant
CRDL	contract-required detection limit
CRQL	contract-required quantitation limit
CSM	Chemical Surety Material
CWA	chemical warfare agent
DL	detection limit
DSHE	Directorate of Safety, Health, and Environment
EE	engineering evaluation
EK	Elkton silt loam
EP	extraction procedure
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ERDEC	Edgewood Research and Development and Engineering Center
ERT	environmental response team

FFA	Federal Facility Agreement
FFS	focused feasibility study
FS	feasibility study
FSP	Field Sampling Plan
GC	gas chromatograph, chromatographic, or chromatography
GPC	gel permeation chromatography
GPR	ground-penetrating radar
HE	high explosives
ICP	inductively coupled plasma
IDL	instrument detection limit
MCL	maximum concentration level
MDE	Maryland Department of the Environment
MSA	method of standard addition
MSL	mean sea level
NAAQS	National Ambient Air Quality Standards
NOAA	National Oceanic and Atmospheric Administration
PAOC	potential area of concern
PARCC	precision, accuracy, representativeness, completeness, and comparability
PB	Prototype Building
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QA/QC	quality assurance and quality control
QC	quality control
RA	risk assessment
RBC	risk-based concentration
RCP	Riot Control Burning Pit
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RI	remedial investigation
RPD	relative percent difference
RPDG	Robins Point Demolition Ground
RPTS	Robins Point Tower Site
SBDG	South Beach Demolition Ground
SBT	South Beach Trench
SCC	Superfund Citizens Coalition
SF	sassafras loam
SOW	statement of work

SWMU	solid waste management unit
SVE	soil vapor extraction
TAL	Target Analyte List
TAP	toxic air pollutant
TBP	Toxic Burning Pits
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
TIC	tentatively identified compound
TLV	threshold limit value
TM	tidal marsh
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UXO	unexploded ordnance
WPP	White Phosphorus Burning Pits
XRF	x-ray fluorescence

CHEMICAL SYMBOLS AND ABBREVIATIONS

As	arsenic
BHC	benzene hexachloride
BNA	base neutral and acid extractable organic compound
BTX	benzene, toluene, and xylenes
BZ	3-quinuclidinyl benzilate
CAH	chlorinated aliphatic hydrocarbon
CN	α-chloroacetophenone
CO	carbon monoxide
CS	ortho-chlorobenzylidene malononitrile
DANC	decontaminating agent, noncorrosive
11DCE	1,1-dichloroethene
12DCE	1,2-dichloroethene
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DNAPL	dense nonaqueous-phase liquid

DNT	dinitrotoluene
DS-2	decontamination solution 2
GA	o-ethyl-N,N-dimethylphosphoramidocyanidate (tabin)
GB	isopropylmethylphosphonofluoridate (sarin)
HD	mustard
HMX	cyclotetramethylene tetranitrate
HTH	high-test hypochlorite
L	lewisite (2-chlorovinyldichloroarsine)
LO	lewisite oxide (2-chlorovinylarsenoxide)
NAPL	nonaqueous-phase liquid
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_3	ozone
PAH	polynuclear aromatic hydrocarbon
Pb	lead
PCB	polychlorinated biphenyl
PETN	penta-erythritol tetranitrate
PM_{10}	particulate matter with an aerodynamic diameter ≤ 10 µm
PS	chloropicrin
RDX	hexahydro-1,3,5-trinitro-1,3,4-triazine
SO_x	sulfur oxides
SVOC	semivolatile organic compound
111TCE	1,1,1-trichloroethane
112TCE	1,1,2-trichloroethane
TCLEA	1,1,2,2-tetrachloroethane
TCLEE	tetrachloroethene
TKN	total Kjeldahl nitrogen
TNT	trinitrotoluene
TOC	total organic carbon
TOX	total organic halides
TPH	total petroleum hydrocarbons
TRCLE	trichloroethene
VOC	volatile organic compound
VX	o-ethyl s-[2-diisopropylaminoethyl]methylphosphonothioate

UNITS OF MEASURE

°C	degree(s) Celsius	m^2	square meter(s)
cal	calorie(s)	m^3	cubic meter(s)
cm	centimeter(s)	µm	micrometer(s)
cpm	count(s) per minute	µg	microgram(s)
d	day(s)	meq	milliequivalent
°F	degree(s) Fahrenheit	mg	milligram(s)
ft	foot (feet)	mi	mile(s)
g	gram(s)	min	minute(s)
gpm	gallon(s) per minute	mL	milliliter(s)
h	hour(s)	ng	nanogram(s)
in.	inch(es)	pCi	picocurie(s)
kg	kilogram(s)	ppb	parts per billion
km	kilometer(s)	ppm	parts per million
L	liter(s)	s	second(s)
m	meter(s)	yr	year(s)

REMEDIAL INVESTIGATION REPORT FOR J-FIELD, ABERDEEN PROVING GROUND, MARYLAND

VOLUME 1: REMEDIAL INVESTIGATION RESULTS

by

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SUMMARY

This report details the results of the remedial investigation (RI) conducted at J-Field in the Edgewood Area of Aberdeen Proving Ground (APG), a U.S. Army installation located in Harford County, Maryland. The RI was performed pursuant to Modification 2 of the Resource Conservation and Recovery Act (RCRA) Permit and a March 1990 Federal Facility Agreement (FFA) between the U.S. Environmental Protection Agency (EPA) Region III and the U.S. Department of the Army. The FFA incorporates both RCRA corrective action requirements and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial action requirements. The results of the RI identify the contamination sources at J-Field, characterize the nature and extent of contamination of various media, assess the human health risk and the ecological risk, and support the remediation feasibility studies for J-Field.

This report is presented in three volumes: the remedial investigation results are provided in this volume (Volume 1), the human health risk assessment is covered in Volume 2, and the ecological risk assessment is given in Volume 3. This volume describes the investigation activities at J-Field. The environmental data collected in the investigations were evaluated to determine if a site was contaminated. The results are summarized here; detailed information on concentration levels of specific contaminants found at each site is presented in the main text and Appendix A. Volumes 2 and 3 further evaluate the results reported in Volume 1. They identify the chemicals of concern that may pose risk to human health and/or the ecological system and identify sites that pose human health risk and ecological risk.

S.1 SITE BACKGROUND

J-Field was used for military purposes as early as 1917; however, use of the site became more active between World War II and the late 1970s. The use of the site was only partially documented. Activities included testing of high explosives and chemical munitions, testing of conventional munitions on structures and buildings, thermal (through open burning) and chemical decontamination of chemical munitions, open detonation, and disposal. Chemicals disposed of at J-Field included nerve agents, blister agents, riot control agents, white phosphorus, chlorinated solvents, and drummed chemical wastes generated by research laboratories, process laboratories, pilot plants, and machine and maintenance shops.

Fifteen areas were investigated, including eight previously identified areas of concern (AOCs) and seven potential areas of concern (PAOCs) outside the AOCs. The AOCs are the Toxic Burning Pits AOC, the inactive portion of the White Phosphorus Burning Pits AOC, the Riot Control Burning Pit AOC, the Prototype Building AOC, the South Beach Demolition Ground AOC, the South Beach Trench AOC, the inactive portion of the Robins Point Demolition Ground AOC, and the Robins Point Tower Site AOC. The PAOCs are Site X1, Area A, Area B, Area C, the Ruins Site across from the White Phosphorus Burning Pits Area, Area D, and Sitewide Craters. Within each AOC and PAOC, multiple potential contamination sources were identified through record research, historical aerial photograph analysis, and field survey. These potential contamination sources were later investigated with a combination of geophysical methods, field screening with in situ x-ray fluorescence, and soil gas surveys. Surface soil, subsurface soil, surface water, sediment, and groundwater samples were analyzed to evaluate whether contamination exists at the potential contamination sources and to provide information for the baseline risk assessment, the Toxic Burning Pits focused feasibility study, and the overall J-Field feasibility study.

J-Field is located at the southern end of Gunpowder Peninsula, in the Eastern Coastal Plain adjacent to Chesapeake Bay in Maryland. The site is underlain by more than 100 ft of Quaternary sediments of fluvial and estuarine origins and other, older geologic formations. The Quaternary deposits can be divided into the following three units (in descending order): an interbedded sand and clay unit about 25–40 ft thick (also hydrogeologically a surficial aquifer), a silty and sandy clay unit about 40–107 ft thick (hydrogeologically a leaky confining bed), and a gravelly sand and clay unit about 15–50 ft thick (hydrogeologically a confined aquifer). The terrain at J-Field is nearly flat, with a maximum relief of about 10 ft. Marshes are common across the site. The groundwater table in the surficial aquifer is shallow, normally less than 7 ft below the ground surface. The groundwater is recharged through precipitation near uplands and is discharged to the surrounding lowlands.

The majority of J-Field is forested. The lowland areas support the development of extensive tidal marshes and wet-mesic forest. The marshes are dominated by common reed and cattail, with common associates including false nettle, sensitive fern, Olney-threesquare, and rose-mallow. Drier upland areas support occasional stands of tulip tree or mixed deciduous hardwoods. Areas at lower elevation, including forested wetlands, are dominated by sweetgum and red maple, with willow oak, black gum, swamp chestnut oak, and sycamore frequently dominating wetter sites. Old open-field areas, including the areas around the Toxic Burning Pits, White Phosphorus Burning Pits, and Prototype Building, are vegetated with upland grasses and forbs.

S.2 OVERVIEW OF RESULTS

The technical approach of the RI was consistent with the approach used at other APG sites. This approach consisted primarily of comparing the environmental data from subject sites with data from regional background areas in the Chesapeake Bay region (ICF Kaiser Engineers 1995) and collecting other data of appropriate quality to support human health and ecological risk assessments. The investigation was conducted by adapting an accelerated strategy that combined a phased approach and "pilot" study concept. Effective investigative tools were used to identify contamination sources, and large quantities of environmental data were collected in a short time. Concurrently, chemical warfare agents were monitored in the field, volatile organic compound (VOC) emissions were modeled (by using passive soil gas data), and rigorous safety protocols were followed to ensure the health and safety of on-site workers during the investigation. The results of this RI are summarized in Table S.1 and briefly described in the following sections. The locations of AOCs and PAOCs are shown in Figure S.1.

S.2.1 Toxic Burning Pits AOC

The Toxic Burning Pits (TBP) AOC was used for the disposal of chemical agents (primarily nerve agents and blister agents) by open burning and for the demolition of high explosives by open detonation. The major sources of contamination at the AOC include two exposed Main Burning Pits, a filled VX Burning Pit, the Pushout Area, a filled Mustard Burning Pit, a small Liquid Smoke Disposal Pit, and the Southwestern Suspect Burning Area. The filled-in areas with no present surface expression were delineated through aerial photograph analysis, directed soil sampling, and geophysical surveys. Two additional sites at the TBP, the High Explosives Demolition Ground and a Storage Area, were also investigated and were determined not to be sources of contamination.

The soil at the two Main Burning Pits, underlying the pits, and near both ends of the pits was contaminated with heavy metals, chlorinated solvents, phthalates, semivolatile organic compounds (SVOCs) related to petroleum products, polychlorinated biphenyls (PCBs), and pesticides. The contamination was localized and varied spatially. At the Northern Main Pit, high concentrations of arsenic, cadmium, chromium, copper, mercury, nickel, antimony, and zinc were found in the central and western sections in the upper 4 ft of soil underlying the pit. Moderate levels of these metals extend more than 10 ft deep. Low levels of chlorinated methane, ethanes, and ethenes; low levels of dioxins and furans; and high levels of chlorobenzene, ethylbenzene, toluene, and xylenes were also found, mostly at a depth of less than 8 ft below the bottom of the pit.

At the Southern Main Pit, PCBs and chlorinated ethanes and ethenes (including 1,1,2-trichloroethane [112TCE], 1,2-dichloroethene [12DCE], 1,1,2,2-tetrachloroethane [TCLEA], tetrachloroethene [TCLEE], trichloroethene [TRCLE], and vinyl chloride) are prominent contaminants in soil, primarily in the eastern part of the pit. The highest concentrations measured

TABLE S.1 Summary Table of Contaminant Categories Identified in Each AOC or PAOC at J-Field[a]

	Environmental Medium			
AOC or PAOC	Soil	Sediment/Surface Water	Groundwater	Remarks
Toxic Burning Pits				
Main Burning Pits	VOCs, SVOCs, Metals, Pesticides, PCBs	VOCs, Metals, CSM/CSM[b] degradation products	VOCs, Metals, CSM/CSM degradation products	
Filled VX Pit	SVOCs, Metals, Pesticides, Dioxins, CSM/CSM degradation products			
Pushout Area	VOCs, SVOCs, Metals, Pesticides (local), PCBs (local)			
Filled Mustard Pit	VOCs, SVOCs, Metals			
Square Pit (Liquid Smoke Disposal Pit)	Metals			
Southwestern Suspect Burning Area	Metals			
Suspect Storage Area				Not a concern
White Phosphorus Pits				
Northwestern Suspect Burning Area	SVOCs, Metals	Metals	CSM/CSM degradation products	
Southwestern Suspect Burning Area	SVOCs (insignificant), Metals (insignificant)			
Suspect Storage Area	Metals (insignificant)			Not likely to be a concern
Riot Control Burning Pit				
Filled Pit and Open Trench	VOCs, SVOCs, Metals, Pesticides	Metals	VOCs	
Pushout	Metals	Metals		
Prototype Building				
Area around building	SVOCs (insignificant), Metals, Pesticides (insignificant)	Metals	SVOCs, Metals (occasionally)	
Northwestern Suspect Burning Area	Metals (insignificant)			Not likely to be a concern
Southwestern Suspect Burning Area	Metals (insignificant)			Not likely to be a concern

TABLE S.1 (Cont.)

	Environmental Medium			
AOC or PAOC	Soil	Sediment/Surface Water	Groundwater	Remarks
South Beach Demolition Ground	Metals (insignificant in a crater)	SVOCs (insignificant), Metals		
South Beach Trench		Metals (insignificant)		Not likely to be a concern
Robins Point Demolition Ground (inactive)	Explosives	Metals		
Robins Point Tower Site	SVOCs (insignificant), Metals (insignificant)	Metals (in a crater)		
X1	Metals (occasionally)			Not likely to be a concern
Area A		VOCs (insignificant), SVOCs (insignificant), Metals (insignificant)		Not likely to be a concern
Area B	Metals (local)			Not likely to be a concern
Area C	Metals (occasionally)			Not likely to be a concern
Ruins Site across from White Phosphorus Burning Pits		Metals		
Area D[c]				Not likely to be a concern
Craters		Metals (near demolition grounds)		Not likely to be a concern

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[a] Analyte category that is underlined represents a prominent contaminant group at the site. No category is shown if no contamination has been found at a site. Descriptions in parentheses are defined as follows: "Insignificant" indicates that the concentration levels of contaminants were either less than 2 times the calculated background level or less than 2 times the method detection limits. "Local" indicates spotty contamination at a site. "Occasionally" indicates contamination that was not detected in every round of sampling.

[b] CSM = chemical surety material.

[c] The major concern at Area D is the impact of craters on the environment. Area D has been incorporated into the sitewide crater study; no separate evaluation was conducted at Area D.

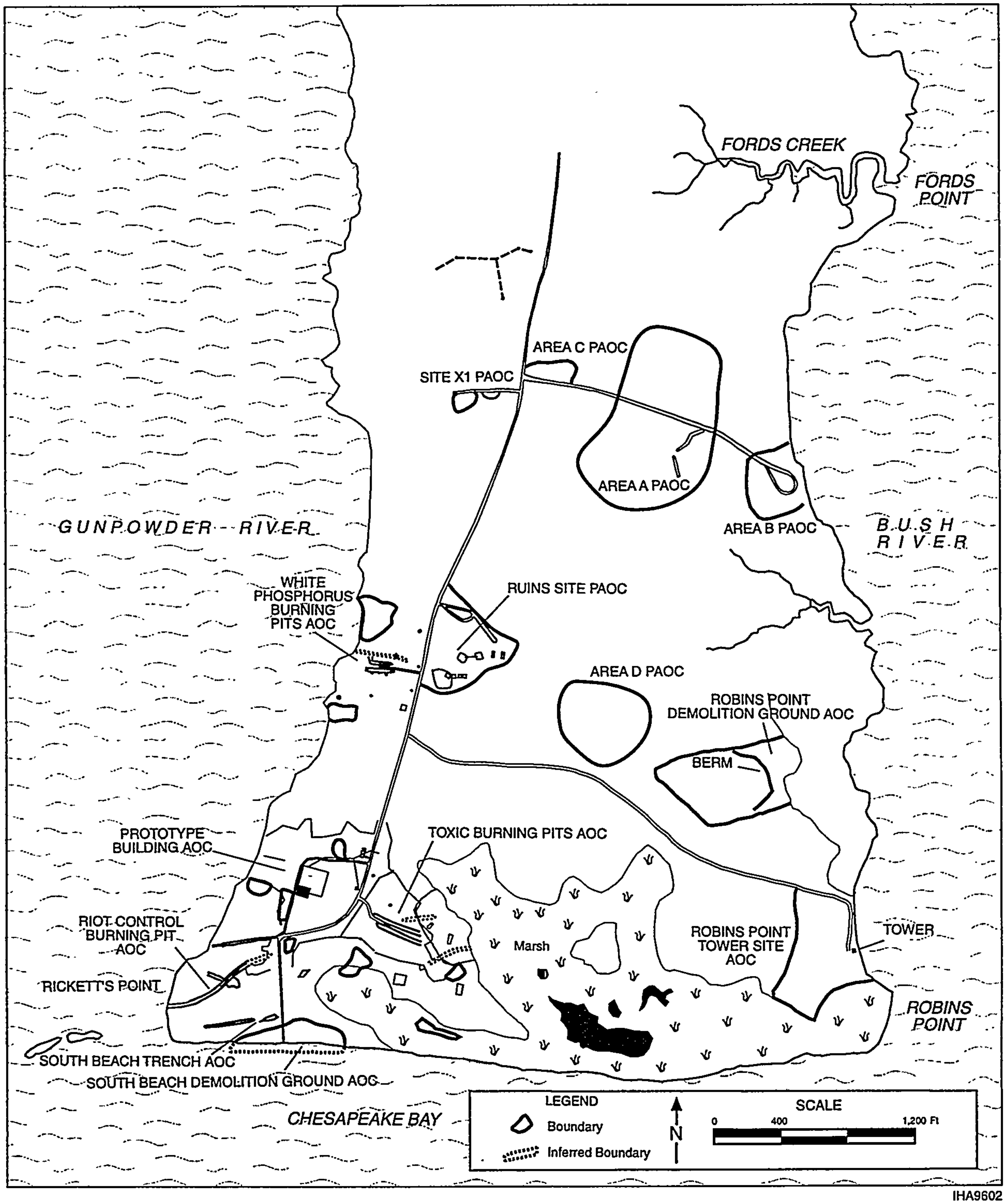

FIGURE S.1 Locations of Areas of Concern, Potential Areas of Concern, and Principal Site Features at J-Field (Source: Adapted from Hughes 1993) to date are as follows: 3,270 mg/kg of TCLEA, 263 mg/kg of TRCLE, and 143 mg/kg of Aroclor 1248 (a PCB). These contaminant concentrations increase with depth. Metal contamination is moderate and occurs in the soil near the ground surface.

At the VX Pit, the surface soil in the western section, where previous disposal activities were concentrated, is contaminated with moderate to high levels of heavy metals and low levels of chlorinated ethanes and ethenes, petroleum-related compounds, pesticides, dioxins and furans, 1,4-dithiane (a mustard agent degradation product), and phthalates. However, the nature and extent of the contamination at the disposal center could not be fully characterized because the potential presence of unexploded ordnance impeded the installation of deep borings. Total petroleum hydrocarbon content is high in deeper soil adjacent to and east of the previous disposal center. Metal contamination, however, is limited to the upper 2 ft of surface soil. Farther to the east, in the Pushout Area, the same contaminants found in the disposal center were detected, but at lower concentrations.

The Pushout Area, which consists of debris that has been pushed out of the burning pits over time and has filled in 30 to 50 ft of a downgradient freshwater marsh, is delimited by the Northern Main Pit, the Southern Main Pit, the VX Pit, and the Mustard Pit. Heavy metals are the most prominent contaminants in the area, especially in the section bounded by the VX Pit, the Mustard Pit, the eastern ends of the two Main Burning Pits, and the marsh. The contamination present, both in terms of types and concentrations, is markedly heterogeneous. Lead and zinc concentrations in some soil samples were found to be more than 8%. Pockets of uncontaminated areas exist. The vertical extent of contamination generally is shallow but can be more than 4 ft in the low-lying area near the eastern part of the Pushout Area. Chlorinated methanes, ethanes, and ethenes (such as 112TCE, TCLEA, TCLEE, TRCLE, and chloroform) and petroleum-related compounds are present at low levels, except at a few locations near the boundary between the Southern Main Pit and the Pushout Area, where elevated levels of PCBs and pesticides were detected at the surface soil. The chlorinated ethane and ethene concentrations may be elevated locally. The origin of these organic compounds is not clear.

The filled Mustard Pit was delineated by analysis of aerial photographs and geophysical survey. However, for safety reasons, the detection of metal in subsurface soil precluded drilling at the inferred previous disposal center of the pit. A full characterization of the nature of contamination at the pit was, therefore, impossible. Analysis of borings installed adjacent to the pit indicate that the surface soil near the pit is contaminated with high levels of heavy metals and low to very low levels of petroleum-related compounds, phthalates, 1,1,1-trichloroethane (111TCE), TCLEA, and TRCLE. Two chemical surety material (CSM) degradation products — diisopropylmethyl phosphonate and 1,4-dithiane — were detected in two subsurface soil samples taken more than 6 ft below ground in a boring.

The detection (by x-ray fluorescence field measurements) of a high level of titanium in soil inside the Square Pit leads to the conclusion that the Square Pit may be the actual Liquid Smoke

Disposal Pit. Titanium is a major component in the liquid smoke titanium tetrachloride. Also, a soil sample collected from the pit contains high levels of heavy metals.

Limited sampling has been conducted in the Southwestern Suspect Burning Area, which is adjacent to the Liquid Smoke Disposal Pit. The area is contaminated with heavy metals in surface soil, especially in an area near the marsh in the southern part of the site, where a mound of metal debris was discovered in the field. The area probably was used for ammunition disposal, and the lateral extent of contamination has not been fully characterized.

Both the surficial aquifer and the confined aquifer were affected by the disposal activities at the Toxic Burning Pits AOC. The surficial aquifer is recharged by precipitation, with its recharge center at the Main Burning Pits. Groundwater flows out from the recharge area in directions ranging from south-southeast to northeast, spreading contaminants (especially VOCs) to the eastern part of the AOC and under the marsh east of the AOC. Since 1986, very high concentrations of 112TCE, 12DCE, TCLEA, TCLEE, and TRCLE have been detected in the surficial aquifer monitoring wells in the TBP AOC as well as in four piezometers installed in the marsh. For example, the highest concentration of TCLEA recorded was 260 mg/L in 1992 from well JF83. Although free-phase dense nonaqueous-phase liquids (DNAPLs) have not been detected at J-Field, the high concentration of TCLEA, a DNAPL compound, in groundwater and in soil suggests that free-phase DNAPL may be present in the subsurface.

Heavy-metal contaminants are not as extensively distributed in the surficial aquifer as are the VOC contaminants described above. Heavy-metal contamination has only been detected in the water from the wells near the Main Burning Pits. Low levels of three CSM degradation products (1,4-dithiane, 1,4-oxathiane, and diisopropylmethyl phosphonate) were also found. Elevated levels of nitrate, lead, and/or nitrocellulose have been detected in two monitoring wells (P2 and P9) near the Southwestern Suspect Burning Area and the inferred Liquid Smoke Disposal Pit. The presence of these compounds implies possible ammunition disposal activities in the area.

Low to moderate levels of 12DCE, 112TCE, and TRCLE were detected in groundwater from the confined aquifer under the Toxic Burning Pits (mainly wells JF51 and JF81). The highest concentrations detected were 0.65 mg/L of 12DCE, 7.1 mg/L of 112TCE, and 1.6 mg/L of TRCLE.

Elevated concentrations of metals were detected in surface water in the marshes south and east of the AOC. A few chlorinated VOCs — such as TCLEA, 112TCE, and TCLEA — were also detected at low to moderate levels in the surface water.

In the marsh east of the AOC, sediment and surface water collected adjacent to the Pushout Area had high levels of heavy metals and various types of chlorinated VOCs, including 12DCE, TRCLE, 112TCE, TCLEA, and vinyl chloride. A few CSM degradation products also were detected. The chlorinated VOCs and the CSM degradation products may come from the seepage of contaminated groundwater into the marsh. The heavy-metal contaminants can be introduced into the marsh by surface water runoff from the Pushout Area or by direct interaction between the pushout material and the marsh water.

Surface water and sediment samples taken near the southeastern tip of the Toxic Burning Pits area did not contain VOCs. However, a surface water sample from the southwestern corner of the pond southeast of the Toxic Burning Pits area tip did show low levels of TCLEA and TRCLE, supporting the results of the soil gas survey at that location.

S.2.2 White Phosphorus Burning Pits AOC

The White Phosphorus Burning Pits (WPP) AOC consists of two main pits and three other sites. The two main burning pits are not described here because they are still used for emergency disposal operations. The three other sites — the Northwestern Suspect Burning Area, the Southwestern Suspect Burning Area, and the Suspect Storage Area — are considered in this report. They were identified on historical aerial photographs and have been inspected in the field. Their uses have not been documented.

Low levels of copper, lead, selenium, zinc, and some SVOCs were found in surface soil at the Northwestern Suspect Burning Area. The detection of the metals in soil is consistent with the low levels of metals detected in surface water and groundwater adjacent to the site. Also, trace levels of 1,3-dithiane (a mustard degradation product) were detected in groundwater adjacent to the site. This area may have been used for disposal of munitions by burning.

In the Southwestern Suspect Burning Area, low levels of zinc and several types of SVOCs were detected in the soil. This suspect area is likely to have been used for small munitions disposal, as evidenced also by the presence of scraps of small munition shells in the field.

The Suspect Storage Area in the southwestern corner of the AOC is not considered a source of contamination. Two surface soil samples collected within the area have only insignificantly elevated levels of arsenic and selenium, which probably reflect the windblown dispersion of contaminants during the detonation operations at the active pits of the AOC.

S.2.3 Riot Control Burning Pit AOC

The Riot Control Burning Pit (RCP) AOC contains two pits that merge in the northeastern part of the AOC and in the southwestern part of the AOC. The merged northeastern section of the pit has been filled and has been delineated in this RI. The pits were used mainly for disposal of riot control agents, primarily through open burning.

The soil contamination at the AOC is quite localized — primarily low to moderate levels of heavy metals in the northeastern and middle sections of the pit. Near the southwestern end of the pit, low levels of antimony and arsenic contamination were also detected. Other contaminants found include low levels of petroleum-related SVOCs along the length of the pit and acetone; benzene, toluene, and xylenes (BTX); TCLEE; and TRCLE in the filled northeastern part of the pit. The nature and extent of contamination underlying the filled pit where previous disposal activities were centered, however, could not be fully characterized because safety considerations prevented deeper borings. Soil gas data and soil data from nearby borings indicate that petroleum-related compounds and chlorinated methane, ethane, and ethene compounds are likely to be present in the subsurface. A groundwater monitoring well (JF13) installed hydraulically downgradient of the disposal center consistently detected benzene as high as 1.5 mg/L. Surface water samples collected at the pit and offshore contained slightly elevated levels of heavy metal.

S.2.4 Prototype Building AOC

The Prototype Building (PB) AOC includes the Prototype Building and two suspect burning areas. The building is a three-level, reinforced-concrete structure constructed during World War II. It was originally used to test the effectiveness of bombs. Since World War II, the building and surrounding area have been intermittently used for temporary storage of solid waste. The two suspect burning areas were identified on historical aerial photographs. Their uses were not documented.

Overall, the surface soil around the Prototype Building has slightly higher levels of arsenic, cadmium, copper, lead, mercury, and zinc than the regional background levels. The surface water in the Gunpowder River offshore of the AOC also exhibited slightly elevated levels of such metals. These features may reflect the past use of the site for bomb testing.

In a strip of land midway between Rickett's Point Road and the building, TCLEE and acetone were detected in soil gas. A surface soil sample near the southern part of that area also showed low levels of several types of SVOCs. The area may have been contaminated with VOCs and SVOCs during past undocumented uses.

No anomalous levels of metals, VOCs, or SVOCs were detected in the two suspect burning areas. Therefore, it is inferred that they are not contamination sources. Low levels of hydrocarbons, benzene, methylisobutyl ketone, total organic halogens, and lead have occasionally been detected in groundwater from a well (TH8) installed near the concrete walk in the AOC. The origin of these contaminants is unknown.

S.2.5 South Beach Demolition Ground AOC

The South Beach Demolition Ground (SBDG) AOC was used as a demolition site for high-explosive munitions during the 1960s, 1970s, and possibly the 1950s. Most of the demolition was conducted on a stretch of a previous 400-ft-wide beach. Because of erosion, that area is now about 50 ft offshore in Chesapeake Bay. Metal debris was reportedly visible about 100 ft offshore during low tide.

Surface water collected offshore near the AOC exhibits slightly elevated concentrations of zinc. Nickel, chromium, and mercury were detected above corresponding method detection limits in some samples. Several metals, phenol, and total organic halogen were also present in one unfiltered surface water sample. The metals could be associated with past munitions disposal activities at the demolition ground.

S.2.6 South Beach Trench AOC

The South Beach Trench (SBT) AOC includes one trench about 75 ft long (South Beach Trench) and a suspect trench about 300 ft long (Western Trench). No information has been found regarding past use of this area.

One surface water sample and two sediment samples collected from the South Beach Trench indicate that the AOC is not a contamination source. No Target Compound List organics, pesticides, PCBs, CSM/CSM degradation products, or explosives-related compounds were detected in the surface water and sediment samples. These samples showed only insignificantly elevated levels of a few metals compared with the background concentrations or the method detection limits.

A boring installed in the Western Trench showed an insignificant level of di-n-butyl-phthalate in soil; however, no other contaminants were found.

S.2.7 Robins Point Demolition Ground AOC

The Robins Point Demolition Ground (RPDG) was first used during the late 1970s for destruction of high explosives and munitions filled with high explosives; in the 1980s, it was used for destruction of a small amount of sensitive and unstable chemicals by detonation with explosives. The original site is now inactive and is the only portion of the site that was investigated. It is a small area east of a berm built in 1985 and extending to the edge of a marsh.

Of the seven soil samples collected from the site, one contained 1.1 mg/kg of 2,4-dinitrotoluene (2,4-DNT) explosive and another contained an elevated level of silver. No VOCs, SVOCs, abnormal radioactivity, or CSM/CSM degradation products were found. The surface water samples collected from the marsh east of the site had elevated concentrations of a variety of metals, including arsenic, lead, copper, mercury, chromium, cobalt, zinc, and iron. However, no elevated levels of these metals were detected in the sediment. The groundwater underneath the active zone of the demolition ground did not demonstrate any contamination. It is inferred that the groundwater under the inactive part of the site is not contaminated.

S.2.8 Robins Point Tower Site AOC

Use of the Robins Point Tower Site (RPTS) AOC began in 1950s for launching and observing rockets; it also was reported as a possible site for test burning of radioactively contaminated wood.

Two radioactivity field surveys conducted at the AOC did not detect any significant anomalies, and the subsequent soil samples collected at the site showed no radiological contamination. Only slightly elevated levels of selenium, mercury, and benzo(b)fluoranthene were detected in three soil samples. These elevated readings are not significant. No volatiles were found in groundwater samples collected in 1994, as reported previously. A surface water sample collected from a bomb crater had a slightly elevated level of lead and a significantly elevated level of zinc.

S.2.9 Site X1 PAOC

The Site X1 PAOC was present on an aerial photograph as early as 1951. It presently consists of two ruins subsites, separated by about 100 ft. Collapsed concrete columns, building foundations, and soil piles were observed in the field. Three shallow depressions were identified near the site. The past use of Site X1 is unknown.

The site has been through Stage I field screening studies. Two of the three shallow depressions were surveyed by electromagnetic, ground-penetrating radar (GPR), and magnetic methods. Magnetic anomalies were found near the center of each of the two depressions; however, no GPR anomalies were detected. The third shallow depression was not surveyed because it did not show any soil disturbance around it. No significant metal anomalies were detected in x-ray fluorescence survey of surface soil. Surface soil samples collected in 1996 showed levels of lead, mercury, and selenium at or above background.

S.2.10 Area A PAOC

The swampy area that constitutes Area A PAOC includes three prominent trenches. The past use of the trenches is unknown. Magnetometry surveys conducted along two of the three trenches did not detect any metal debris. Although results of the soil gas samples collected from the three trenches suggest the presence of anthropogenic organic compounds in two of the three trenches, sediment samples from those trenches revealed no organic contamination source or anomalous metal contents. It is inferred that the trenches are not contamination sources.

S.2.11 Area B PAOC

Also referred to as Fords Point Firing Position, Area B PAOC is a large open area near the northeastern part of J-Field and adjacent to the Bush River. Concrete slabs are piled up near the shore of the river, most likely to protect the shore against erosion. The past use of the site is unknown.

An x-ray fluorescence field survey and surface soil sampling were conducted at Area B. Surface soil samples collected in 1996 showed levels of cadmium, copper, lead, nickel, and zinc above background in the central and southern portions of the site.

S.2.12 Area C PAOC

Area C PAOC is a ruins site near the northern part of J-Field. Remnants of a standing concrete wall and bricks were found on the ground surface in the field. Bomb craters are visible near the site.

Surface soil samples were collected in 1996; except for lead and mercury, metals concentrations were below background.

S.2.13 Ruins Site PAOC across from the White Phosphorus Burning Pits Area

A ruins site across from the WPP AOC includes two building ruins, two connected artificial ponds, remnants of four retaining wall structures, a suspect filled trench, and an old open area in the southwestern part of the site. The site was used for munitions testing in World War II.

The Ruins Site PAOC is slightly contaminated with heavy metals in places. Slightly elevated levels of barium, cadmium, chromium, copper, and lead were found in 2 of 12 sediment samples collected around the two building ruins in the eastern part of the site. The contamination is likely related to ammunition testing on the buildings. A slightly elevated level of cadmium was also found in one of eight pond sediment samples.

No consistent anomalies were found in the electromagnetic and magnetic data collected at the suspect filled trench. It is inferred that the suspect filled trench could have been an old road bed. The old open area in the southwestern part of the site did not show any elevated metal contents in surface soil.

S.2.14 Area D PAOC

Area D PAOC is a flooded swamp dotted with many craters. No road extends to this site, which was probably used for either bomb testing or targeting. The main concern at this site is the potential contamination in the craters. Evaluation of the site has been incorporated in the Sitewide Craters PAOC study (see next subsection).

S.2.15 Sitewide Craters PAOC

Hundreds of craters are located at J-Field in ruins, woods, marshes, and areas with no access roads. They are the result of bomb and projectile testing and in-place detonation of ordnance.

In total, 19 sediment samples were collected in 16 craters distributed in upland area and in low-lying marsh area. All samples were analyzed for Target Analyte List metals. Five samples were also analyzed for explosives-related compounds. The analytical results indicated that most craters did not have metal contamination. Sediment samples that showed slightly elevated metal concentrations generally tended to be associated with demolition grounds and may be related to past demolition activities. No contamination from explosives-related compounds was found in the craters.

S.3 CONCEPTUAL EXPOSURE MODEL

The number of potential contamination sources in the original conceptual exposure model in the RI work plan has been reduced on the basis of the evaluation of the environmental data. The primary contamination sources at J-Field include burning pits, demolition grounds, and suspect burning areas. Primary contaminants are heavy metals; petroleum-related compounds; and chlorinated methanes, ethanes, and ethenes. In the Main Burning Pits at the Toxic Burning Pits AOC, pesticides and PCBs are also present.

The contaminants were released near the land surface through surface disposal, open burning, pushout operation, and open detonation. These activities resulted in secondary contamination sources, such as metal debris; contaminated soil, sediment, surface water, and groundwater; and the potential presence of DNAPLs in the subsurface. Additional leaching, infiltration, evaporation, and groundwater and surface water dispersions help release the contaminants into various media, including air, soil, sediment, surface water, and groundwater.

Because groundwater at J-Field is not a potable water source, it is not a medium of direct concern. The exposure routes of the contaminants to human and biotic receptors would be through air, soil, sediment, and surface water media. The receptors identified in the model include on-site workers and trespassers, off-site fishermen, and terrestrial and aquatic biota. These exposure routes have been further modeled in the human health risk assessment and the ecological risk assessment. The results of the risk assessments are presented in the two companion documents to this report: Volume 2, the J-Field human health risk assessment (Ripplinger et al. 1998), and Volume 3, the J-Field ecological risk assessment (Hlohowskyj et al. 1999).

S.4 REFERENCES FOR SUMMARY

Hlohowskyj, I., et al., 1999, *Remedial Investigation Report for J-Field, Aberdeen Proving Ground, Maryland, Volume 3: Ecological Risk Assessment*, ANL/EAD/TM-81, Argonne National Laboratory, Argonne, Ill., Nov.

Hughes, W.B., 1993, *Hydrogeology and Soil-Gas at J-Field, Aberdeen Proving Ground, Maryland*, Water-Resources Investigations Report 92-4087, U.S. Geological Survey, prepared in cooperation with the U.S. Army, Aberdeen Proving Ground Support Activity, Environmental Management Division, Towson, Md.

ICF Kaiser Engineers, 1995, *Aberdeen Proving Ground Installation Restoration Program, Reference Sampling and Analysis Program: Soil, Sediment, and Surface Water Reference Data Report*, Draft Final, prepared for U.S. Army Environmental Center, Aberdeen Proving Ground Installation Restoration Risk Assessment Support, Aberdeen Proving Ground, Md.

Ripplinger, J., et al., 1998, *Remedial Investigation Report for J-Field, Aberdeen Proving Ground, Maryland, Volume 2: Human Health Risk Assessment*, Final Document, prepared by ICF Kaiser Engineers, Abingdon, Md., for U.S. Army Environmental Center, Aberdeen Proving Ground, Md.

1 INTRODUCTION

1.1 PURPOSE OF REPORT

This report presents the results of the remedial investigation (RI) conducted at J-Field in the Edgewood Area of Aberdeen Proving Ground (APG), a U.S. Army installation located in Harford County, Maryland (Figure 1.1). Since 1917, activities in the Edgewood Area have included the development, manufacture, and testing of chemical agents and munitions and the subsequent destruction of these materials at J-Field by open burning[1] and open detonation. These activities have raised concerns about environmental contamination at J-Field. This RI was conducted by the Environmental Conservation and Restoration Division, Directorate of Safety, Health and Environmental Division of APG, pursuant to requirements outlined under the Comprehensive Environmental Response, Compensation, and Liability Act, as amended (CERCLA). The RI was accomplished according to the procedures developed by the U.S. Environmental Protection Agency (EPA 1988).

The RI provides a comprehensive evaluation of the site conditions, nature of contaminants present, extent of contamination, potential release mechanisms and migration pathways, affected populations, and risks to human health and the environment. This information will be used as the basis for the design and implementation of remedial actions to be performed during the remedial action phase, which will follow the feasibility study (FS) for J-Field.

1.2 SITE BACKGROUND

1.2.1 Site Description

The J-Field site is almost flat and is covered by open fields, woods, and nontidal marshes. It encompasses about 460 acres at the southern end of the Gunpowder Neck Peninsula (Figures 1.1 and 1.2). The peninsula is surrounded on three sides by tidal estuaries — the Gunpowder River to the west, the Chesapeake Bay to the south, and the Bush River to the east. Some areas within the original site boundary are now under water because of erosion and subsequent inundation. Rickett's Point, a jetty that once extended from the southwestern tip of J-Field, is an example of land lost to the surrounding bay.

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[1] Pursuant to Title 40, *Code of Federal Regulations* (CFR), Part 260.10, "open burning" means the combustion of any material without the following characteristics: (1) control of combustion air to maintain adequate temperature for efficient combustion, (2) containment of the combustion reaction in an enclosed device to provide sufficient residence time and mixing for complete combustion, and (3) control of emission of the gaseous combustion products.

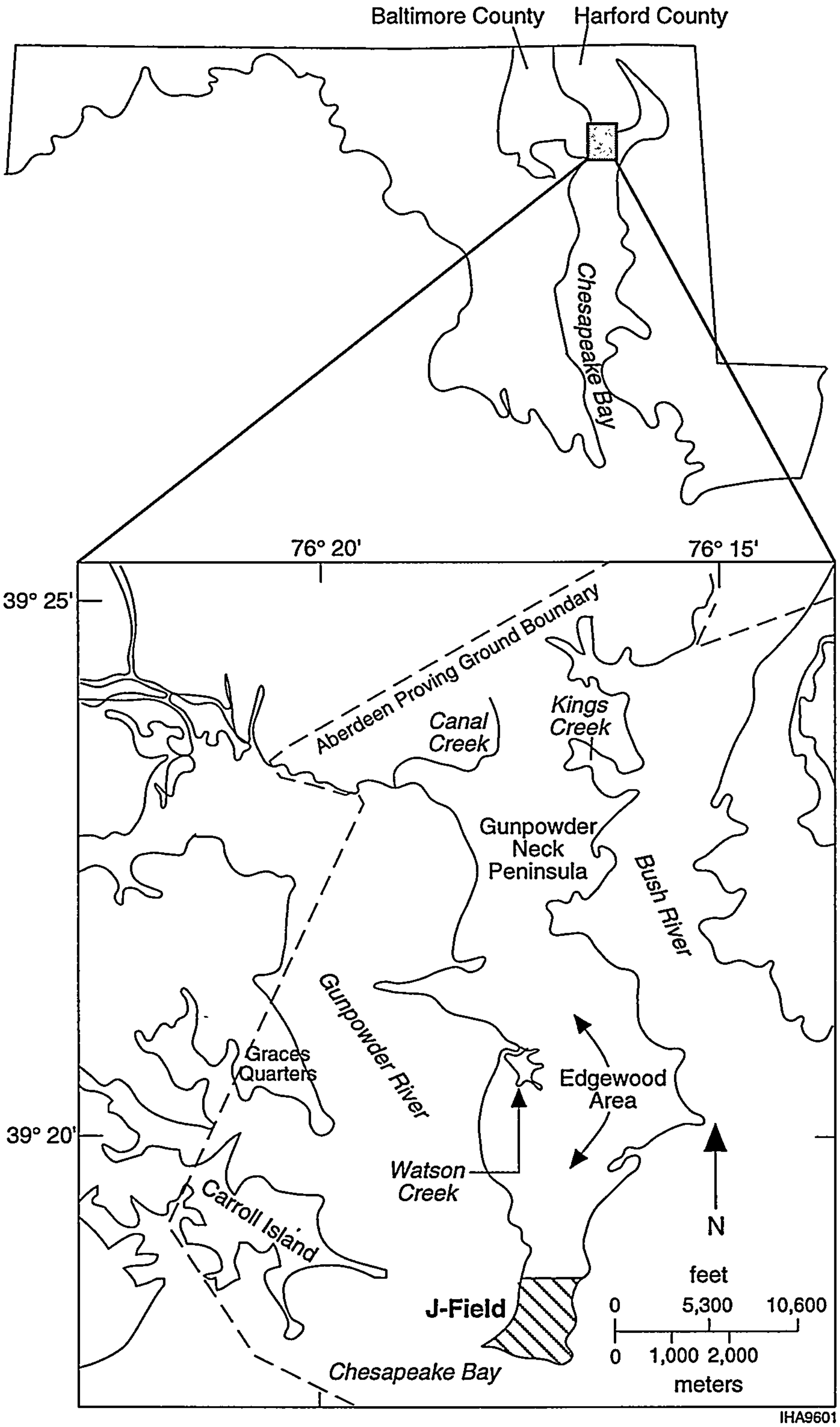


FIGURE 1.1 Location of J-Field in the Edgewood Area at Aberdeen Proving Ground (Source: Adapted from Hughes 1993)

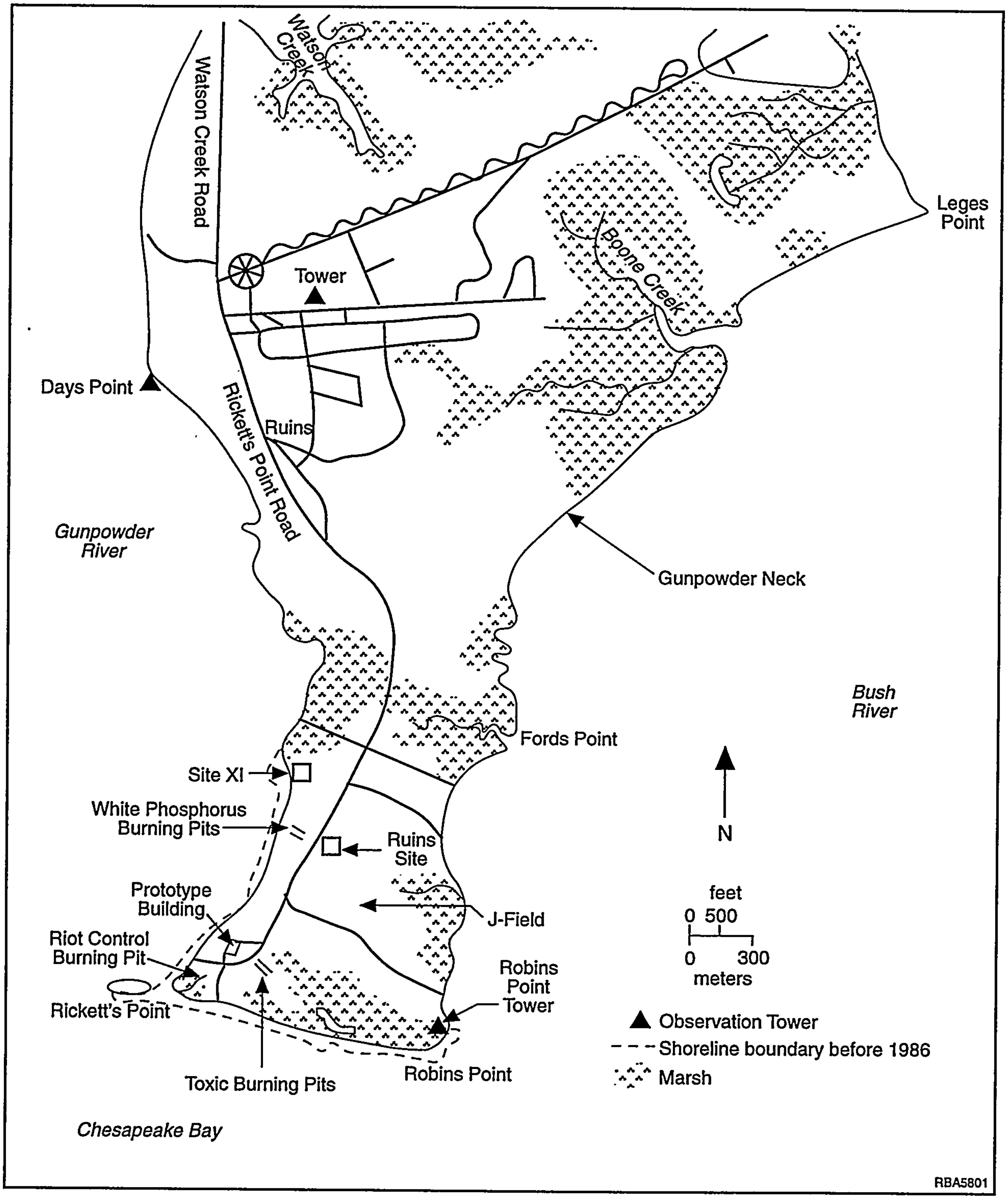


FIGURE 1.2 Locations of J-Field and Major Associated Features on the Gunpowder Neck Peninsula (Source: Adapted from Hughes 1993)

For the purposes of the RI/FS, J-Field has been divided into eight geographic areas or features that are designated in this report as areas of concern (AOCs) (Figure 1.3). These AOCs correspond to the eight solid waste management units identified by Nemeth (1989). Several subareas within these AOCs could represent discrete sources of contamination. In addition, 11 potential areas of concern (PAOCs) have been identified within the AOCs. Six other PAOCs not associated with the current AOCs have also been identified, and numerous craters located throughout the site (Yuen 1994) are collectively considered as a seventh PAOC.

The AOCs and PAOCs and their associated subareas follow:

- Toxic Burning Pits (TBP) AOC
    - Main Burning Pits (a northern and a southern burning pit)
    - Methyl Phosphonothioic Acid (VX) Burning Pit
    - Pushout Area
    - Mustard Burning Pit
    - Liquid Smoke Disposal Pit
- TBP PAOCs
    - Storage Area
    - Square Pit (later found to be the Liquid Smoke Disposal Pit)
    - Southwestern Suspect Burning Area
    - High-Explosives (HE) Demolition Area near the southeastern portion of TBP
- White Phosphorus Burning Pits (WPP) AOC (The Principal Burning Pits, Pushout Area, Mounded Areas, and Historic White Phosphorus Disposal Area [located south to southeast of the principal burning pits] are considered active areas and are excluded from this study.)
- WPP PAOCs
    - Suspect Storage Area

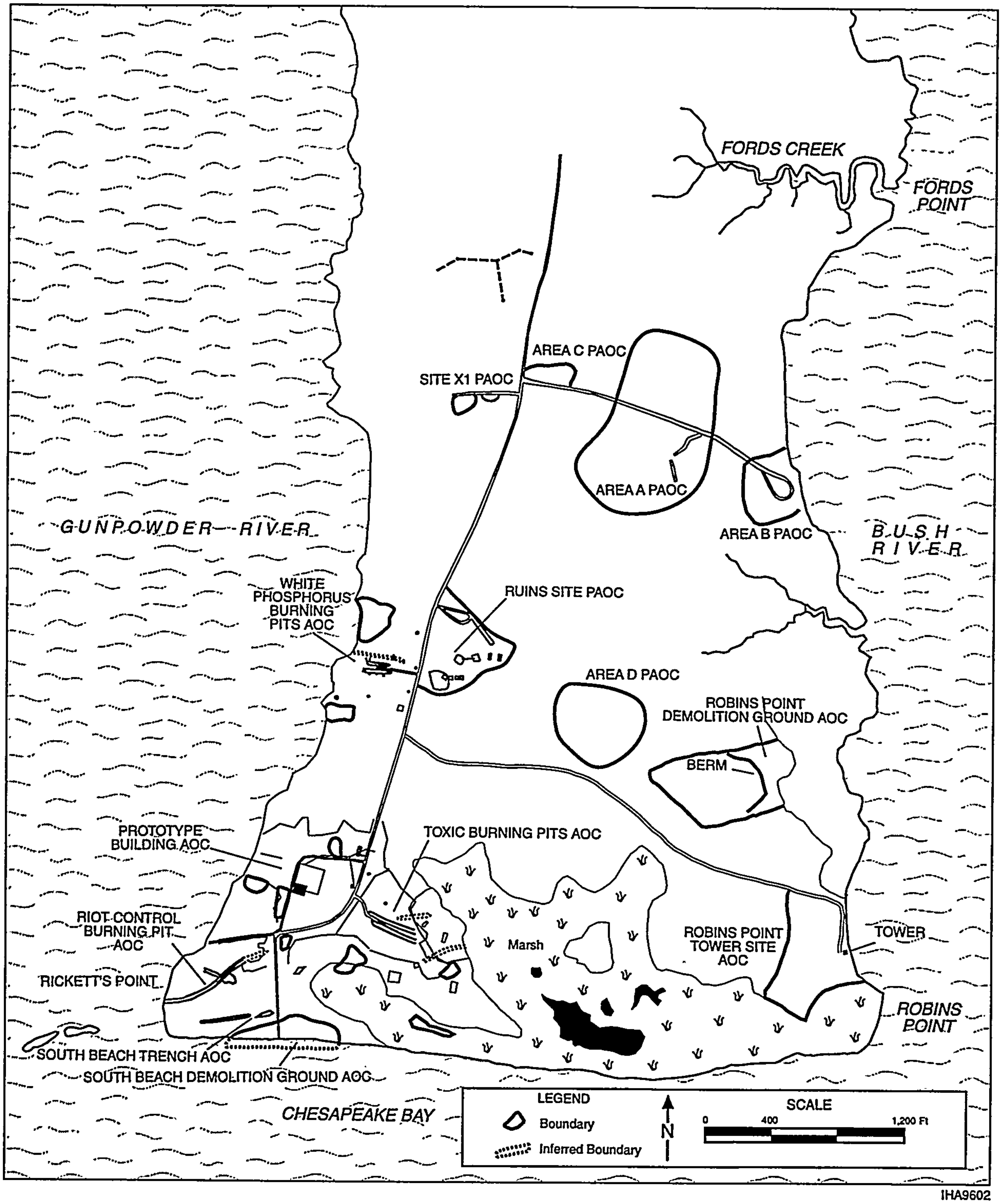


FIGURE 1.3 Locations of Areas of Concern, Potential Areas of Concern, and Principal Site Features at J-Field (Source: Adapted from Hughes 1993)

  - Northwestern Suspect Burning Area
  - Southwestern Suspect Burning Area
- Riot Control Burning Pit (RCP) AOC
  - Burning Pit
  - Pushout Area
- Robins Point Demolition Ground (RPDG) AOC
  - Inactive Area
- Robins Point Tower Site (RPTS) AOC
- South Beach Trench (SBT) AOC
  - Western Trench PAOC
- South Beach Demolition Ground (SBDG) AOC
- Prototype Building (PB) AOC
- PB PAOCs
  - Southwestern Suspect Burning Area
  - Northwestern Suspect Burning Area
  - Clearing near southwestern corner of PB
- PAOCs not associated with AOCs
  - Site X1
  - Area A
  - Area B (Fords Point Firing Position)
  - Area C

- Ruins Site (across from WPP)
- Area D
- Craters (scattered throughout site)

Although most of the AOCs and PAOCs are no longer used for open burning or detonation, a portion of the RPDG (west of the berm) is currently active and is operating with interim status under the Resource Conservation and Recovery Act (RCRA). A RCRA Part B Permit application was submitted in November 1988. The other active areas used for emergency disposal operations are an open burning pan located 160 ft west of the PB and an open detonation area at the WPP AOC. The open burning pan at the PB AOC was never used and was administratively closed (Kuhfahl 1998). These active areas are outside the scope of this study.

1.2.2 Site History

The extent of activities at J-Field before World War II is unknown; however, a terrain map from the 1920s–1930s era indicates that some areas of J-Field were cleared at that time. These cleared areas may have been used for test activities (Nemeth 1989). During World War II, J-Field was used to test HE and chemical munitions. At that time, steel-reinforced structures (such as bunkers, buildings, and slab walls) were built as targets for testing conventional munitions. In addition, J-Field was used for the thermal and chemical decontamination of chemical munitions. Chemical agents, chemical wastes, and HE were burned or detonated in open pits.

Chemicals disposed of at J-Field include nerve agents (such as VX), blister agents, riot control agents, white phosphorus, chlorinated solvents, and drummed chemical wastes generated by research laboratories, process laboratories, pilot plants, and machine and maintenance shops. Between 1946 and 1971, limited testing of lethal chemical agents continued at J-Field (Nemeth 1989). Open-air testing of lethal chemical agents stopped in 1969 (Nemeth 1989). Table 1.1 summarizes disposal activities at various J-Field locations. A sample list of wastes disposed of at J-Field is provided in Appendix C.

Radioactive waste is known to have been disposed of at J-Field. The TBP area was used for disposal of small amounts of radioactively labeled chemicals. In addition, test burns of contaminated wood wastes, including wood contaminated with radium and strontium-90, may have been conducted at the RPTS (Nemeth 1989).

J-Field has had only limited use since 1980. However, as mentioned, the RPDG and the WPP are still occasionally used for the destruction of explosives-related materials (Nemeth 1989).

TABLE 1.1 Summary of Disposal/Destruction Activities at J-Field

Site Name	Period of Use	Activity
AOCs		
TBP (originally 5 separate pits; only 2 remain visible but are not in use)	1940–1980	Disposal of HE-filled munitions, nerve agents, mustard, liquid smoke, chlorinated solvents, and radioactive chemicals; open burning and detonation of HE in southeastern portion
WPP	Late 1940s–1980; current use: occasional emergency disposal of white phosphorus	Open burning and detonation of white phosphorus, plasticized white phosphorus, and other chemicals; potential for disposal of CN[a] and trichloroethene
RCP	Late 1940s–early 1970s; riot control agent disposal, 1960s to early 1970s	Open burning of chemicals, chemical-filled munitions, and riot control agents (CS,[b] CN)
RPDG	Late 1970s–present	Open detonation of explosive materials and sensitive and unstable chemicals
SBDG	Late 1950s–1970s	Open detonation of HE
PB	World War II	Stored wastes and HE munitions; possible storage of solid wastes in building or nearby; building used to test bombing effects; periodically used for storage since World War II
RPTS	Late 1950s–1960s	Potential test burn of radioactively contaminated wood
SBT	Late 1950s	Unknown

TABLE 1.1 (Cont.)

Site Name	Period of Use	Activity
PAOCs Not Associated with AOCs		
Site X1	Early 1950s– ?	Unknown (collapsed concrete columns and relict soil piles in the field)
Area A	Unknown	Unknown (several abandoned trenches in the field)
Area B (Fords Point Firing Position)	Early 1950s– ?	Unknown (concrete slabs, dirt mounds, and scrap drums in the field)
Area C	? –1968	Potential test site for bombing of structures (building remnants and bomb craters)
Area D	Unknown	Possibly used as a bombing range (craters, dark areas on aerial photographs)
Ruins Site across from WPP	1940s– ?	Bomb testing in cratered areas; use of suspect trench area and ponds is unknown (bomb craters, relict structures, discolored soil, ponds, and a trench)
Craters (distributed throughout J-Field)	1940s– ?	Explosives testing and destruction (?)

[a] CN = α-chloroacetophenone.

[b] CS = ortho-chlorobenzylidene malononitrile.

Sources: Adapted from Nemeth (1989); EPA and U.S. Department of the Army (1990); McNamara (1994).

1.2.3 Disposal and Decontamination Procedures

Thermal decontamination procedures for open burning in J-Field pits involved placing 3 to 4 ft of wood dunnage in a pit, placing the materials to be burned on top of the dunnage, adding fuel oil (or, on occasion, gasoline), and igniting the materials. The depths of the pits were maintained by pushing burned soil and ash out toward the nearby marshes. In the case of the TBP AOC, this procedure moved the edge of the adjacent marsh eastward more than 100 ft (Sonntag 1991). Scrap metal items were removed and reburned in the same manner in a reburn pit. Large metal items were recovered and disposed of as scrap.

Chemical decontamination procedures involved either enhanced hydrolysis or oxidation with a chlorinated agent. Enhanced hydrolysis was most often accomplished by raising the pH of the agent-contaminated solution by adding caustic (sodium hydroxide) solution. The caustic solution was used to hydrolyze a wide variety of chemical agents, including chloropicrin, lewisite (2-chlorovinyldichloroarsine), GB (isopropylmethylphosphonofluoridate; also known as sarin), VX, BZ (3-quinuclidinyl benzilate), CS (ortho-chlorobenzylidene malononitrile), and CN (α-chloroacetophenone). (Sodium hydroxide solution was not the preferred decontaminant for all of these agents; often the caustic solution would have to be combined with alcohol or reacted at elevated temperatures.)

The caustic solution was also used to decontaminate mustard (bis[2-chloroethyl]sulfide), although it was not as effective on pure mustard as on production-grade (undistilled) mustard. Another limitation of the use of a caustic solution was the relatively low aqueous solubility of mustard agent. However, the widespread use of a caustic solution to decontaminate mustard at APG (at least through World War II) was probably due in part to the availability of caustic as a by-product from the on-site chlorine production plant.

Although sodium hydroxide is mobile in both surface water and groundwater, it is largely neutralized by soil acids or open waters. Therefore, the sodium hydroxide introduced into the environment during agent decontamination would only be a significant environmental contaminant locally and for relatively short periods of time. Current contamination effects from past application of sodium hydroxide would probably be minimal.

Another chemical hydrolysis accelerator was sodium carbonate, used by the U.S. Army to decontaminate G agents (nerve agents such as GA [ethyl N, N-dimethylphosphoramidocyanidate]). The potential environmental impact from sodium carbonate is small in most situations; however, high usage of sodium carbonate could elevate sodium concentrations in groundwater.

One widely used oxidizing agent is known as "decontaminating agent, noncorrosive" (DANC). DANC is an organic N-chloroamide compound in solution with 1,1,2,2-tetrachloroethane (TCLEA) that was used to decontaminate mustard, lewisite, and VX. It was not effective against

G agents. DANC typically contained 90-95% (by weight) TCLEA. Recovered scrap materials were decontaminated with DANC in the pit before being removed; the oxidizing agent would be neutralized by reduction and result in the amide as an expected degradation product. Because of the high concentration of solvent in the mixture, the most significant residual impact from the use of DANC would have been the introduction of TCLEA into the environment. Available information indicates that the use of DANC at J-Field was widespread and common (Nemeth 1989).

Incomplete records indicate that other organic decontamination agents used at the time included DS-2 (decontamination solution 2), CD-1, and C-8 emulsion. DS-2 (70% diethylenetriamine, 28% ethylene glycol monomethyl ether, and 2% sodium hydroxide) was developed around 1960 and used to decontaminate mustard, G agents, and V agents (e.g., VX). Much of DS-2 is biodegraded in the environment; the diethylenetriamine breaks down to produce residual nitrosamines. CD-1 (a mixture consisting of 55% monoethanolamine and 45% 2-hydroxy-1-propylamine [by weight], to which 2.5% lithium hydroxide hydrate [by weight] is added) was used to decontaminate mustard, VX, and GB. Amines may be degradation products. The C-8 emulsion, used to oxidize contaminants, contained approximately 76% water, 15% tetrachloroethene (TCLEE), 8% calcium hypochlorite, and 1% of a sulfonate and alcohol mix emulsifier. TCLEE would be the major long-term environmental contaminant resulting from the use of C-8.

1.3 PREVIOUS SITE INVESTIGATIONS

Considerable archival information about J-Field exists as a result of efforts by APG staff to characterize the hazards associated with the site (see Table A.1, Appendix A). Contamination of J-Field was first detected during an environmental survey of the Edgewood Area conducted in 1977 and 1978 (Nemeth 1989) by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) (predecessor to the U.S. Army Environmental Center [AEC]). As part of a subsequent USATHAMA environmental survey, 11 wells were installed and sampled at J-Field (Nemeth 1989). Contamination was also detected in 1983 during a munitions disposal survey conducted by Princeton Aqua Science (1984). The Princeton Aqua Science investigation involved installing and sampling nine wells and collecting and analyzing surficial and deep composite soil samples. In 1986, the EPA issued a RCRA Permit (MD3-21-002-1355) requiring a basewide RCRA Facility Assessment (RFA) and a hydrogeologic assessment of J-Field. In 1987, the U.S. Geological Survey (USGS) began a two-phase hydrogeologic assessment in which data were collected to model groundwater flow at J-Field. Soil gas investigations were conducted, several well clusters were installed, a groundwater flow model was developed, and groundwater and surface water monitoring programs were established that continue today. The results of the USGS study were reported by Hughes (1993).

While APG was investigating J-Field under RCRA corrective action, the Edgewood Area was added to the National Priorities List on February 21, 1990. Because of that listing, an RI/FS is required for the entire Edgewood Area pursuant to Modification 2 of the RCRA Permit and a March

1990 Federal Facility Agreement (FFA) between EPA Region III and the U.S. Department of the Army. The current study is conducted under the FFA, which incorporates both RCRA and CERCLA.

1.4 REPORT ORGANIZATION

Section 1 presents the purpose and scope of the RI and provides a site background that includes a description of J-Field, its history, and a listing of previous environmental studies at the site. Section 2 details the physical characteristics of the site, including surface morphology, climate, hydrology (surface water and groundwater), geology, soils, land use, and ecology. Section 3 summarizes the technical approach used in conducting the RI, including the investigative strategies, data quality assurance and control, and the data evaluation factors and criteria involved in completing the RI.

Section 4 presents site descriptions of the various AOCs and PAOCs. Section 5 provides an evaluation and interpretation of the data collected at J-Field, including the data from each environmental medium sampled. Section 6 summarizes the conceptual exposure model and the fate and transport of potential contaminants at J-Field. Section 7 lists references cited in this report, and Section 8 lists the individuals who prepared this report.

Appendix A presents a detailed summary of data collected at J-Field. Appendix B contains a sample log from 1953 of waste sent to J-Field.

Volume 2 of this report provides the results of the human health risk assessment (Ripplinger et al. 1998). Volume 3 provides the results of the ecological risk assessment for J-Field (Hlohowskyj et al. 1999).

2 ENVIRONMENTAL SETTING

2.1 SURFACE FEATURES

J-Field is nearly flat, with a maximum relief of about 10 ft. The ground surface slopes gently toward marshy areas or toward Chesapeake Bay and on-site surface water. In some places, wave erosion has formed short, steep cliffs (2–10 ft high) along the shore (Hughes 1993).

Surface water occurs in demolition craters, marsh areas, and a few open ponds within the marshes. When precipitation is abundant, water collects in wooded areas where drainage is poor because the low-permeability soils slow the rate of infiltration. Figure 2.1 shows the overall topography of the site.

2.2 CLIMATE

The climate in the area of APG is temperate and moderately humid, and it is moderated by Chesapeake Bay. The average annual precipitation of 45 in. is distributed relatively uniformly during the year. The average annual temperature is about 54°F (Nemeth 1989; Hughes 1993).

2.3 SURFACE WATER HYDROLOGY

The southern and eastern shores of J-Field are covered by an extensive marsh system (Figure 2.2). The marshes may be flooded during storms and very high tides but are not affected by normal tides of 1–2 ft. The water level in the marshes is generally about 2 ft above high tide in Chesapeake Bay. The disposal pits at J-Field originally drained into these marshes or into the Gunpowder and Bush Rivers. During the 1970s, drainage from the disposal pits was blocked. Currently, surface water can be 1–2 ft deep in the TBP and WPP during wet periods (Hughes 1993). Several ponds are located within the marshy areas of J-Field (Figure 2.2). The largest pond, which is about 5 ft deep, is southeast of the TBP. Two unnamed streams on the eastern side of J-Field are the only on-site streams and do not carry much runoff except during storms.

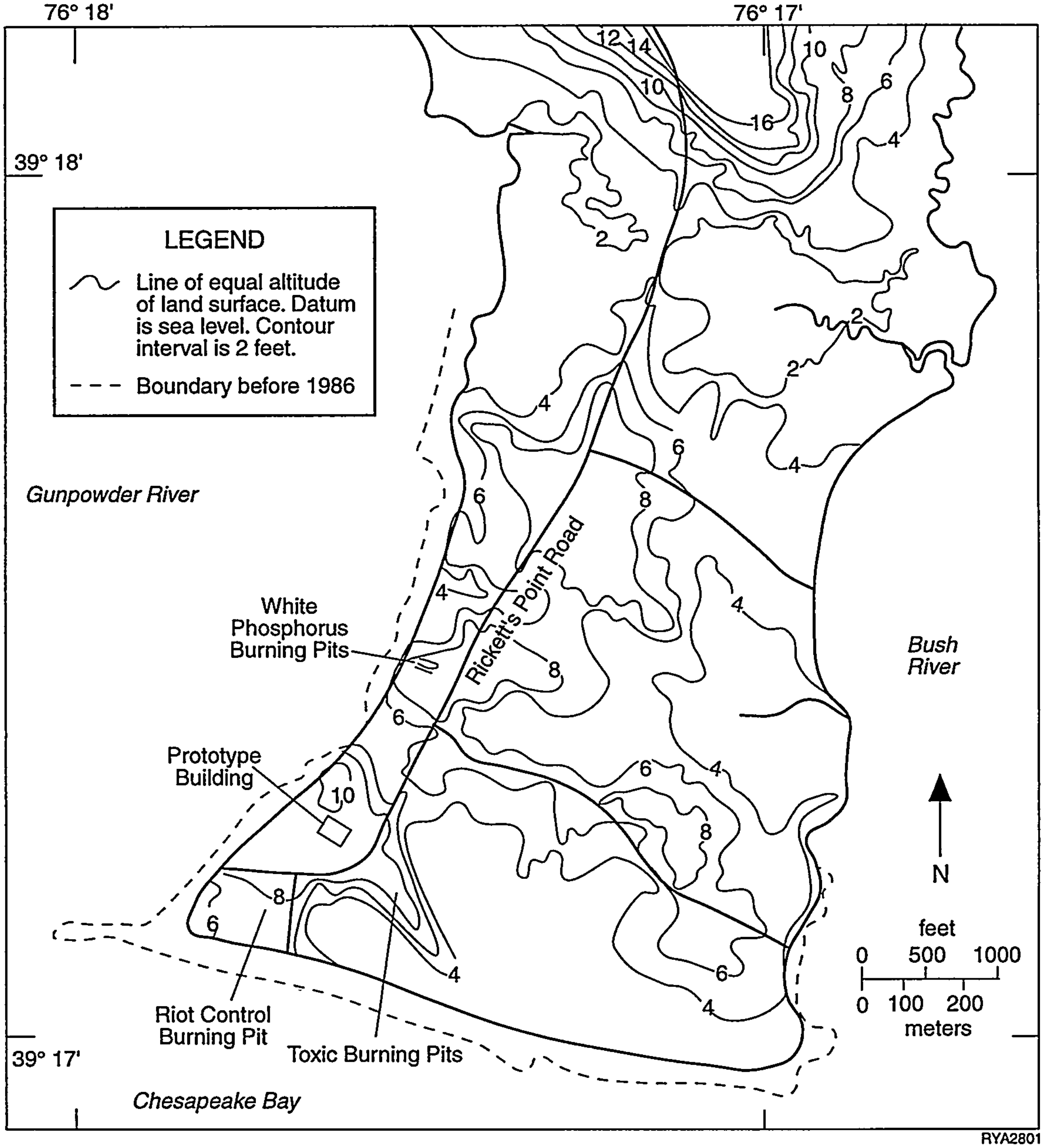


FIGURE 2.1 Topography of the J-Field Study Area (Source: Adapted from Hughes 1993)

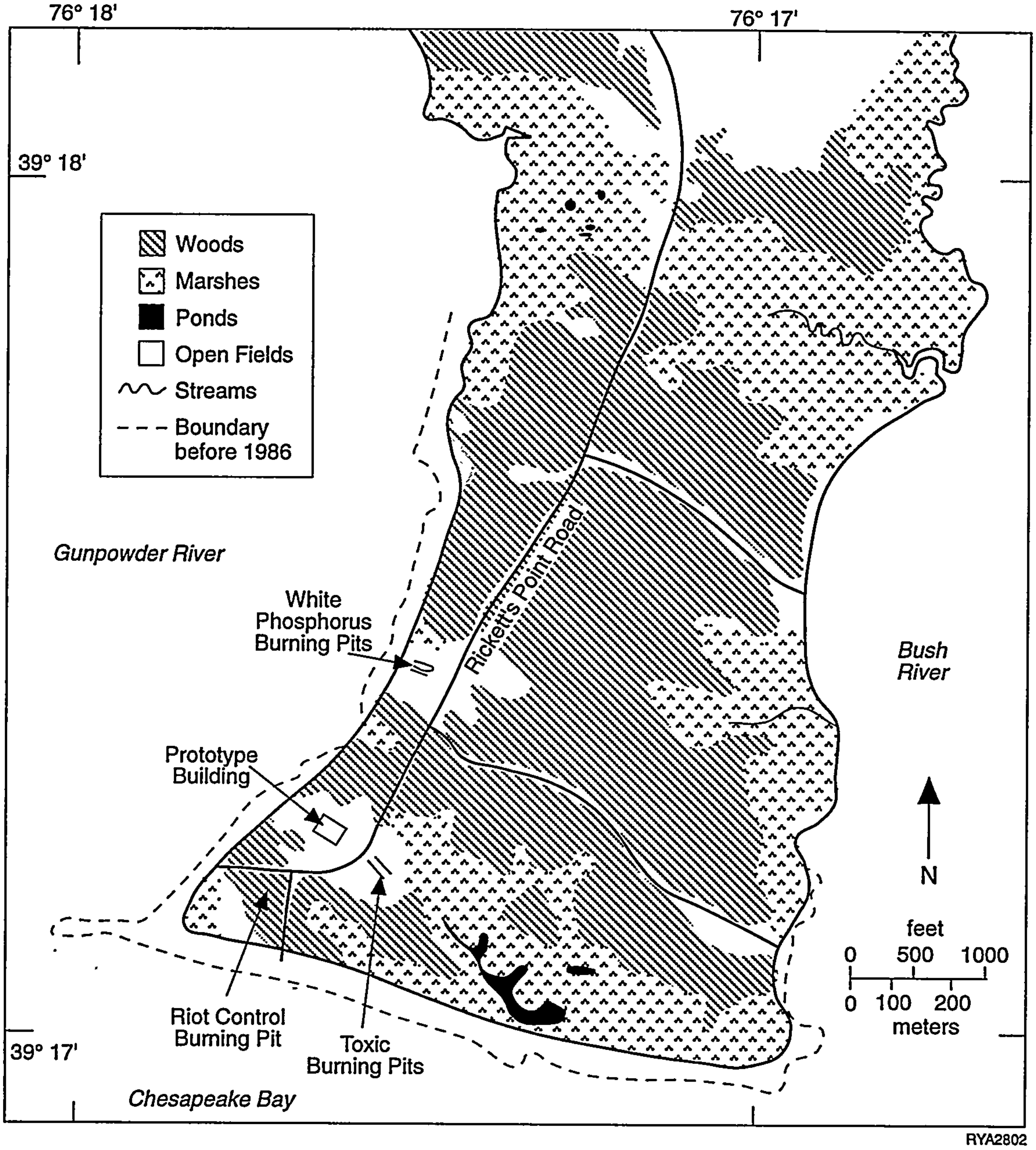


FIGURE 2.2 Locations of Woods, Marshes, Ponds, Open Fields, and Streams at J-Field (Source: Adapted from Hughes 1993)

2.4 GEOLOGY AND SOILS

2.4.1 Geology

The stratigraphy of J-Field consists of Quaternary (Talbot) sediments underlain by Cretaceous (Potomac Group) sediments. The Quaternary sediments constitute a fluvial, estuarine, and marginal marine unit of sand, gravel, and silty clay. The Cretaceous sediments are a sand and clay unit of fluvial origin.

The Quaternary sediments can be divided into three units (Figures 2.3 and 2.4). The surface unit (Unit C) consists of interbedded sand and clay about 30–40 ft thick; the middle unit (Unit B) is silty, sandy clay and organic matter about 36–107 ft thick; and the base unit (Unit A) is gravelly sand and clay about 13–50 ft thick. The Cretaceous sediments consist of interbedded layers of fine-grained sand and massive clay. The top of this layer is at a depth of 110–160 ft. Metamorphic bedrock underlies the sediments at depths ranging from 200 to 900 ft.

Site-specific cross sections through the TBP AOC illustrate the three general units of the Talbot sediments (Figure 2.3 through 2.7). Lithologies were identified by continuous split-spoon sampling (Hughes 1993). Both cross sections indicate variability in the surficial aquifer (Unit C); silty sand dominates, but silt and clay units also are present. The clayey estuarine Unit B dominates each cross-sectional view. Cross sections C-C′ (Figure 2.4) and A-A′ (Figure 2.6) show a deepening of Unit B to the southeast. The underlying sand and gravel (Unit A) is partially penetrated by several of the deeper wells (JF41, JF201, and JF81).

2.4.2 Soils

Three primary soil groupings occur at J-Field (Figure 2.8). The majority (78%) of the site is underlain by hydric soils that consist of poorly drained clayey-silt soils common in marshes, depressions, and other low-lying areas concentrated in the center and eastern portions of the site (U.S. Department of Agriculture [USDA] 1927, 1975). Soils in slightly upland areas along the western portion of the site range from moderate to well-drained loams (Figure 2.8).

The tidal marsh (TM) soil is a hydric soil found in the wetlands along the southern and eastern borders of J-Field that contact the Chesapeake Bay and in the marsh that extends from Chesapeake Bay to the Gunpowder River estuary along the northern margin of the site. The tidal marsh soil covers approximately 34.6% (140 acres) of the site and is developed in brackish or salty conditions in areas subject to increased water saturation either by tidal inundation directly or by water table conditions directly influenced by tidal fluctuations. The soil material ranges from sand to clay, and in places it may consist of peat or muck. Some locations contain sulfur compounds,

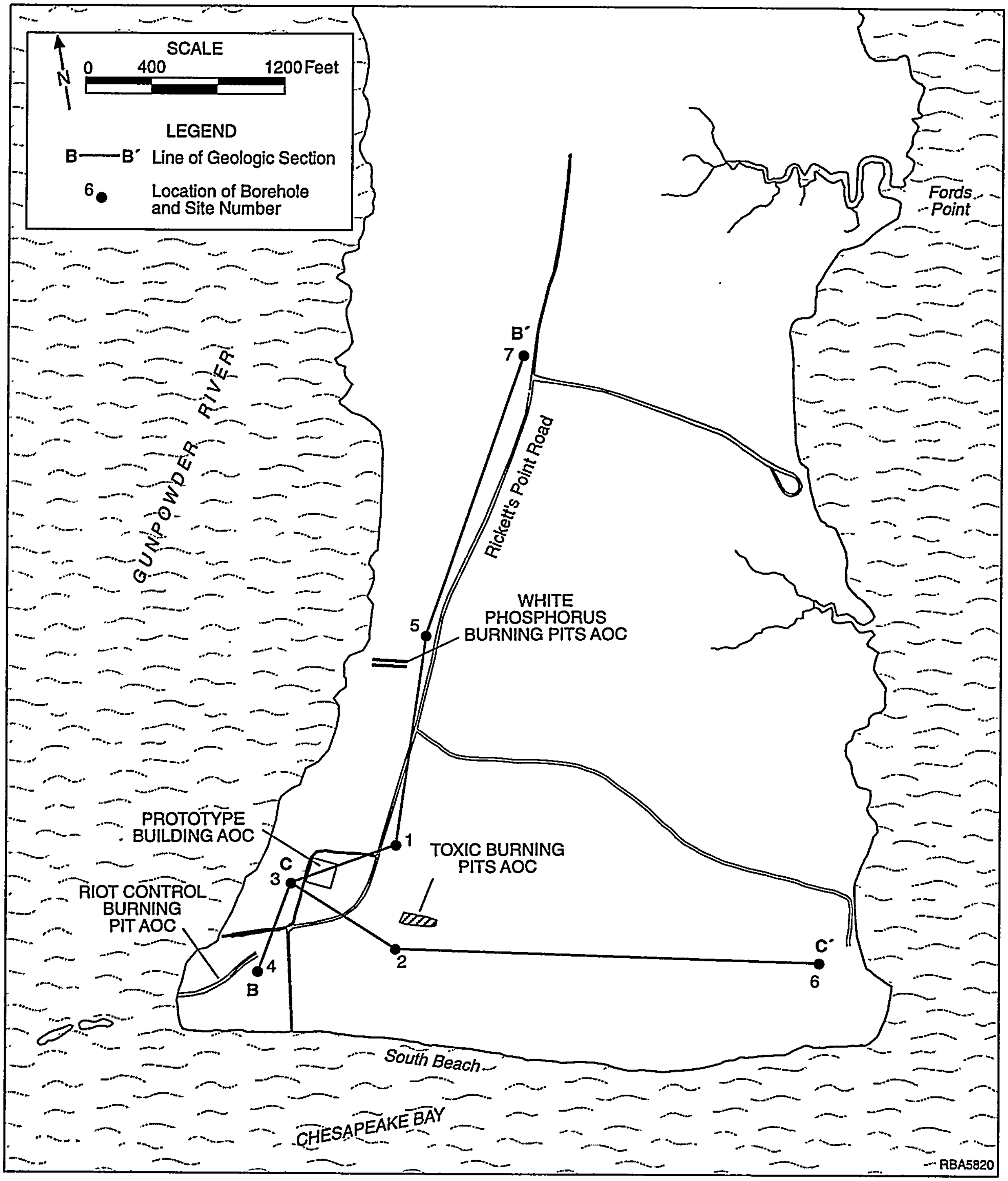


FIGURE 2.3 Locations of Geologic Cross Sections Shown in Figure 2.4 (Source: Adapted from Hughes 1993)

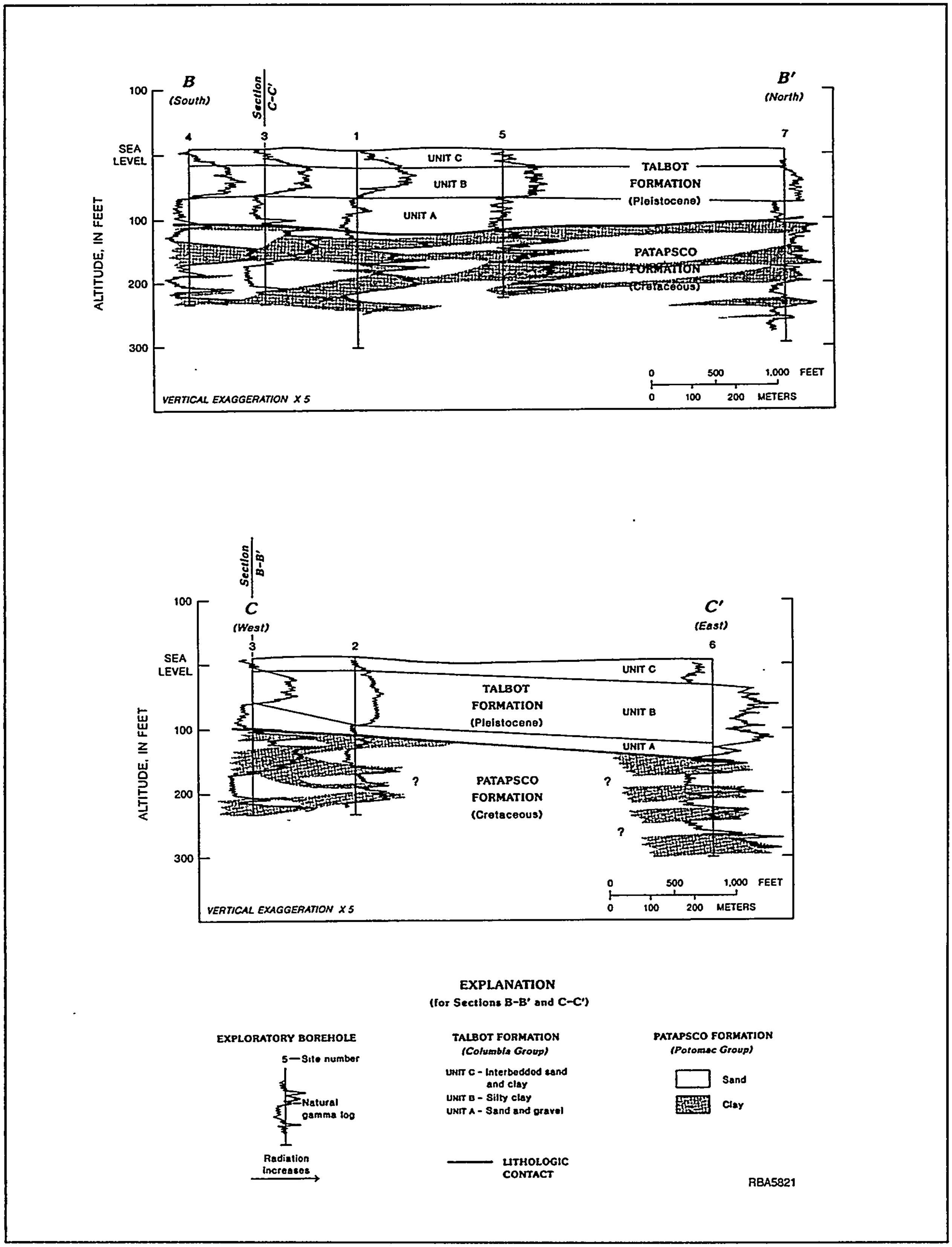


FIGURE 2.4 Geologic Cross Sections B-B′ and C-C′ (Source: Adapted from Hughes 1993)

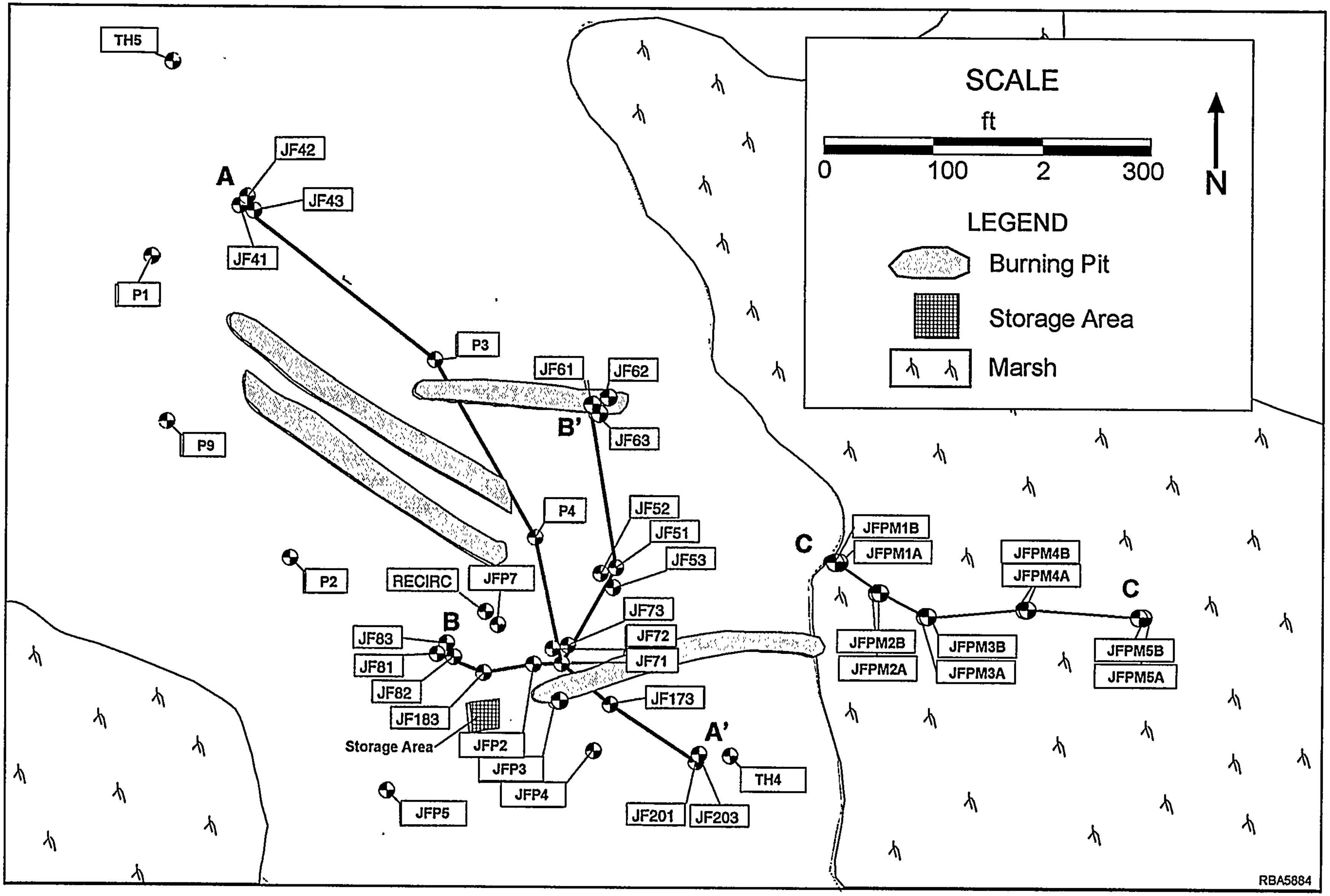


FIGURE 2.5 Locations of Hydrogeologic Cross Sections Shown in Figures 2.6, 2.7, and 2.11 (TBP AOC)

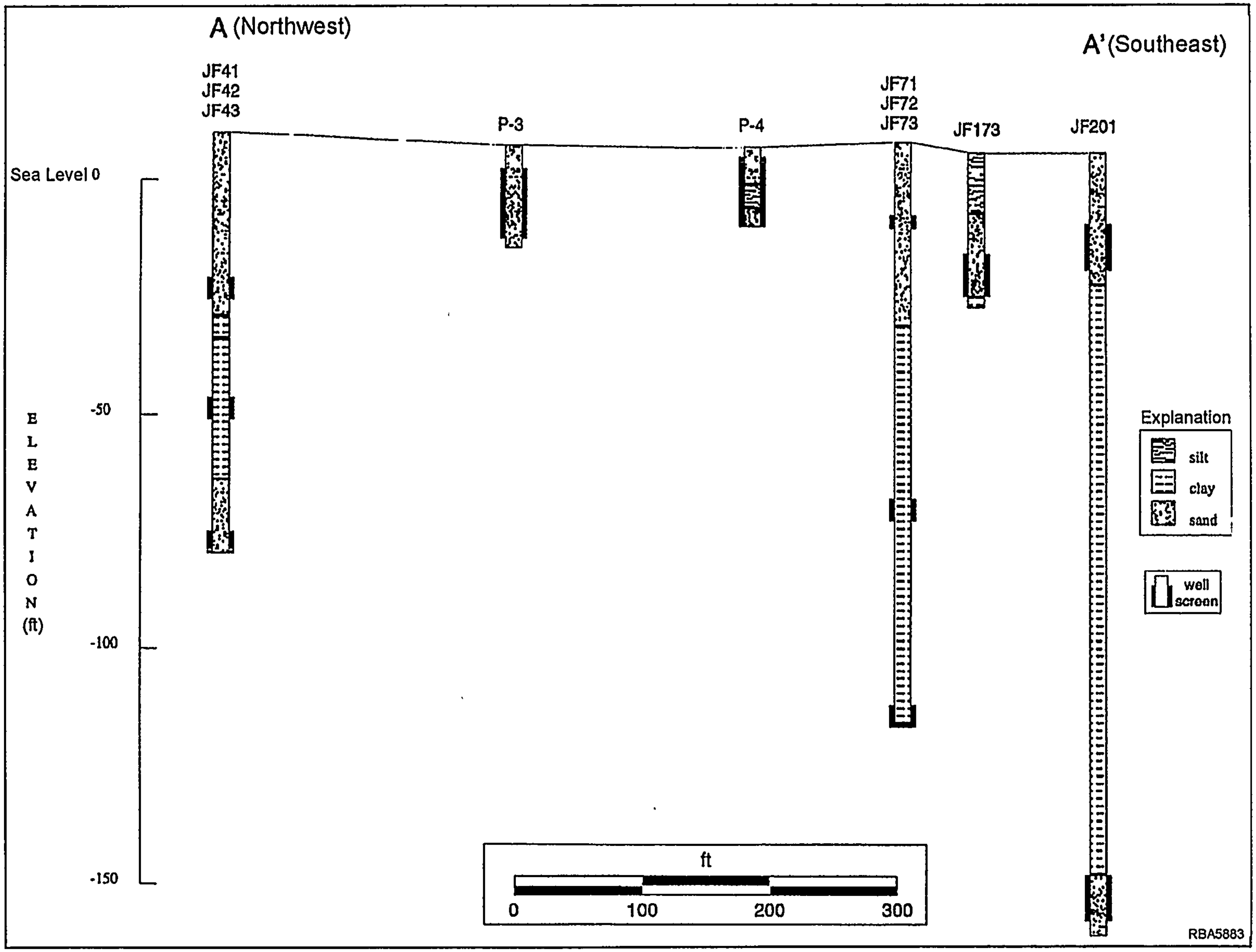


FIGURE 2.6 Northwest to Southeast Hydrogeologic Cross Section (A–A′)

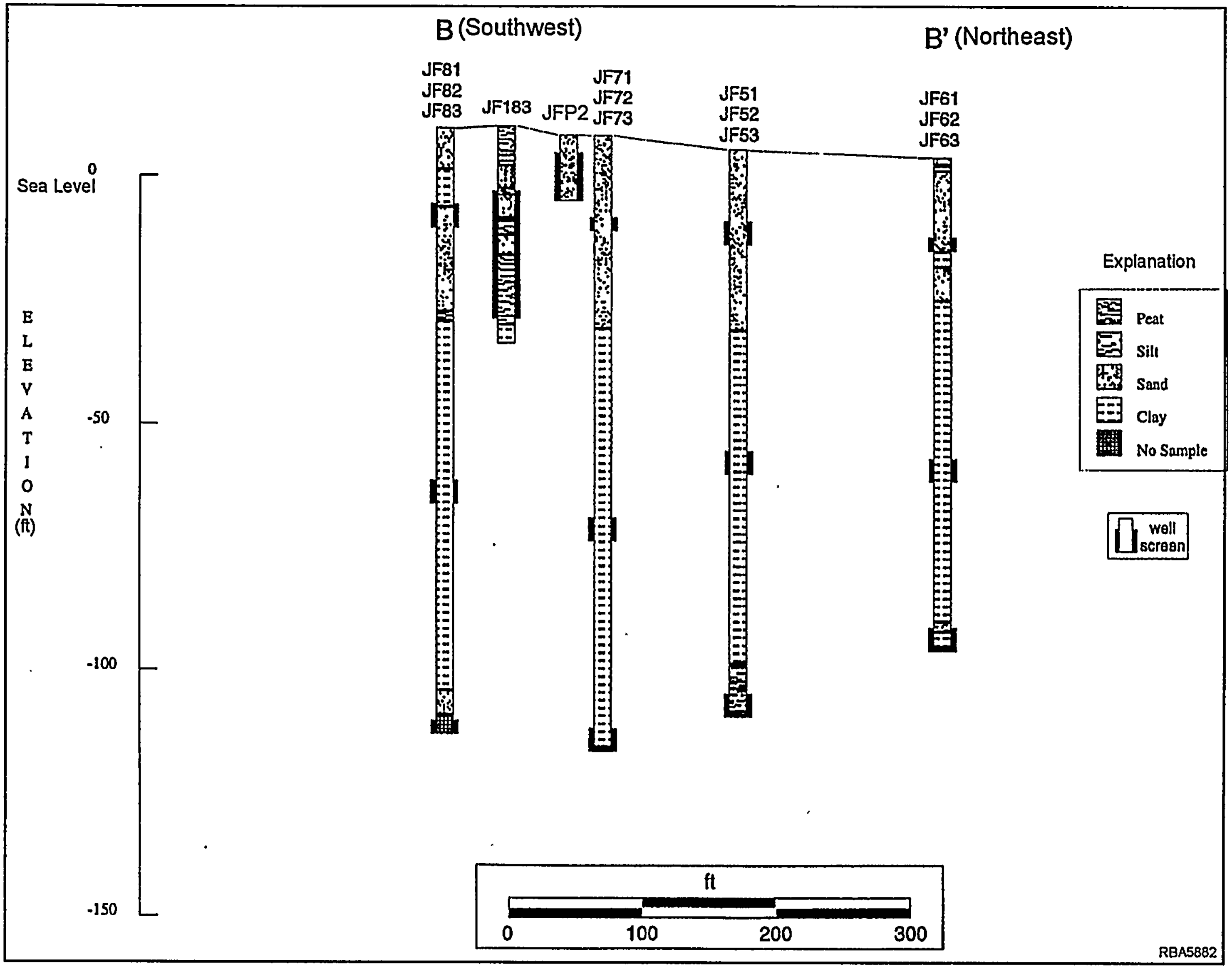


FIGURE 2.7 Southwest to Northeast Hydrogeologic Cross Section (B–B′)

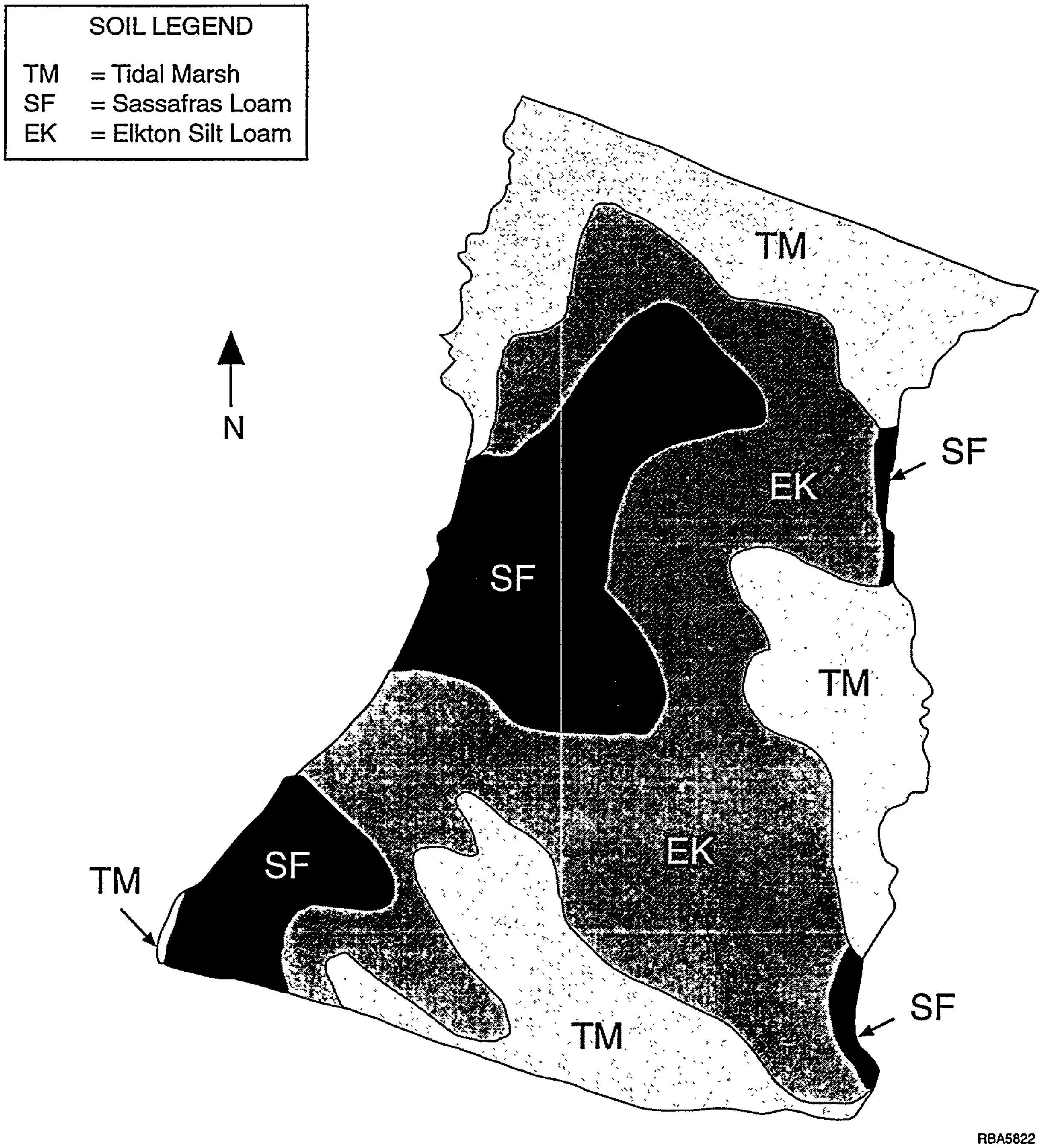


FIGURE 2.8 Soil Associations at J-Field

resulting in acid soil conditions, especially as the land is drained and dried. Typical vegetation is salt-tolerant emergent wetland species, such as marsh grasses, sedges, and low shrubs. In its natural state, this soil is not suited to crops, pastures, or woodlands.

Elkton silt loam (EK) is the dominant hydric soil throughout much of the center of J-Field, covering approximately 44.3% (180 acres). Elkton silt loam is a deep, poorly drained, level soil formed in old deposits of clayey marine sediment. The surface horizon consists of a dark gray-brown silt loam about 7 in. thick. The subsoil, which ranges between 34 and 60 in. thick, is a gray silty clay with yellow-brown mottles. The soil is very sticky and plastic when wet. Elkton silt loam will generally support heavy machinery (such as grading and earth-moving equipment) only when it is dry. The water table under the Elkton silt loam is usually high for much of the year. Artificial drainage is difficult and requires closely spaced open drainage ditches with adequate outlets. Tile drains do not function well in draining this soil. Natural vegetation is typically woodland shrubs and trees.

Sassafras loam (SF) is a deep, well-drained soil formed in old marine sediments containing moderate amounts of silt and clay. Sassafras loam covers 21.2% (86 acres) and is found in three scattered areas at J-Field, predominantly along the western margin. The surface horizon is a brown loam about 8 in. thick. The upper 2–3 ft of the subsoil is a brown, light sandy clay loam that is slightly sticky when wet. The lower subsoil is a dark-brown, loose loamy sand. The soil is moderately permeable, with a medium to high available water capacity. The soil is susceptible to erosion along steep grades. The soil will support earth-moving equipment in most conditions. The native vegetation is mixed hardwoods, especially oak species.

2.5 HYDROGEOLOGY

Four major hydrologic units have been identified beneath J-Field — the surficial aquifer (Unit C, in the overlying Talbot layer), the leaky confining unit (Unit B, in the middle layer), the confined aquifer (Unit A, in the bottom Talbot unit), and the Potomac Group aquifer (Figure 2.9). Groundwater flow in these units is described below on the basis of current knowledge of the aquifers. More detailed information on groundwater flow is presented in the specific site evaluations presented in Section 4. Monitoring well locations at J-Field are shown in Figure 2.10.

In general, the water table at J-Field is within 3–4 ft of the land surface. The depth of the water table ranges from the ground surface in the marsh areas to approximately 5–6 ft below the surface under the forested and open-field areas of the site. Because of the low relief of J-Field, depth to the water table is influenced by seasonal precipitation and by tidal fluctuations locally near the Chesapeake Bay. There are no drinking water wells in J-Field.

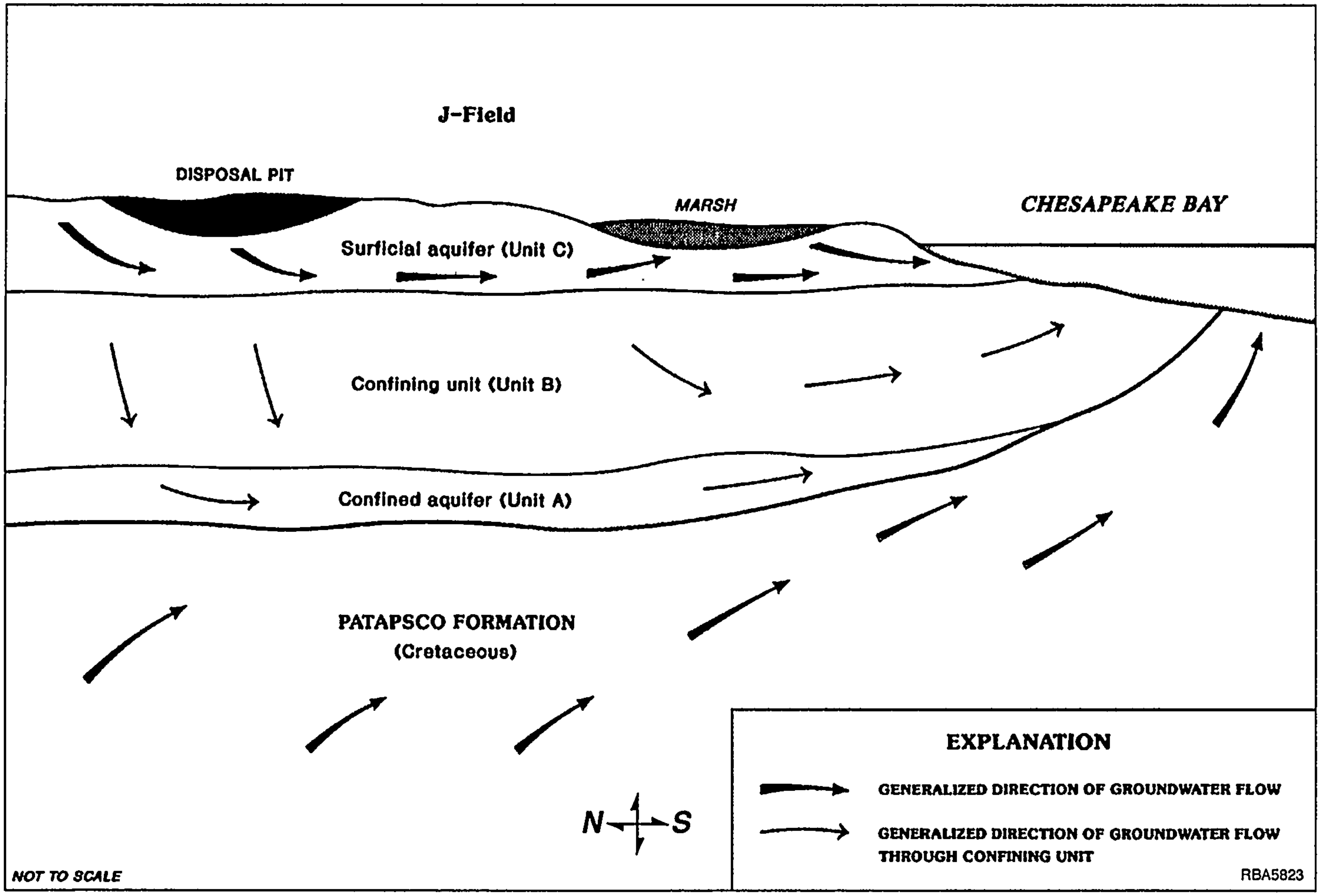


FIGURE 2.9 Hydrogeologic Units and Generalized Direction of Groundwater Flow at J-Field (Source: Hughes 1993)

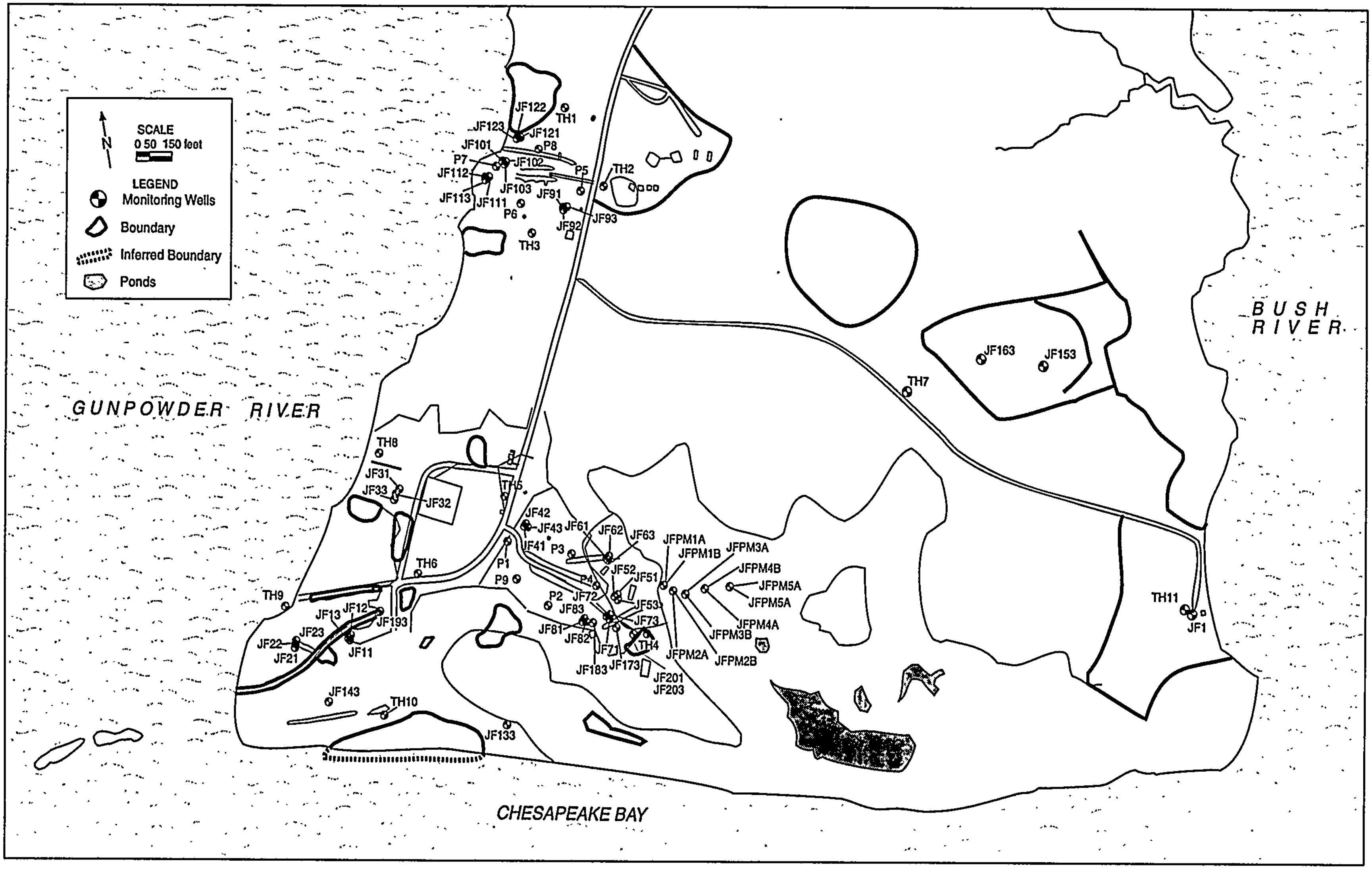


FIGURE 2.10 Monitoring Well Locations at J-Field

2.5.1 Surficial Aquifer

The surficial aquifer (Unit C) consists of interbedded sand and clay and corresponds to the surface unit of the Quaternary (Talbot Formation, Columbia Group) sediment; it ranges from 25 to 40 ft in thickness, with elevations following the surface topography. The steepest hydraulic gradients were found near the TBP and WPP. Because the closest pumping of this aquifer is about 4 mi to the west (across the Gunpowder River), the pumping does not affect the groundwater flow system. The major influences on the flow system at J-Field are recharge, evapotranspiration, and tidal fluctuations. The vadose zone ranges from the surface at the edges of the marshes and rivers to as much as 7 ft deep on the uplands during the dry season. Recharge is mainly through rainfall, and the system discharges into the marshes and Chesapeake Bay. Some recharge from Chesapeake Bay may occur during droughts (Hughes 1993). Figure 2.9 shows the general direction of groundwater flow in the surficial aquifer. The hydraulic conductivity of Unit C, as measured in slug tests, ranges between 0.29 and 1.04 ft/d, with a median value of 0.69 ft/d (Table 2.1) (Hughes 1993).

TABLE 2.1 Results of Slug Tests

				Hydraulic Conductivity	
Hydrologic Unit	Well No.	Length of Screen (ft)	Screen Opening (in.)	Hvorslev Method (ft/d)	Cooper Method (ft/d)
Surficial aquifer	JF3	5	0.001	0.70	1.04
	JF93	5	0.01	0.29	-[a]
	JF113	3	0.01	0.69	0.58
Confining unit	JF32	5	0.001	0.05	0.09
	JF42	5	0.06	<0.01	0.02
	JF92	5	0.06	0.20	-[a]
Confined aquifer	JF31	5	0.001	13.6	51.8
	JF41	5	0.01	272	932
	JF91	5	0.001	3.16	7.41
	JF111	5	0.01	111	508
Patapsco Formation	JF2	5	0.01	0.61	0.06

[a] Measurement could not be determined.

Source: Hughes (1993).

Several pump tests have been conducted at the TBP AOC at several sets of nearby monitoring wells. The pump well (JF183 in Figure 2.10), was installed in a 13 5/8-in. borehole in 1994 specifically for use in pump testing. The well is screened from 13 to 39 ft below ground surface (Quinn 1995). This screened interval extends across the entire saturated thickness of the surficial aquifer, which at this well consists of silty fine- and medium-grained sand interbedded with clay. Each test was performed by using this pump well and various monitoring wells. An initial pump test of this well that took place in December 1994 determined that the well yield is approximately 1 gallon per minute (gpm). The test was conducted at this pump rate for 72 hours and indicated hydraulic conductivity values in the range of 4.2 to 6.2 ft/d (Quinn 1995). A second pump test was performed in November 1996 to evaluate the performance of the aquifer when a higher pumping rate than that used in the first test was used. A rate of 1.6 gpm was maintained for most of a 75-hour period, and hydraulic conductivity values in the range of 2.1 to 9.9 ft/d were calculated (Quinn 1997). A month-long pumping event took place in June 1997 to check the changing concentrations of contaminants in the aquifer. During the test, water-level data were collected from a larger set of monitoring points than in the prior tests. Pumping during the first 10 days was approximately 1.2 gpm. The results suggest a range in hydraulic conductivity of 2.3 to 11.3 ft/d (Quinn 1997). Drawdown data collected over the month of June were useful in determining a high permeability trend in the surficial aquifer, from west-northwest to east-southeast in the vicinity of the pump well. These data support a sedimentological model of a river-mouth sand bar in the TBP AOC, as proposed by Yuen and Biang (1996). This conceptual model of the stratigraphic framework has application in explaining and predicting contaminant distributions at the site.

A general downward gradient that occurs between the water table and the confined aquifer indicates that the confined aquifer is recharged primarily by the surficial aquifer (Hughes 1993). During the summer, the direction of vertical flow is reversed at some locations. Groundwater under the marsh and rivers, which are discharge areas, probably leaks upward from the confined aquifer and the leaky confining unit into the surficial aquifer.

Hand-driven piezometers were installed in the marsh east of the TBP AOC by the USGS to investigate groundwater flow near the boundary between the marsh sediments and the surficial aquifer (Figure 2.5). These piezometers, the JFPM series, were installed as five pairs, each with a deeper piezometer ("A") and a shallower piezometer ("B"). The screen length for each piezometer is 1.5 ft. Water-level data collected by the USGS from 1994 to 1997 indicate seasonal reversals in the vertical groundwater gradient. For example, in a wet springtime, the heads in the piezometers indicate an upward gradient (Figure 2.11), as recharge on the upland infiltrates the surficial aquifer and discharges to the marsh. In dry summer and fall periods, a downward gradient is present along the transverse (Figure 2.11), as recharge decreases because of the increased evapotranspiration on the upland. Because the water table is lower in the summer, the groundwater flow direction may change near the marsh. Recent USGS data (Phelan 1998) indicate that the surficial aquifer near the marsh is recharged by the marsh during dry periods. The net result of the flow reversals is that

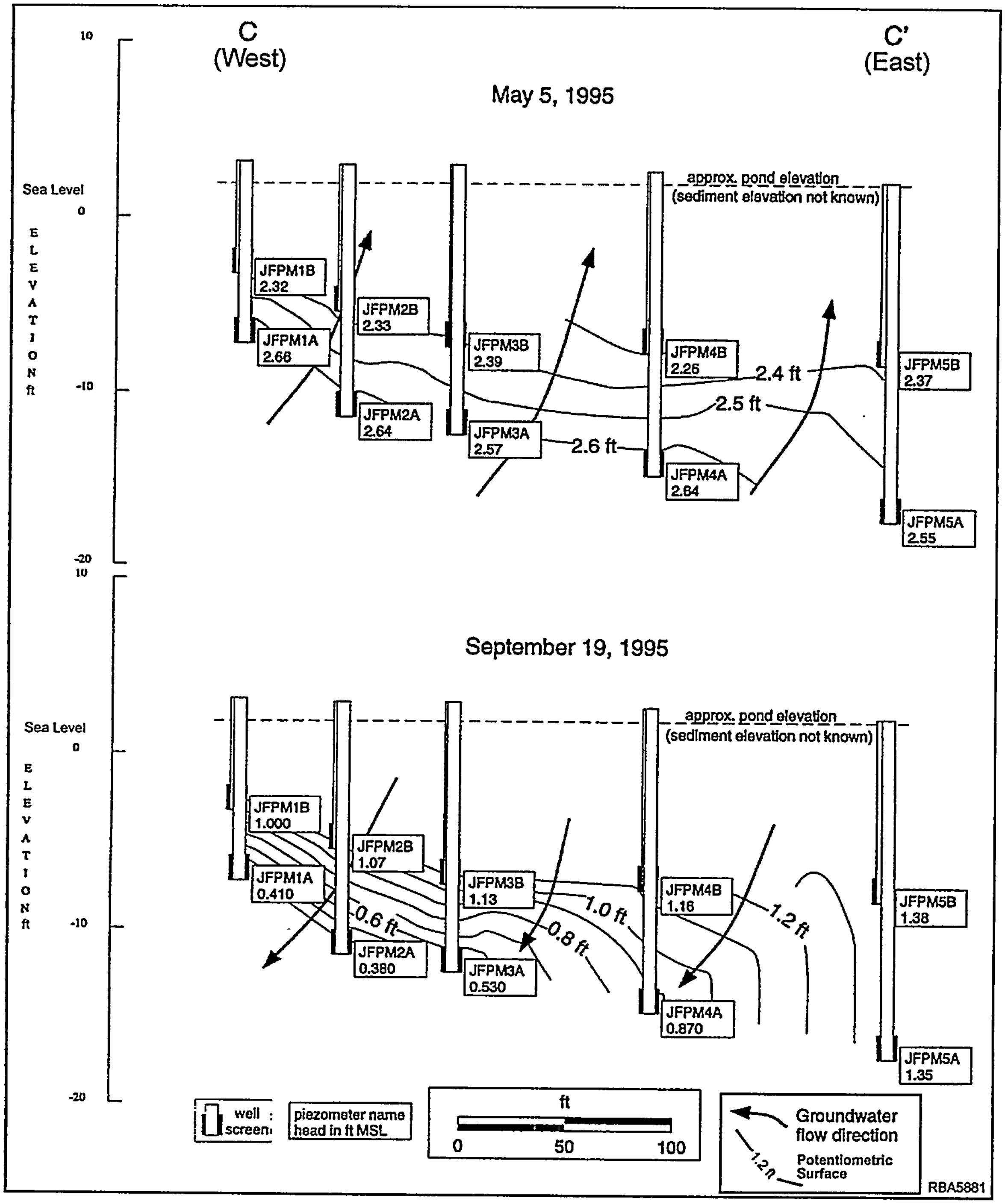


FIGURE 2.11 Seasonal Changes in Groundwater Flow below the Marsh

groundwater has a longer residence time in the biologically active marsh sediments than if the flow system were continuously in one direction. The upward and downward movement of groundwater beneath the marsh is expected to increase the effects of natural attenuation on VOCs before their discharge to surface water. When the water level data were integrated over several years, a vertically upward gradient was found to prevail.

2.5.2 Leaky Confining Unit

The leaky confining unit (Unit B) consists of silty, sandy clay and organic matter and corresponds to the middle unit of the Quaternary (Talbot Formation) sediments. Vertical leakage from this unit to the underlying confined aquifer occurs at all sites beneath J-Field but is probably quite limited offshore. The direction of vertical flow may be reversed in some offshore areas (Hughes 1993).

Lateral flow in the leaky confining unit is generally in the same directions as that of the surficial aquifer (Figure 2.9). In the western part of J-Field, the unit is 40 ft thick, with a surface elevation 25 ft below mean sea level (MSL). In the eastern portion of J-Field, the unit is 107 ft thick and has a surface elevation 35 ft below MSL. Hydraulic conductivities, as measured in slug tests, range from less than 0.01 to 0.20 ft/d, with a median value of 0.05 ft/d (Table 2.1) (Hughes 1993).

2.5.3 Confined Aquifer

The confined aquifer (Unit A) consists of gravelly sand and clay and corresponds to the base unit of the Quaternary (Talbot Formation) sediments. In the western part of J-Field, the top of the confined aquifer is 60 ft below MSL, and the unit is 50 ft thick. In the southeastern part of J-Field, this aquifer dips to a surface elevation of 142 ft below MSL and decreases to 15 ft in thickness (Hughes 1993). Flow in the confined aquifer has been thought to be radial from the J-Field peninsula under low horizontal hydraulic gradients (Hughes 1993). Because of diurnal tidal loading in the confined aquifers (Hughes 1993), hand measurements of water levels of confined aquifer wells are of limited use. Therefore, continuous recorder data collected from seven confined aquifer wells during the 1993 water year were analyzed to provide a more accurate picture of the overall head distribution (Quinn et al. 1996). The calculated average heads (Quinn et al. 1996) confirm radial flow of the groundwater in the confined aquifer. Because the timing and magnitude of the tidal loading effect are independent of position relative to the J-Field shore, it is assumed the tidal loading has no impact on the lateral groundwater flow within the confined aquifer.

Groundwater flows away from the TBP toward the marshes and Chesapeake Bay. During the summer, the flow direction of the confined aquifer exhibits short periods of seasonal variation (Hughes 1993). Where the paleochannel extends beneath the Chesapeake Bay, groundwater probably discharges upward to the bay (Hughes 1993; Powars 1997). The rate of discharge is most likely minimal because of the low hydraulic conductivity of the overlying confining unit and the low vertical head gradient across the confining unit (Hughes 1993). The degree of connection between the confined aquifer and any permeable portions of the Cretaceous units along the paleochannel wall has not been established.

Confined aquifer wells in the TBP area include JF51, JF61, JF71, and JF81; however, an inspection of the well construction and stratigraphy presented in Hughes (1993) indicates that only well JF81 is screened in the permeable confined aquifer sediments. The other three wells are completed in interlayered clay, sand, silt, or organic matter. Well JF81 yields water during sampling, but the other three typically purge dry.

2.5.4 Potomac Group Aquifer

The Potomac Group aquifer consists of interbedded, fine-grained sand and massive clay. This aquifer corresponds to the Cretaceous (Patapsco Formation, Potomac Group) sediments of fluvial origin. Surface elevations of the Potomac Group aquifer range from 105 ft below MSL in the eastern part of J-Field to 157 ft below MSL in the western part. The thickness of the aquifer is, in general, uncertain but may be up to 800 ft. The sediments are underlain by metamorphic bedrock. Insufficient data are available to determine lateral or vertical flow directions or the effects of the seasons and tides on the Potomac Group aquifer (Hughes 1993).

2.6 LAND USE AND DEMOGRAPHY

Current land use in the vicinity of J-Field is restricted to military operations, primarily munitions testing and destruction. Land access to the site is strictly controlled by a security station located between the main portion of the Edgewood Area and the southern part of the Gunpowder Neck Peninsula. Public access to J-Field by water is prohibited. No people live at the lower end of the peninsula; only authorized military personnel and government contractors conduct day-use activities at the site. Hunting is not allowed at the site. Other than contractor trailers and small structures providing shelter for site communications, no permanent structures are now used at J-Field. Permanent day-use facilities, consisting of laboratories, storage areas, and military training facilities, begin approximately 2 mi north of J-Field. Approximately 5 mi north of J-Field are barracks housing U.S. Army personnel stationed at the Edgewood Area of APG. The closest civilian habitation to J-Field is approximately 5 mi west, across the mouth of the Gunpowder River and beyond the APG boundary.

2.7 ECOLOGY

APG is located within the northern portion of the Middle Atlantic Coastal Plain ecoregion, which extends from southern New Jersey to eastern Georgia (Omernik and Gallant 1989). The predominant land uses in the ecoregion are woodland and forest. The low elevations and relatively flat topography of the Atlantic Coastal Plain support the development of extensive tidal marshes and wet-mesic forest.

Tidal marshes occur along most of the eastern and southern shorelines of J-Field and intermittently along the Gunpowder River shoreline. These marshes are primarily dominated by common reed and cattail, with associates commonly including false nettle, sensitive fern, Olney-threesquare, and rose-mallow. Woody species found frequently along the upland margins include wax myrtle and groundsel bush. The southern shoreline includes a natural berm vegetated by common reed. Only extreme high tides rise above the berm, thus enabling the development of a freshwater pond. An unusual aspect of this pond is the presence of floating mats of common reed along the periphery. These mats are formed by the plants' intertwining rhizomes.

The majority of J-Field is forested. Drier upland areas support occasional stands of tulip trees or mixed deciduous hardwoods, including Spanish oak, hickory, and scarlet oak, with an open understory. Persimmon, black locust, and black cherry also occur frequently throughout much of the forested areas, along with holly, Japanese honeysuckle, and Virginia creeper. Lower elevations, including forested wetlands, support extensive areas dominated by sweetgum and red maple, with willow oak, black gum, swamp chestnut oak, and sycamore frequently dominating wetter sites. The understory is frequently open, with greenbrier and highbush blueberry increasing into lower and wetter areas. Seasonal forested wetlands are scattered throughout J-Field and range from small crater-like depressions (many with 2- to 3-ft water depths) to large tracts of several acres with relatively shallow water depths. These wetlands are primarily sites of groundwater discharge with little surface flow. A large forested and scrub-shrub wetland is located in the central portion of J-Field, extending from the Gunpowder River on the west to the tidal marsh along the Chesapeake Bay on the east. Surface water in this wetland flows in an east-to-west direction.

Open old-field areas are uncommon at J-Field. These sites include the areas around the WPP, TBP, and PB. Such areas are infrequently mowed and are vegetated with upland grasses and forbs, including broom sedge, velvet grass, purple-top grass, sweet vernal grass, switchgrass, gama grass, and bracted plantain. The RPDG, in the southeastern area of J-Field, is a large, disturbed area, most of which is sparsely vegetated. Peripheral areas of the RPDG support herbaceous vegetation, including grasses, rushes, and sedges. A large emergent wetland has formed at the eastern side of the RPDG as a result of a berm constructed between the RPDG and the tidal marsh.

Wildlife species at J-Field include the bald eagle (a designated federal threatened species), osprey (several nesting pairs), white-tailed deer, red fox, and flying squirrel. Eastern box turtles and black racers are common in the forested areas throughout J-Field. The many reptile and amphibian species that use the seasonal wetlands as breeding sites include spotted turtle, painted turtle, snapping turtle, and red-spotted newt. Waterfowl also commonly forage in these wetlands. More information on flora and fauna at J-Field is given in the ecological risk assessment (RI Volume 3) (Hlohowskyj et al. 1999).

3 TECHNICAL APPROACH

The technical approach used for the J-Field RI was consistent with the approach used for other APG sites, as specified by ICF Kaiser Engineers (1995). In general, data gathered during the RI were used to support the human health and ecological risk assessments, which, in turn, will be used as the basis for future remediation decisions at J-Field. Data collection for the RI, therefore, was designed to meet the requirements of the data quality objectives of both risk assessments as well as to meet the requirements provided by the EPA (1988). The sampling and analytical procedures used in this investigation are specified in the RI Field Sampling Plan (FSP) (Benioff et al. 1995b) and Quality Assurance Project Plan (QAPjP) (Prasad et al. 1995). These documents were prepared in accordance with the APG Generic Work Plan for the CERCLA Remedial Investigation/Feasibility Study (U.S. Army Corps of Engineers 1992).

Because of the logistical complexities of conducting fieldwork at J-Field, Argonne developed a phased investigation strategy (Yuen et al. 1995). The first phase of investigation, Phase I, took place at the TBP AOC, the most contaminated site at J-Field. The purpose of Phase I was to generate characterization data in an accelerated manner so that a remedial strategy for the TBP AOC could be developed early in the RI/FS process. In addition, Phase I activities helped investigators learn more about the logistics of working at J-Field (e.g., gaining access to the site and coordinating with support personnel, such as the Technical Escort Unit for unexploded ordnance [UXO] clearance and subcontractors for chemical agent monitoring) and identify the best investigative tools for the site.

Phase I took place in two stages (Stage I and Stage II). Stage I consisted of aerial photographic interpretation, geophysical surveys, passive and active soil-gas sampling, and portable x-ray fluorescence (XRF) soil analysis. Stage II consisted of more direct sampling of all media of concern. During Phase I, investigative efforts were concentrated at the TBP AOC; fewer investigative activities were carried out at other AOCs and PAOCs during this time.

In Phase II, an effective investigative protocol was developed for each AOC and PAOC. Phase II also took place in two stages. Stage I consisted of field screening activities and limited sampling (in "hot spot" areas, if found). The results of the Stage I screening were used to determine whether a site required a more detailed investigation (Stage II).

With the exception of a few PAOCs, most contaminated sites at J-Field have been investigated through the Phase II, Stage II level of sampling. A detailed description of the results for each AOC and PAOC is presented in Appendix A. Section 5 provides a brief evaluation of the data results for each AOC and PAOC.

A main concern in conducting the RI was the potential health hazard caused by the volatile organic compound (VOC) contaminant vapor and chemical agents on-site. The VOC vapor issue was addressed through modeling by using on-site passive soil gas data (Section 3.1). Passive soil gas data were used because they reflect existing conditions at J-Field. The chemical agent issue was handled by applying a stringent field monitoring program when field sampling was conducted (Section 3.1), as specified in the J-Field Health and Safety Plan (Argonne National Laboratory [ANL] 1995).

One RI objective is to provide data to support the human health and ecological risk assessments. The data quality in the risk assessments may need to meet rigorous quality assurance and quality control (QA/QC) requirements. Section 3.2 presents the QA/QC results of RI field and laboratory activities. Figure 3.1 shows the role of the RI in the risk and impact assessment at APG (ICF Kaiser Engineers 1993). Figure 3.2 shows the ecological risk assessment (ERA) framework and identifies the components of the process that require RI results (see also Volume 3 of this report). Use of the RI results for the ERA is similar to use of them for the human health risk assessment.

The methodology used to evaluate the environmental data is described in Section 3.3. The evaluation determines whether a site was contaminated by (1) comparing the soil, surface water, and sediment data with regional background data collected by ICF Kaiser Engineers (1995) and (2) comparing the groundwater data with the maximum concentration levels (MCLs) of the Primary Drinking Water Regulations (40 CFR 141.6) and freshwater Ambient Water Quality Criteria (AWQC) (EPA 1991). The reference groundwater data collected by ICF Kaiser Engineers (Thebeau 1998) were not used for comparison because they are not representative of the local groundwater quality at J-Field.

3.1 CHEMICAL AGENT SCREENING AND AIR QUALITY

3.1.1 Chemical Agent Screening

Because of the potential presence of chemical agents at J-Field, investigation activities were monitored in two ways: (1) the fieldwork environment was monitored with near-real-time agent detection equipment, and (2) the Edgewood Research and Development and Engineering Center (ERDEC) analyzed solid media samples for agent before they were released for further handling.

As specified by the J-Field Health and Safety Plan (ANL 1995), the following activities required work space monitoring for agents: collecting Stage I sediment boring samples from the TBP marsh and installing Stage I and II borings in the former burning pits at the WPP, TBP, and RCP AOCs. During field activities, the work space was monitored by either the Technical Escort Unit or ERDEC. No agent was detected above 0.8 of the established threshold limit values (TLVs).

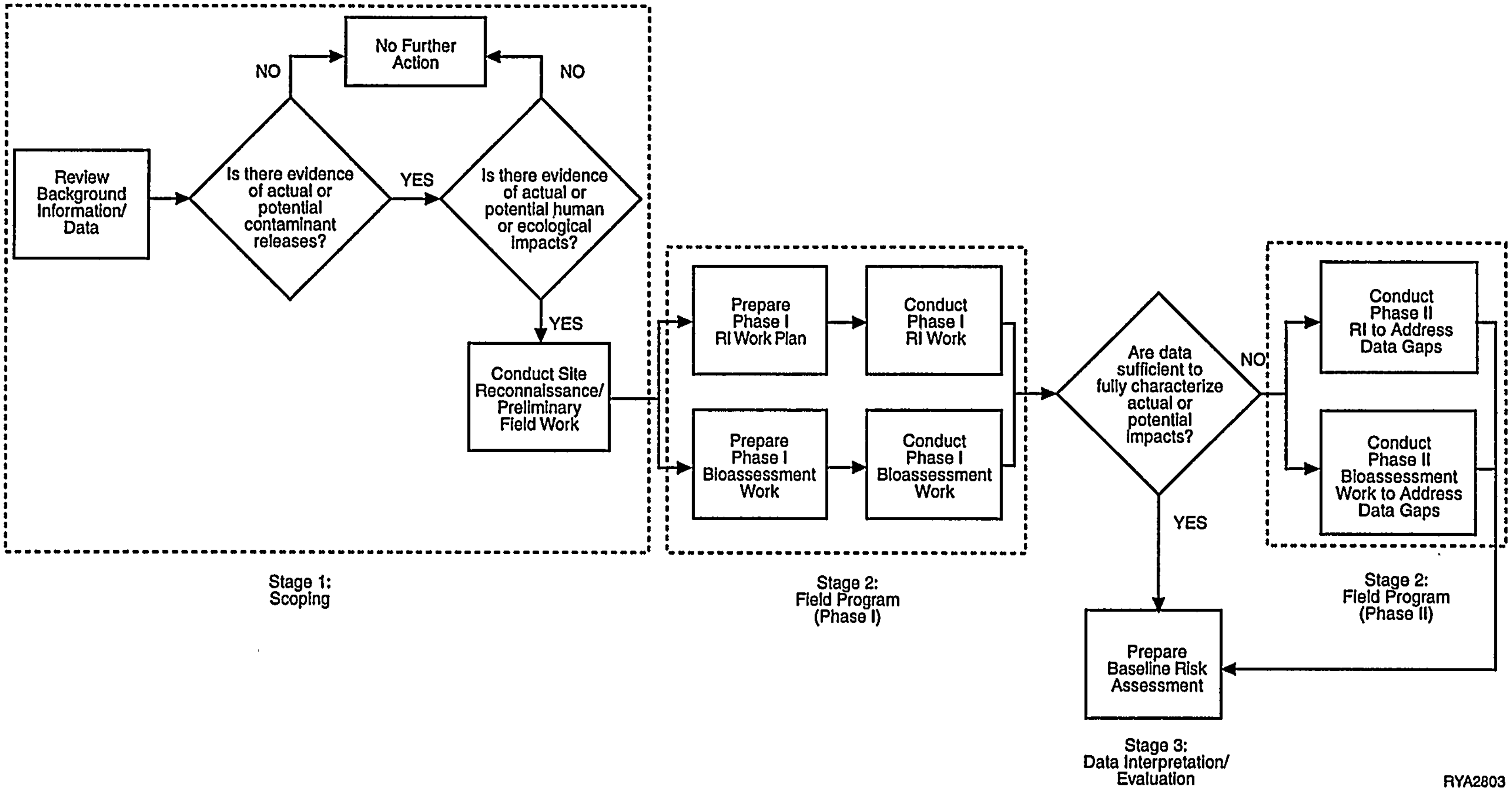


FIGURE 3.1 Overview of Proposed Approach to Risk and Impact Assessment at Aberdeen Proving Ground (Source: ICF Kaiser Engineers 1993)

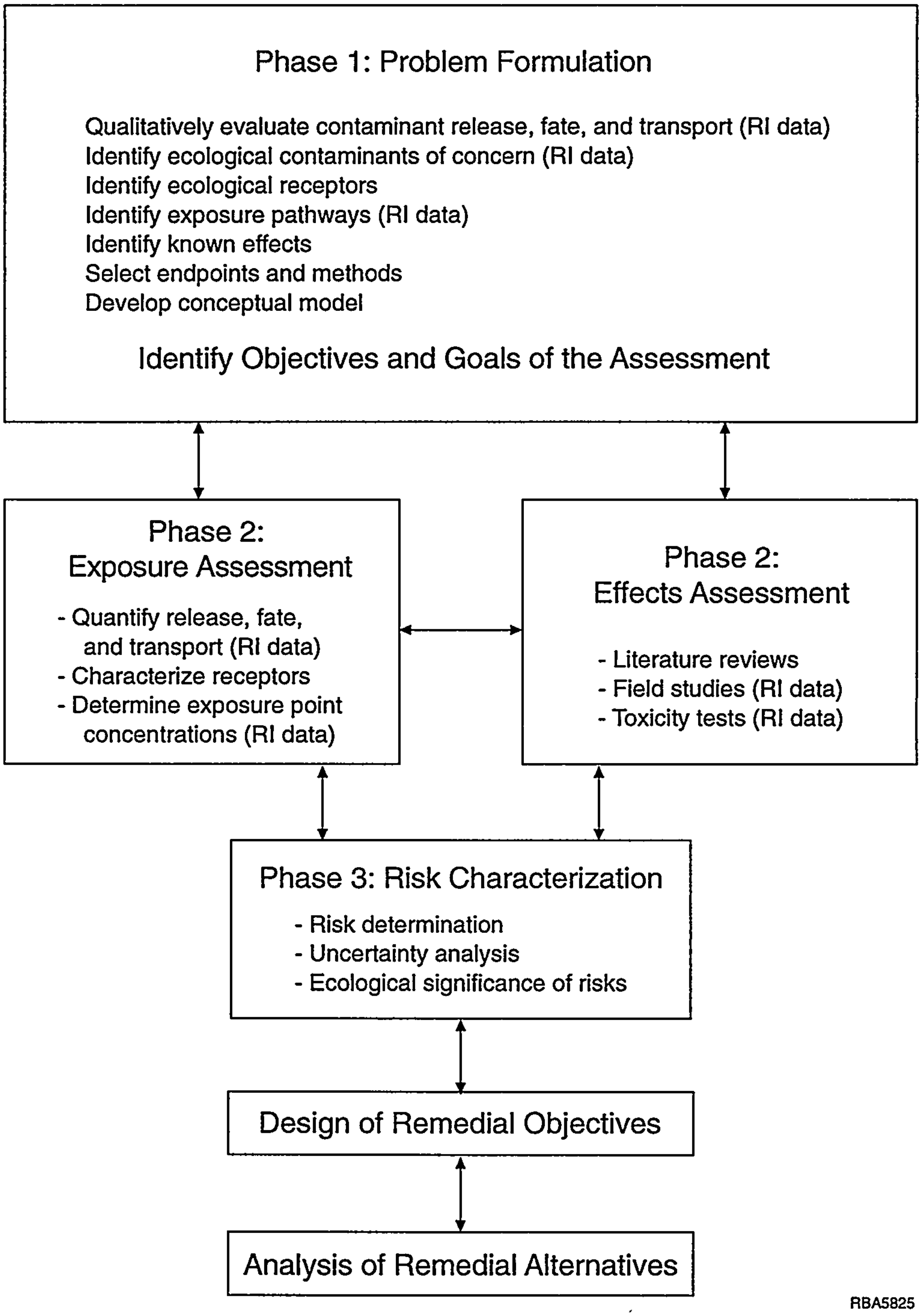


FIGURE 3.2 Framework for Conducting Ecological Risk Assessments (Source: EPA 1992)

As specified by the J-Field Health and Safety Plan (ANL 1995), the soil and sediment samples collected from the burning pits and Pushout Area and the soil and sediment samples collected at depths greater than 6 in. in all other areas were screened for agent before they were sent off-site for analyses. Solid media samples were screened by ERDEC according to the agent screening methodology detailed by SciTech (1992).

Approximately 200 solid media samples collected from J-Field were analyzed for agents as part of the RI. All the samples tested negative for agents and were therefore able to be analyzed by on-site or off-site laboratories, as specified in the FSP (Benioff et al. 1995b).

3.1.2 Air Quality

Rather than quantifying the air quality across the whole J-Field site, a surrogate site, the TBP AOC, was selected to represent the worst air quality scenario in evaluating the air quality at J-Field. A considerable amount of environmental data (including passive soil gas) have been collected in the TPB AOC, and existing data indicate that it is the most contaminated site at J-Field (see Section 4).

Air quality consists of two components: ambient levels of criteria pollutants (CPs) and toxic air pollutants (TAPs). J-Field, including the TBP AOC, is located in the Metropolitan Baltimore Intrastate Air Quality Control Region (Area III of the State of Maryland air quality control area). The State of Maryland Ambient Air Quality Standards are identical to the National Ambient Air Quality Standards (NAAQS) established for six CPs: sulfur oxides (SO_x), carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2), PM_{10} (particulate matter with an aerodynamic diameter of ≤ 10 μm), and lead (Pb). Harford County, where J-Field is located, is designated as an attainment area for all CPs except ozone (40 CFR 81.321).

Table 3.1 summarizes the CP concentrations at selected ambient air quality monitoring stations within the APG site and its vicinity in 1993. The concentrations of all CPs (except ozone) monitored around the APG are currently well below the applicable ambient standards. Potential CP-related emissions from the TBP AOC include PM_{10} due to wind erosion and VOCs due to soil gas volatilization into the atmosphere. Along with nitrogen oxides (NO_x) (NO plus NO_2), VOCs are a major component in tropospheric O_3 production. However, these emissions are expected to be minor because contaminated soils at the TBP AOC are mostly covered with vegetation or located in marsh areas. Consequently, CP-related emissions from the TBP AOC are not expected to contribute significantly to ambient air quality.

The Industrial Source Complex Model (EPA 1992) was used to evaluate the TAP emissions from contaminated soil at the TBP AOC, thus taking advantage of the passive soil gas data collected

TABLE 3.1 National and Maryland State Ambient Air Quality Standards and 1993 Air Quality Conditions in the Vicinity of Aberdeen Proving Ground

		NAAQS (mg/m^3)[a]		Ambient Air Quality Monitored near the Site	
Pollutant	Averaging Time	Primary	Secondary	Concentration[b] (mg/m^3)	Monitoring Location[c]
SO_2	Annual	80	–[d]	24	Fort Holabird
	24 hours	365	–	86	
	3 hours	–	1,300	162	
NO_2	Annual	100	100	40	Essex
CO	8 hours	10,000	10,000	5,000	Essex
	1 hour	40,000	40,000	8,000	
O_3	1 hour	235	235	314	Edgewood
PM_{10}	Annual	50	50	27	Essex
	24 hours	150	150	67	
Lead	Calendar quarter	1.5	1.5	0.025	I-95

[a] Maryland has adopted the NAAQS. The NAAQS, other than those for O_3 and PM_{10} and those based on annual averages, are not to be exceeded more than once per year. The O_3 standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is less than or equal to 1. The 24-hour PM_{10} standard is attained when the expected number of days per calendar year with a 24-hour average concentration above the standard is less than or equal to 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.

[b] Concentration levels other than annual averages are the maximum values observed.

[c] Edgewood, Essex, Fort Holabird, and I-95 are located about 7 mi north, 11 mi west-northwest, 12 mi west-southwest, and 14 mi west of J-Field, respectively.

[d] – = no standard exists.

Sources: 40 CFR 50; Code of Maryland Regulations (COMAR) 26.11.03; and Maryland Department of the Environment (MDE 1994a).

at the AOC. Input included passive soil gas data collected by ANL from the TBP AOC, meteorological data obtained from the Aberdeen Test Center from H-Field at APG, and the 1993 mixing height data at Sterling, Virginia. The model also assumed a 20- × 20-m pixel size, within which the emission rate is uniform and equal to the measured soil gas flux, as well as a flat terrain at the site. The soil gas emission flux, which was measured in February 1994 in the field, was assumed to be constant diurnally and seasonally.

Of the 33 VOCs on the Target Compound List (TCL) for the EPA Contract Laboratory Program (CLP) (EPA 1994), 19 were identified in the soil gas at the TBP AOC (Prasad and Martino 1994). Table 3.2 lists the estimated maximum concentrations of these VOCs, on the basis of the modeling results, around the TBP AOC and the APG site boundary. The concentrations estimated within and at the site boundary were to be used to assess potential health impacts to on-site workers and the general public, respectively. Table 3.2 also presents ratios of the estimated ambient concentrations to the American Conference of Governmental Industrial Hygienists TLVs (ACGIH 1994) and Maryland Department of the Environment screening levels (MDE 1994b). A ratio of greater than one means that the estimated concentration exceeds the respective TLV or MDE screening level. All ratios are well below one (by five orders of magnitude or more). The modeling results indicate that ambient volatile TAP concentrations around the TBP AOC and at the APG site boundary would be very low under current conditions.

Also identified in the soil were semivolatile organic compounds (SVOCs), such as hexachlorobenzene and polychlorinated biphenyls (PCBs); nonvolatile compounds, such as nitrite and sulfate; and metals, such as arsenic, cadmium, and lead (Benioff et al. 1995b) (see Section 4.1). The SVOCs have very low vapor pressures and do not easily volatilize under ambient conditions. Under current conditions, potential SVOC emissions in gaseous form are expected to be negligible. In addition, potential emissions of SVOCs, nonvolatile compounds, and metals embedded in particulate matter, which can be entrained into the atmosphere by wind erosion, are expected to be minor. Consequently, ambient concentrations of SVOCs, nonvolatiles, and metals at the TBP AOC and at the APG site boundary are expected to be negligible under current conditions.

3.2 QUALITY ASSURANCE AND CONTROL ACTIVITIES

QA and QC activities during the J-Field RI were consistent with procedures detailed in the J-Field QAPjP (Prasad et al. 1995). Such activities included field, office, and laboratory audits; review and validation of laboratory data; and evaluation of whether QA/QC objectives for measurement data were achieved.

TABLE 3.2 Estimated Maximum Ambient Concentrations of Selected EPA Target Compounds at the Toxic Burning Pits Area and the Site Boundary

	ACGIH TLV[a] (mg/m^3)		Estimated Maximum Concentration at TBP (mg/m^3)		Ratio of Estimated Maximum Concentration to TLV	
Compound Name	TWA[a]	STEL[a]	8-hour	1-hour	8-hour	1-hour
Acetone	1,780	2,380	1.45E-05	2.71E-05	8.16E-09	1.14E-08
Benzene	32		9.39E-07		2.93E-08	
Bromomethane	19		5.66E-06		2.98E-07	
2-Butanone	590	885	1.14E-06	2.02E-06	1.93E-09	2.28E-09
Carbon disulfide	31		5.20E-05		1.68E-06	
Chlorobenzene	46		1.76E-07		3.83E-09	
Chloroform	49		3.53E-06		7.20E-08	
Chloromethane	103	207	3.07E-05	5.58E-05	2.98E-07	2.69E-07
1,2-Dichloroethane	40		6.79E-07		1.70E-08	
1,1-Dichloroethene	20	79	2.12E-06	3.22E-06	1.06E-07	4.07E-08
1,2-Dichloroethene (total)	793		1.94E-05		2.45E-08	
Styrene	213	426	7.21E-07	1.32E-06	3.38E-09	3.10E-09
1,1,2,2-Tetrachloroethane	6.9		7.49E-05		1.09E-05	
Tetrachloroethene	170	685	1.31E-06	2.53E-06	7.71E-09	3.69E-09
Toluene	188		5.00E-06		2.66E-08	
1,1,1-Trichloroethane	1,910	2,460	1.74E-06	3.07E-06	9.10E-10	1.25E-09
1,1,2-Trichloroethane	55		3.20E-06		5.81E-08	
Trichloroethene	269	537	7.98E-05	1.44E-04	2.97E-07	2.67E-07
Xylene (total)	434	651	3.13E-07	5.79E-07	7.21E-10	8.89E-10

TABLE 3.2 (Cont.)

	Maryland Department of the Environment Screening Level[b] (µg/m^3)			Estimated Maximum Concentration at APG Boundary (µg/m^3)			Ratio of Estimated Maximum Concentration to MDE Screening Level		
Compound Name	8-hour	1-hour	Annual	8-hour	1-hour	Annual	8-hour	1-hour	Annual
Acetone	17,800	23,800		7.15E-04	2.62E-03		7.15E-04	2.62E-03	
Benzene	320		1.21	5.99E-05		2.60E-07	5.99E-05		2.60E-07
Bromomethane	190			3.03E-05			3.03E-05		
2-Butanone	5,900	8,850		8.22E-06	3.01E-05		8.22E-06	3.01E-05	
Carbon disulfide	310			1.90E-03			1.90E-03		
Chlorobenzene	460			1.70E-06			1.70E-06		
Chloroform	490		0.435	3.41E-05		1.30E-07	3.41E-05		1.30E-07
Chloromethane	105	525	5.55	5.98E-04	2.01E-03	2.65E-06	5.98E-04	2.01E-03	2.65E-06
1,2-Dichloroethane	400		0.385	5.61E-06		2.00E-08	5.61E-06		2.00E-08
1,1-Dichloroethene	200	790	0.2	3.92E-06	2.55E-05	3.00E-08	3.92E-06	2.55E-05	3.00E-08
1,2-Dichloroethene (total)	7,930			2.17E-04			2.17E-04		
Styrene	2,130	4,260		5.35E-06	1.95E-05		5.35E-06	1.95E-05	
1,1,2,2-Tetrachloroethane	69		0.1724	7.54E-04		2.84E-06	7.54E-04		2.84E-06
Tetrachloroethene	1,700	6,850	17.24	4.07E-05	1.85E-04	1.60E-07	4.07E-05	1.85E-04	1.60E-07
Toluene	1,880			8.47E-05			8.47E-05		
1,1,1-Trichloroethane	19,100	24,600		3.39E-05	1.54E-04		3.39E-05	1.54E-04	
1,1,2-Trichloroethane	550		0.625	4.36E-05		1.70E-07	4.36E-05		1.70E-07
Trichloroethene	2,690	5,370	5.83	9.36E-04	3.63E-03	3.65E-06	9.36E-04	3.63E-03	3.65E-06
Xylene (total)	4,340	6,510		8.26E-06	3.10E-05		8.26E-06	3.10E-05	

[a] Notation: TLV = threshold limit value; TWA = time-weighted average; STEL = short-term exposure limit. Source: ACGIH (1994).

[b] Source: MDE (1994b).

3.2.1 Field and Laboratory Audits

System and performance audits were conducted for field and laboratory activities during the RI. The QAPjP specifies that at least one system audit and one performance audit must be conducted during field sampling and laboratory testing activities. However, because of the wide diversity of field and laboratory activities associated with the RI and because four analytical laboratories and three toxicity testing laboratories were used, ANL elected to conduct additional performance audits.

The system audits, conducted at the beginning of the RI, evaluated all components of the measurement systems established by the RI/FS project. The system audit evaluated project staff responsibilities, personnel expertise and experience, the project filing/index system, and the availability and knowledge of standard operating procedures and the QAPjP.

3.2.1.1 Field Audits

ANL conducted five performance audits of field activities, as described by Benioff et al. (1995b). The system audit categories included soil and groundwater sampling, piezometer sampling, geophysical survey activities, and a pump test. In general, the five audit reports did not find any "nonconformance" as defined in the QAPjP. However, the field audit of May 5, 1994, specified that soil sample storage areas must be separate from the sample processing area to preclude potential cross-contamination of stored samples. The deficiency was corrected by installing a refrigerator for storing samples.

ANL also conducted five performance audits of field sampling activities related to the ERA, as described by Hlohowskyj et al. (1999). The system audit categories included surface water, sediment, and soil sampling; macroinvertebrate survey; and fish diversity survey. The audit reports did not find any "nonconformance" as defined in the QAPjP.

A U.S. EPA Region 3 contractor also conducted two performance audits of field sampling activities (groundwater) in the fall of 1997 and winter of 1998. No nonconformances were identified as a result of these two audits.

3.2.1.2 Laboratory Audits

Both an ANL-operated on-site analytical laboratory and off-site analytical laboratories were used during the RI. In general, the laboratory audit efforts focused on the off-site laboratories, which used EPA CLP and AEC analytical methods for results determined to be critical to site characterization and risk assessment.

System, performance, and method-specific audits were performed at two of the three primary analytical laboratories and the two primary ecotoxicology laboratories. The third primary analytical laboratory and the referee laboratory participate in a QA/QC program administered by ANL's Analytical Chemistry Laboratory. Audit categories included an assessment of the following items: laboratory chain of custody, internal sample tracking, compliance with established procedures, analytical data documentation, instrument calibration, QA/QC protocols, inspection of the quarterly EPA Performance Evaluation audit reports, and data reporting. However, ANL made no attempt to audit the laboratories that generated the archival analytical data.

3.2.2 Data Review and Validation

3.2.2.1 Archival Analytical Data

Past investigations at J-Field provided a considerable amount of archival analytical data. All of the archival analytical data were taken into consideration as part of the RI process. For example, archival analytical data were used:

- To prioritize AOCs for investigative efforts,

- As an aid in identifying constituents of potential concern, and

- To assist in identifying data gaps and prospective sample locations in the FSP.

Where appropriate, archival analytical data have been incorporated into this report. However, because the archival analytical data were not collected or analyzed under the QAPjP and ANL could not reconstruct the "paper trail" for these data (i.e., field logbooks, data packages from analytical laboratories), the archival analytical data did not undergo a quality review.

3.2.2.2 Analytical Data Generated by Field Screening and the On-Site Laboratory

Field screening data, such as active and passive soil gas surveys and in situ XRF, are qualitative in nature. They are subject to less rigorous QC procedures than the data generated by off-site laboratories. All field screening data were acquired according to the standard operating procedures specified in the QAPjP. The procedures followed recommendations provided by equipment manufacturers. The XRF equipment was calibrated daily before being used in the field. The off-site laboratory that analyzed the passive soil gas samples has its own QA program. However, ANL did not audit that laboratory. The data are Level I or Level II as defined by the EPA (1987).

Both an ANL-operated on-site analytical laboratory and off-site analytical laboratories were used to analyze samples collected during the RI. The on-site analytical laboratory data were Level I, II, or III data as defined by the EPA (1987). In general, samples collected by ANL and analyzed by the on-site laboratory have a prefix "O" in the sample name. In some cases, samples that do not have the "O" prefix in their names were analyzed by both the on-site laboratory (for parameters such as explosives, petroleum hydrocarbons, PCBs, and polynuclear aromatic hydrocarbons [PAHs]) and an off-site laboratory (for parameters such as Target Analyte List [TAL] metals and TCL organics).

The Level I, II, and III data developed by the on-site analytical laboratory were used in preparing this report. The accuracy of field and on-site laboratory measurements was ensured by rigorous adherence to the standard operating procedures developed as part of the QAPjP. Analytical data generated by the on-site laboratory did not undergo a rigorous quality review. However, records of raw data derived from on-site measurements were subject to a field records audit. Data recorded in separate logbooks were reviewed. Data review consisted of spot checking at least 10% of the sample data packages and checking the data packages for completeness. Minimal spot checking of calculations was also performed.

The screening data and the on-site laboratory data were used to identify potential "hot spots," identify data gaps, and guide later sampling events with more rigorous QC. This effort would expedite the investigation.

3.2.2.3 Analytical Data Generated by Off-Site Laboratories

The analytical data collected by ANL and analyzed in off-site analytical laboratories are Level IV and V data (EPA 1987). The Level IV and V data have undergone a quality review as specified in the QAPjP. Data packages were reviewed to ensure compliance with specified analytical, QA, and data reduction procedures and data-reporting requirements. The following items were reviewed to validate the data:

- Sample holding times;
- Documentation that the analytical results were controlled and within a certified (linear) range of the analysis;
- Qualitative and quantitative data used in determining the presence and concentration of the target compounds;
- Calibration data associated with specific methods and instruments;
- Routine instrument checks (calibration, control samples, etc.);

- Documentation on traceability of instrument standards, samples, and data;
- Documentation on analytical methodology and QC methodology;
- Potential presence of interferences in analytical methods (check of reference blanks and spike recoveries);
- Documentation of routine maintenance activities to ensure analytical reliability; and
- Documentation of sample preservation and transport.

Case narratives produced by the off-site laboratories working under the QAPjP were reviewed as part of the data validation process. In addition, all sample data from off-site analytical laboratories were reviewed for key items, including sample holding times, documentation of sample preservation, and any other items highlighted in the relevant case narrative.

Data review also included a complete check of at least 10%, but not more than 40%, of the data packages for the key items bulleted above. Problem areas and deviations from QA protocols that were not addressed in case narratives were flagged. These flags were entered in the J-Field database. Both laboratory-generated data flags and Argonne's "secondary" flags appear in the database and can readily be distinguished. These flags will help human health and ecological risk assessors in doing the assessments.

3.2.3 Data Quality Evaluation

The analytical results have been assessed for the following parameters (known as PARCC parameters): precision, accuracy, representativeness, completeness, and comparability. These parameters were established in the QAPjP to ensure that data collected during the RI meet desired data quality objectives.

3.2.3.1 Precision

Precision measures the reproducibility of measurements under a given set of circumstances, including established protocols for field sampling and laboratory analyses. Precision is expressed in terms of the relative percent difference (RPD), which is estimated by the following mathematical expression:

$$RPD = (XA - XB)/XM \times 100 \, ,$$

where *XA* and *XB* are duplicate analyses and *XM* is the mean value of the duplicate analyses. The overall precision of measurement data for J-Field is a mixture of sampling and analytical factors. In general, precision was evaluated by assessing the RPD for sample duplicates. Levels of 65% precision (i.e., RPD≤35%) for water samples and 50% (i.e., RPD≤50%) for soil and sediment were established as a goal for a review of the RI/FS. RPD values greater than the values established for the review would be considered to have poor precision and be indicative of poor sampling techniques, improper handling, a heterogeneous sample matrix, or poor laboratory performance (EPA 1996).

3.2.3.1.1 Laboratory Precision. The analytical laboratory conducting the analyses evaluated analytical precision through the use of laboratory-generated duplicates. For organic parameters, a matrix spike and a matrix spike duplicate were analyzed. For inorganic parameters, sample duplicates were analyzed. The analytical laboratory flagged any data sets with duplicate analyses that did not meet control limits. A subset of the data packages was reviewed for criteria such as analytical precision, and "secondary" project QC flags may have been used to highlight results for which duplicate analyses did not meet control limits. These flags appear in the J-Field database under the field name "qc_flags."

3.2.3.1.2 Interlaboratory Precision. Interlaboratory precision was assessed by evaluating the primary analytical laboratory's performance against that of a referee laboratory. Five pairs of groundwater samples were analyzed by the primary laboratory and the referee laboratory for TCL VOCs. Interlaboratory precision was evaluated by calculating the RPD for analytes from each sample pair. An RPD was not calculated for parameters not detected in both samples in the pair.

The RPD review criterion was not achieved by a number of analytes in three of the sample pairs. However, a large majority of the analytes in each pair did achieve the RPD review criterion or the analytes were not detected by both laboratories (Table 3.3).

3.2.3.1.3 Field Sampling Precision. Field sampling precision was assessed by evaluating duplicate samples collected in the field. Typically, field duplicates were submitted to the analytical laboratory as "blind" sample duplicates. In general, ANL collected a minimum of 1 duplicate sample for every 10 samples of each environmental medium. For the analytical results received and incorporated into the database (as of May 29, 1998), 40 pairs of soil samples, 7 pairs of sediment samples, 4 pairs of surface water samples, and 11 pairs of groundwater samples were used to gauge sampling precision.

Field sampling precision was evaluated by calculating the RPD for analytes common to each sample pair. An RPD was not calculated for analytes not detected in both samples in the pair.

TABLE 3.3 Interlaboratory Duplicate Groundwater Sample Summary

	Volatile Organics (30)[a]	
Sample Pair	RPD<35%[b]	RPD>35%[b]
1	0	0
2	4	3
3	2	1
4	3	3
5	0	0

[a] Denotes number of analytes in the analytical group.

[b] Denotes number of parameters in the pair with the relative percent differences noted. Does not include parameters "not detected" for both samples in the pair.

The results of the RPD evaluation for groundwater, surface water, sediment, and soil sample duplicates are summarized in Tables 3.4 through 3.7. The poorest field sampling precision was associated with metals analyses for a few of the surface water and soil sample duplicates. In general, for the majority of the analytes within each pair, the RPD review criterion was achieved, or the analytes were not detected.

Failure to achieve the RPD review goal for all analytes common to each sample in the pair was probably a result of the heterogeneity inherent in the environmental media samples. Because, in the majority of cases, the RPD review goal was achieved for most of the analytes from each sample pair or the analytes were not detected in both samples in the pair, it has been determined that sampling precision has not had a negative impact on data quality.

3.2.3.2 Sampling Accuracy

Sampling accuracy was assessed by evaluating field blanks, including field rinsate, filter, and trip blanks. Data from these blanks assisted in determining whether contamination was introduced during sampling.

TABLE 3.4 Duplicate Summary Table for Groundwater Sample Duplicates[a]

Duplicate Number	General Chemistry (16)[b]		Volatile Organics (35)		SVOCs (64)		Metals, Dissolved (23)	
	RPD<35%[c]	RPD>35[c]	RPD<35%	RPD>35%	RPD<35%	RPD>35	RPD<35%	RPD>35
1	5	1	0	0				
2	6	1	0	0				
3	7	1	5	2	0	1	9	1
4			4	0				
5			0	0				
6			0	1				
7					0	0		
8			3	1				
9			1	0				
10			1	0				
11			0	3				

TABLE 3.4 (Cont.)

Duplicate Number	Metals, Total (23)		CSM-Related Compounds (12)[d]		Explosives-Related Compounds (16)	
	RPD<35%	RPD>35	RPD<35%	RPD>35	RPD<35%	RPD>35
1						
2						
3	11	1	0	1		
4						
5						
6			0	0	0	0
7						
8	13	0	3	0		
9	8	3				
10	7	1				
11						

[a] Notation: blanks denote no analysis.

[b] Denotes number of parameters analyzed in each respective analytical group.

[c] Denotes number of parameters in the pair with relative percent difference value noted. Does not include parameters "not detected" for both samples in the pair.

[d] CSM = chemical surety material.

TABLE 3.5 Duplicate Summary Table for Surface Water Sample Duplicates

	General Chemistry (16)[a]		Volatile Organics (35)		SVOCs (64)		Pesticides (28)	
Duplicate Number	RPD<35%[b]	RPD>35[b]	RPD<35%	RPD>35	RPD<35%	RPD>35	RPD<35%	RPD>35
1	5	3	0	6				
2			8	1	0	0	0	0
3			2	0				
4			4	0				

	Metals, Total (23)		CSM-Related Compounds (12)[c]		Explosives-Related Compounds (16)	
Duplicate Number	RPD<35%	RPD>35	RPD<35%	RPD>35	RPD<35%	RPD>35
1	5	12			0	1
2						
3						
4	9	8	0	0	0	0

[a] Denotes number of parameters analyzed in each respective analytical group.

[b] Denotes number of parameters in the pair with relative percent difference value noted. Does not include parameters "not detected" for both samples in the pair.

[c] CSM = chemical surety material.

TABLE 3.6 Duplicate Summary Table for Sediment Sample Duplicates

Duplicate Number	General Chemistry (16)[a]		Volatile Organics (35)		SVOCs (64)		Cyanide (1)	
	RPD<35%[b]	RPD>35[b]	RPD<35%	RPD>35	RPD<35%	RPD>35	RPD<35%	RPD>35
1					0	0		
2					1	0		
3								
4								
5							1	
6								
7								

Duplicate Number	Metals, Total (23)		CSM-Related Compounds (12)[c]		Explosives-Related Compounds (16)	
	RPD<35%	RPD>35	RPD<35%	RPD>35	RPD<35%	RPD>35
1	15	3				
2	15	2				
3	19	1	0	1		
4	19	1				
5						
6	18	1				
7	12	7				

[a] Denotes number of parameters analyzed in each respective analytical group.

[b] Denotes number of parameters in the pair with relative percent difference value noted. Does not include parameters "not detected" for both samples in the pair.

[c] CSM = chemical surety material.

TABLE 3.7 Duplicate Summary Table for Soil Sample Duplicates

Duplicate Number	Dioxin (12)[a]		Volatile Organics (35)		SVOCs (64)		Cyanide (1)	
	RPD<35%[b]	RPD>35[b]	RPD<35%	RPD>35	RPD<35%	RPD>35	RPD<35%	RPD>35
1								
2							1	0
3							1	0
4							1	0
5								
6	1	1						
7					0	0		
8			0	0				
9			2	1				
10			0	0				
11								
12								
13					0	0		
14					0	0		
15					0	0		
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								

TABLE 3.7 (Cont.)

Duplicate Number	Dioxin (12)[a]		Volatile Organics (35)		SVOCs (64)		Cyanide (1)	
	RPD<35%[b]	RPD>35[b]	RPD<35%	RPD>35	RPD<35%	RPD>35	RPD<35%	RPD>35
29			0	0	1	9	0	0
30			0	4	2	1		
31			1	5	8	17	0	0
32			0	1	1	2	0	0
33					0	0	0	0
34							0	0
35			0	1				
36								
37					0	0		
38					0	0		
39								
40								

TABLE 3.7 (Cont.)

Duplicate Number	Metals, Total (23)		CSM-Related Compounds (12)[d]		Explosives-Related Compounds (16)	
	RPD<35%	RPD>35	RPD<35%	RPD>35	RPD<35%	RPD>35
1	15	3	0	0	0	1
2						
3	17	3				
4						
5			1	1		
6						
7	19	1				
8						
9						
10						
11	9	7				
12			0	0		
13	15	8				
14	20	1				
15	20	3				
16	8[c]	0				
17	7[c]	0				
18	6[c]	1				
19	6[c]	1				
20	6[c]	1				
21	7[c]	0				
22	4[c]	2				
23	7[c]	0				
24	7[c]	1				
25	7[c]	0				
26	7[c]	0				
27	5[c]	1				

TABLE 3.7 (Cont.)

	Metals, Total (23)		CSM-Related Compounds (12)[d]		Explosives-Related Compounds (16)	
Duplicate Number	RPD<35%	RPD>35	RPD<35%	RPD>35	RPD<35%	RPD>35
28	4[c]	1				
29	20	2				
30	19	0				
31	20	1				
32	19	0				
33	12	6				
34						
35						
36	9	2				
37	18	0				
38						
39	17	3				
40	16	0				

[a] Denotes number of parameters analyzed in each respective analytical group.

[b] Denotes number of parameters in the pair with relative percent difference value noted. Does not include parameters "not detected" for both samples in the pair.

[c] On-site analytical suite has 12 inorganic analytes.

[d] CSM = chemical surety material.

One trip blank accompanied each shipment of sample coolers. Each trip blank was analyzed for VOCs. Low concentrations of methylene chloride, benzene, toluene, and carbon disulfide were detected in trip blanks that accompanied soil, surface water, sediment, and groundwater sample shipments. These low concentrations were associated with laboratory contamination.

Field blanks were collected in an amount equaling approximately 10% of the total number of samples collected per medium, where applicable. Field blanks included ambient, filter, and equipment rinsate blanks. They were typically analyzed for TCL VOCs and TAL metals. Six major metals were detected in the field blanks: aluminum, barium, calcium, iron, manganese, and zinc. These metals were detected in concentrations lower than the contract-required detection limit (CRDL) but greater than the instrument detection limit. In addition, lead was detected at 1 µg/L in an ambient blank associated with groundwater sampling.

3.2.3.3 Accuracy of Analyses

The accuracy of analyses conducted in the analytical laboratory was assessed by evaluating percent recoveries associated with reference samples (e.g., matrix spikes, surrogates, continuing calibration checks). Potential sample contamination was assessed by evaluating the laboratory method blanks and holding blanks. If any difficulties regarding the accuracy of the analyses arose, the results were highlighted with laboratory or project QC flags.

3.2.3.4 Representativeness

Representativeness is defined as the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that is best satisfied by ensuring that sampling locations are properly selected and that a sufficient number of samples is collected.

Field handling protocols were designed to protect the representativeness of the samples. Documentation, procedures, and QA audits were used to ensure that protocols were followed and that sample identification and integrity were maintained. Field sampling records indicate that if a site was contaminated, samples were collected from locations most likely to be contaminated. A sufficient number of samples were collected, as specified in the FSP. However, certain samples and analytes were not collected or analyzed as proposed in the FSP. The referenced samples and analytes were not collected or analyzed for the following reasons:

- The presence of numerous metal contacts in the subsurface soil in prospective sample locations precluded collecting samples because of the possibility that the metal may have been UXO.

- Field conditions or field screening results led to an alteration of the sampling or analyses proposed.

3.2.3.5 Completeness

The overall completeness goal for the data collected as part of the J-Field RI was 80–100%. Completeness was estimated by the following expression:

Percent Completion = (Total samples of validated data/total samples proposed) × *100%* .

Validated data are sample and analytical data points that were determined to be valid after the data validation procedure.

The completeness goal was achieved for groundwater, surface water, surface soil, and soil boring samples (90%, 100%, 100%, and 89%, respectively). The completeness goal was almost achieved for surface sediment samples (74%); however, many of the proposed sediment sample locations were, in fact, soil sample locations. The completion goal was also not achieved for sediment boring samples (68%). Many of the sediment borings were installed through a 4- to 5-ft vegetative layer; therefore, the first few depth intervals of those borings could not be sampled.

3.2.3.6 Comparability

Comparability is a qualitative parameter that expresses the confidence with which one data set can be compared with another. On the basis of the data review, it was determined that for the samples collected by ANL under the J-Field QAPjP, sample data were comparable for similar samples and sample conditions. It was determined that comparability was achieved through the use of standardized techniques for collecting and analyzing samples, such as procedures from the QAPjP for collecting, documenting, packaging, and shipping environmental media samples; standardized techniques for analyzing environmental media samples, including adherence to applicable procedures for field measurements and analyses conducted in the on-site analytical laboratory; and the use of CLP- and AEC-approved analytical methods.

3.3 EVALUATION OF DATA

To determine whether a site is contaminated, environmental data were collected from that site. The choice of sampling locations correlated to the target areas or media that were most likely to be contaminated. These target areas were identified as potential contaminant sources by evaluating previous studies, aerial photograph analysis results, and recent geophysical survey results.

The environmental data collected were compared with the corresponding background data collected by ICF Kaiser Engineers (1995) for soil, sediment, and surface water media. For groundwater, data were compared with the MCLs specified in the national primary drinking water regulations (40 CFR 141) and the freshwater AWQC (EPA 1991). For the soil, sediment, and surface water data, if the concentration level of an analyte was less than the calculated background (which is the mean plus two times the standard deviation of the background data [Tables 3.8–3.10]), the analyte was considered to be within the background range. Samples with analytes outside the background range are summarized in these tables for each site. Not all analytes in the samples collected at J-Field were analyzed in the ICF Kaiser Engineers (1995) study (e.g., organics were not analyzed for surface water samples in the study); for these analytes, the method limit detection was used for comparison. Only those samples with analyte levels exceeding method detection limits are summarized for each site.

Groundwater MCLs (40 CFR 141) and the freshwater AWQC (EPA 1991) were used for comparison. Groundwater samples exceeding either the MCL or the AWQC were included in the groundwater summary table of each site.

TABLE 3.8 Analytes in Sediment[a]

Analyte	Estuarine River		Estuarine Marsh		Freshwater Marsh		Freshwater Pond	
	Calculated Back-ground[b]	Range[c]	Calculated Back-ground[b]	Range[c]	Calculated Back-ground[b]	Range[c]	Calculated Back-ground[b]	Range[c]
Metals (mg/kg)								
Antimony	1.5	0.53–1.25	2	0.4–1.3[d]	2	0.4–0.7[d]	1	1–1.6[d]
Arsenic	16	1.8–14	9	3–7	8	0.8–11[d]	8	0.7–6.0
Barium	129	23–112	110	6–100	160	37–114	165	54–130
Beryllium	2.8	0.17–2.40	4	0.1–3	4	0.2–2.5	1	0.5–1.1
Cadmium	0.85	0.08–0.68	2	0.3–2	5	0.4–3.4	0	0.1–0.16[d]
Chromium	123	5–117	60	5–51	44	24–37	125	39–97
Cobalt	32	2–25	42	1–35	33	6–20	33	3–21
Copper	48	2.4–42	90	3–74	61	7–40	10	13–33
Iron	65,000	2,540–54,100	49,900	3,350–41,500	41,880	12,000–29,300	54,000	3,730–33,900
Lead	70	5–70	80	4–91	96	6–66	66	20–51
Manganese	1,651	86–1,590	1,175	232–1,040	672	374–575	751	41–527
Mercury	0.21	0.12–0.37[d]	0.5	0.3–0.4	0.3	0.1–0.5[d]	0.3	0.27–0.31
Nickel	54	2.8–42	67	2–57	98	9–70	41	13–32
Selenium	0.81	0.3–0.9[d]	1	0.7–1.5	1	0.3–1.3[d]	0.4	0.55–0.66[d]
Silver	0.33	0.07–0.62[d]	1	0.03–1.8[d]	0.2	0.03–0.3[d]	0.15	0.13–0.24[d]
Thallium	0.59	0.3–0.9[d]	1	0.3–0.9[d]	0.4	0.3–0.6[d]	1	0.55–0.80[d]
Vanadium	104	5–93	80	7–73	76	18–53	124	14–85
Zinc	240	19–214	365	10–284	184	29–110	247	12–152

TABLE 3.8 (Cont.)

Analyte	Estuarine River		Estuarine Marsh		Freshwater Marsh		Freshwater Pond	
	Calculated Back-ground^{b}	Range^{c}	Calculated Back-ground^{b}	Range^{c}	Calculated Back-ground^{b}	Range^{c}	Calculated Back-ground^{b}	Range^{c}
Organics (µg/kg)								
Anthracene	146	<90–<260^{d}	209	52–170	126	<80–<170^{d}	135	<150–<230^{d}
Benzo(a)anthracene	208	<130–<370^{d},	304	81–280	337	<120–<500^{d}	193	<220–<230^{d}
Benzo(b)fluoranthene	206	<89–<160^{d}	350	130–370	388	31–270	193	<220–<330^{d}
Benzo(k)fluoranthene	146	<130–<230^{d}	181	130–140	174	<120–<240^{d}	147	<220–<280^{d}
Benzo(g,h,i)perylene	NA^{f}	NA	NA	NA	95	<190^{d}	NA	NA
Benzo(a)pyrene	269	<180–<460^{d}	300	140–250	248	<170–<340^{d}	193	<310–<460^{d}
Chrysene	208	<130–<370^{d}	343	100–330	337	<120–<500^{d}	193	<220–<330^{d}
4,4′-DDD^{e}	2.1	<1.3–<3.7^{d}	6	5.1–5.3	3.4	<1.2–<5.0^{d}	2	<2.2–<3.3^{d}
4,4′-DDE^{e}	5.5	<1.3–<3.7^{d}	11.6	4.8–11	3.4	<1.2–<5.0^{d}	10	<2.8–<3.3^{d}
4,4′-DDT^{e}	2.1	<1.3–<3.7^{d}	3.6	<1.2–<4.5^{d}	3.4	<1.2–<5.0^{d}	2	<2.2–<3.3^{d}
Fluoranthene	253	126–220	676	98–600	233	50–64	148	<190–<230^{d}
Fluorene	146	<90–<260^{d}	173	<90–<270^{d}	126	<80–<170^{d}	135	<150–<230^{d}
Heptachlor	2.1	<1.3–<3.7^{d}	3.2	<1.2–<4.5^{d}	3.4	<1.2–<5.0^{d}	2	<2.2–<3.3^{d}
Heptachlorodibenzo-p-dioxins (total)	0.1	<0.009–<0.11^{d}	0.17	<0.03–<0.22^{d}	NA	NA	NA	NA
Indeno(1,2,3-c,d)pyrene	150	<200–<220^{d}	100	<200^{d}	95	<190^{d}	NA	NA
Lindane	2.1	<1.3–<3.7^{d}	3.2	<1.2–<4.5^{d}	3.4	<1.2–<5.0^{d}	2	<2.2–<3.3^{d}
2-Methylnaphthalene	136	59–61	328	90–300	337	<120–<500^{d}	239	<280–<330^{d}
Naphthalene	125	54–79	419	98–470	237	<80–<350^{d}	135	<150–<230^{d}
Octachlorodibenzodioxin	3.1	0.8–2.5	1.9	0.8–1.4	NA	NA	0.73	0.73
Phenanthrene	158	47–120	535	160–600	237	<80–<350^{d}	146	63–100

TABLE 3.8 (Cont.)

Analyte	Estuarine River		Estuarine Marsh		Freshwater Marsh		Freshwater Pond	
	Calculated Background[b]	Range[c]	Calculated Background[b]	Range[c]	Calculated Background[b]	Range[c]	Calculated Background[b]	Range[c]
Pyrene	260	97–230	554	100–480	405	49–290	NA	NA
Other								
Gross alpha (pCi/g)	12.7	5.5–10.6	16	1.5–12.4	NA	NA	6.6	6.6
Gross beta (pCi/g)	10.7	3.4–8.8	8.4	0.4–7.9	NA	NA	5.8	5.8
pH (units)	6.8–7.9	6.9–7.7	6.7–7.5	6.9–7.5	6.5–7.5	6.7–7.2	6.4–7.2	6.4–6.9

[a] Data contain roundoffs.

[b] Background = (Mean) + (Two times the standard deviation); derived from ICF Kaiser Engineers (1995).

[c] Range taken from ICF Kaiser Engineers (1995).

[d] Method detection range.

[e] DDD = dichlorodiphenyldichloroethane; DDE = dichlorodiphenyldichloroethene, DDT = dichlorodiphenyltrichloroethane.

[f] NA = not available from ICF Kaiser Engineers (1995).

TABLE 3.9 Regional Background Levels of Analytes in Soil (all locales)[a]

Metals (mg/kg)	Calculated Back-ground[b]	Range[c]	Organics (µg/kg)	Calculated Back-ground[b]	Range[c]	Organics (µg/kg)	Calculated Back-ground[b]	Range[c]
Antimony	4	<5–<10[d]	Acenaphthrene	57	<70–<140[d]	Hexachlorodibenzo-p-furans (total)	0.09	0.120
Arsenic	5	1–5	Anthracene	57	<70–<140[d]	Indeno(1,2,3-cd)pyrene	165	40–210
Barium	94	10–125	Benzo(a)anthracene	135	53–230	2-Methylnaphthalene	74	<120–<145[d]
Beryllium	1	<0.5–<0.7[d]	Benzo(b)fluoranthene	183	35–350	Octachlorodibenzo-p-dioxins	6.8	0.3–9.1
Cadmium	0.7	<0.5–<0.7[d]	Benzo(k)fluoranthene	102	29–140	Pentachlorodibenzo-p-furans (total)	0.23	<0.2–<0.43[d]
Chromium	41	3.5–70	Benzo(g,h,i)perylene	153	73–200	Phenanthrene	105	25–170
Chromium VI	0.1	0.03–0.16	Benzo(a)pyrene	259	57–440	Pyrene	290	38–620
Cobalt	19	0.7–26	Carbazole	73	<120–145[d]			
Copper	20	3–28	Chrysene	197	67–380			
Iron	23,400	2,610–23,500	Dibenzo(a,h)anthracene	132	<170–<320[d]			
Lead	61	5–117	Dibenzofuran	87	<140–<175[d]			
Manganese	868	5–1,140	4,4′-DDD[c]	3.7	3–8			
Mercury	0.1	0.07	4,4′-DDE[c]	162	4–392			
Nickel	20	2–24	4,4′-DDT[c]	61	2–143			
Selenium	0.4	0.3–0.5	Diethylphthalate	59	41–72			
Silver	0.4	<0.5–<1.0[d]	Fluoranthene	173	20–320			
Thallium	0.4	<0.3–<0.5[d]	Fluorene	57	<70–<140[d]			
Vanadium	47	9–59	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxins	0.13	0.1–0.14			
Zinc	118	5–242	Heptachlorodibenzo-p-dioxins (total)	0.05	0.04–0.06			

[a] Data contain roundoffs.

[b] Background = (Mean) + (Two times the standard deviation); derived from ICF Kaiser Engineers (1995).

[c] Range taken from ICF Kaiser Engineers (1995).

[d] Method detection range.

[c] DDD = dichlorodiphenyldichloroethane; DDE = dichlorodiphenyldichloroethene, DDT = dichlorodiphenyltrichloroethane.

TABLE 3.10 Analytes in Surface Water[a]

Metals (µg/L)	Estuarine River		Estuarine Marsh		Freshwater Marsh		Freshwater Pond	
	Calculated Background[b]	Range[c]	Calculated Background[b]	Range[c]	Calculated Background[b]	Range[c]	Calculated Background[b]	Range[c]
Antimony	4	<3[d]–4	NA[e]	NA	NA	NA	NA	NA
Arsenic	NA	NA	2	<2[d]–2.1	NA	NA	NA	NA
Barium	68	17–70	54	9–65	160	25–179	129	21–127
Beryllium	0.2	<0.2[d]–0.2	NA	NA	0.3	0.2[d]–0.2	NA	NA
Chromium	NA	NA	7	<5[d]–10	15	<5[d]–14	8	<5[d]–6
Cobalt	NA	NA	4	<5[d]–6	12	<5[d]–10	21	<5[d]–21
Copper	5	<5[d]–5	8	<5[d]–7	10	<5[d]–10	NA	NA
Iron	2,140	406–2,690	3,385	178–3,900	18,810	492–9,670	5,750	786–5,170
Lead	3	<1.5[d]–4	4	<1.5[d]–4	6	<1.5[d]–8	6	<1.5[d]–6
Manganese	216	44–284	215	38–247	4,364	136–6,290	1,206	72–856
Mercury	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	25	<10[d]–24	25	<10[d]–20
Silver	0.6	<0.45[d]–0.6	NA	NA	NA	<0.5[d]–0.6	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	16	<5[d]–17	20	<5[d]–23	24	<5[d]–20	9	<5[d]–7
Zinc	15	<5[d]–21	22	<5[d]–26	61	7–56	76	5–62

[a] Data contain roundoffs.

[b] Background = (Mean) + (Two times the standard deviation averaged between spring and fall data); derived from ICF Kaiser Engineers (1995).

[c] Range taken from ICF Kaiser Engineers (1995).

[d] Method detection range.

[e] NA = Not available in ICF Kaiser Engineers (1995).

4 SITE DESCRIPTIONS

This chapter summarizes the physical and hydrological conditions at the eight AOCs and the seven PAOCs at J-Field. The level of detail presented in these summaries reflects the amount of information available.

4.1 TOXIC BURNING PITS AOC

The TBP AOC is located near the southern end of the Gunpowder Neck Peninsula at J-Field (Figure 1.3). It was used for disposal (by burning) of toxic chemical material from the late 1940s until about 1980 (McNamara 1994). The pits were used most extensively between the late 1940s and the 1960s.

The TBP AOC contains many potential contaminant sources (Figure 4.1). Only two open pits (Northern and Southern Main Pits) are currently visible. Two other burning pits (the VX and Mustard Pits) are buried. The Liquid Smoke Disposal Pit, a small pit measuring about 4 × 6 ft, has also been reported (Nemeth 1989); however, its specific location is not certain. In the HE Demolition Ground, near the southeastern edge of the AOC, high-explosive munitions were disposed of by detonation (Nemeth 1989). The TBP Storage Area, a fenced area near the southwestern end of the Mustard Pit, was used for storage, as evidenced by aerial photographs taken in the 1960s (U.S. Army 1965). A scrap metal mound has been observed near the southwestern part of the AOC, adjacent to the marsh. Historical aerial photographs indicate that this area (called the TBP Southwestern Suspect Burning Area) was probably active in the 1950s and 1960s and is suspected of having been used for burning and/or demolition. A small square pit, measuring about 3.5 × 4.25 ft, lies northwest of the suspect burning area. This pit is suspected to be the Liquid Smoke Disposal Pit (see Section 4.1.4).

The TBP AOC is bounded to the northeast by marsh and to the south and southeast by woods and marsh (Nemeth 1989). Because the ground surface elevation is highest in the northwestern portion of the TBP AOC, surface water probably drains to the southeast, south, and north into low-lying areas. The soils are brownish-yellow, silty fine sand at the surface, grading to bluish-gray, silty fine sand below a depth of 14 ft (Princeton Aqua Science 1984).

The groundwater flow regime in the surficial aquifer at the TBP AOC was derived for winter 1994 (Figure 4.2) and spring 1995 (Figure 4.3) on the basis of data collected by the USGS (Phelan 1995). The flow patterns are generally consistent with the results of a previous USGS study (Hughes 1993). Recharge to the shallow groundwater flow system at the TBP AOC results from precipitation on the land surface. Groundwater level data indicate that the main groundwater recharge area is near the two main burning pits (Figures 4.2 and 4.3). Water percolates downward through the vadose zone to the water table in the surficial aquifer and then flows horizontally

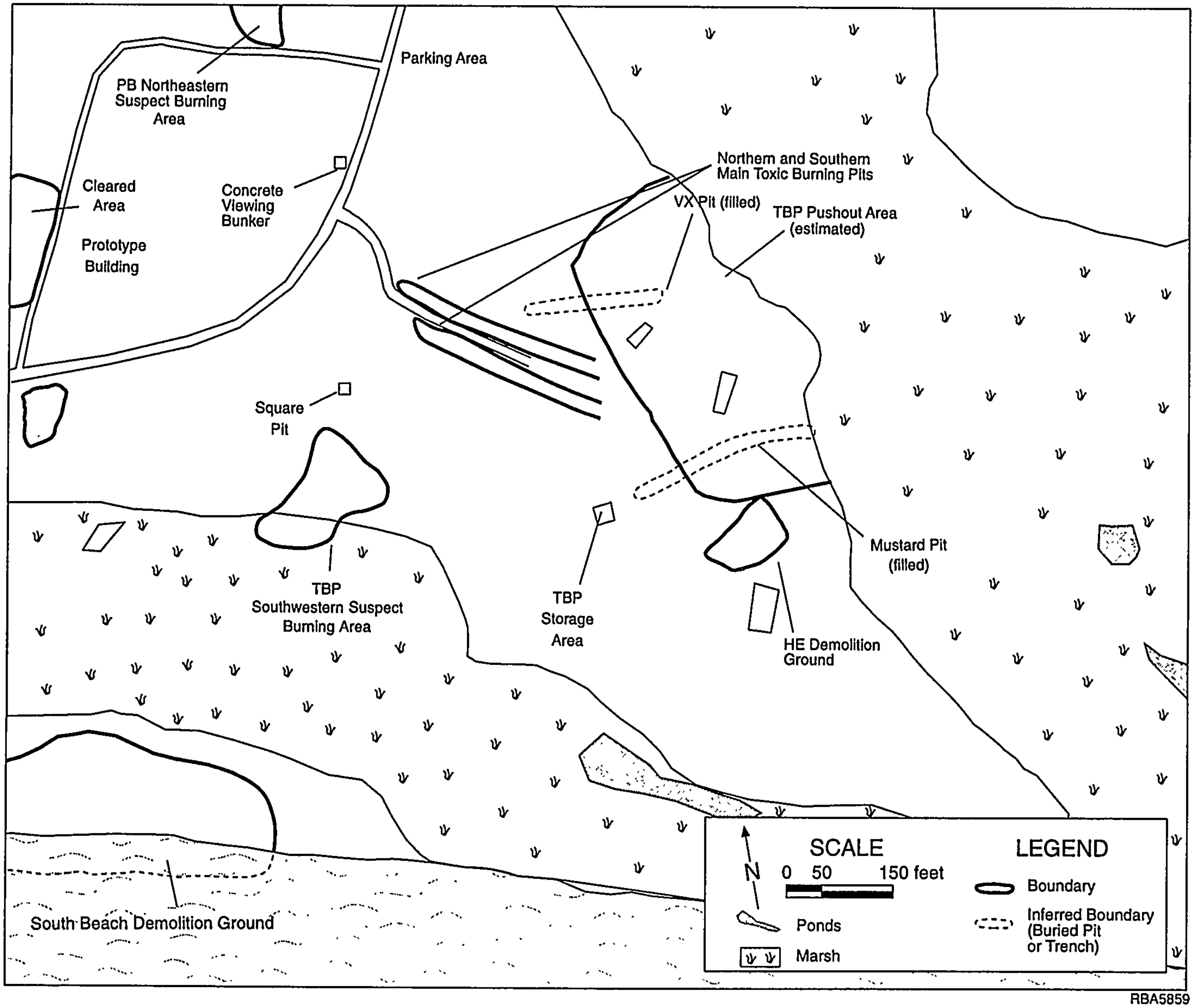


FIGURE 4.1 Potential Contamination Sources at the Toxic Burning Pits AOC

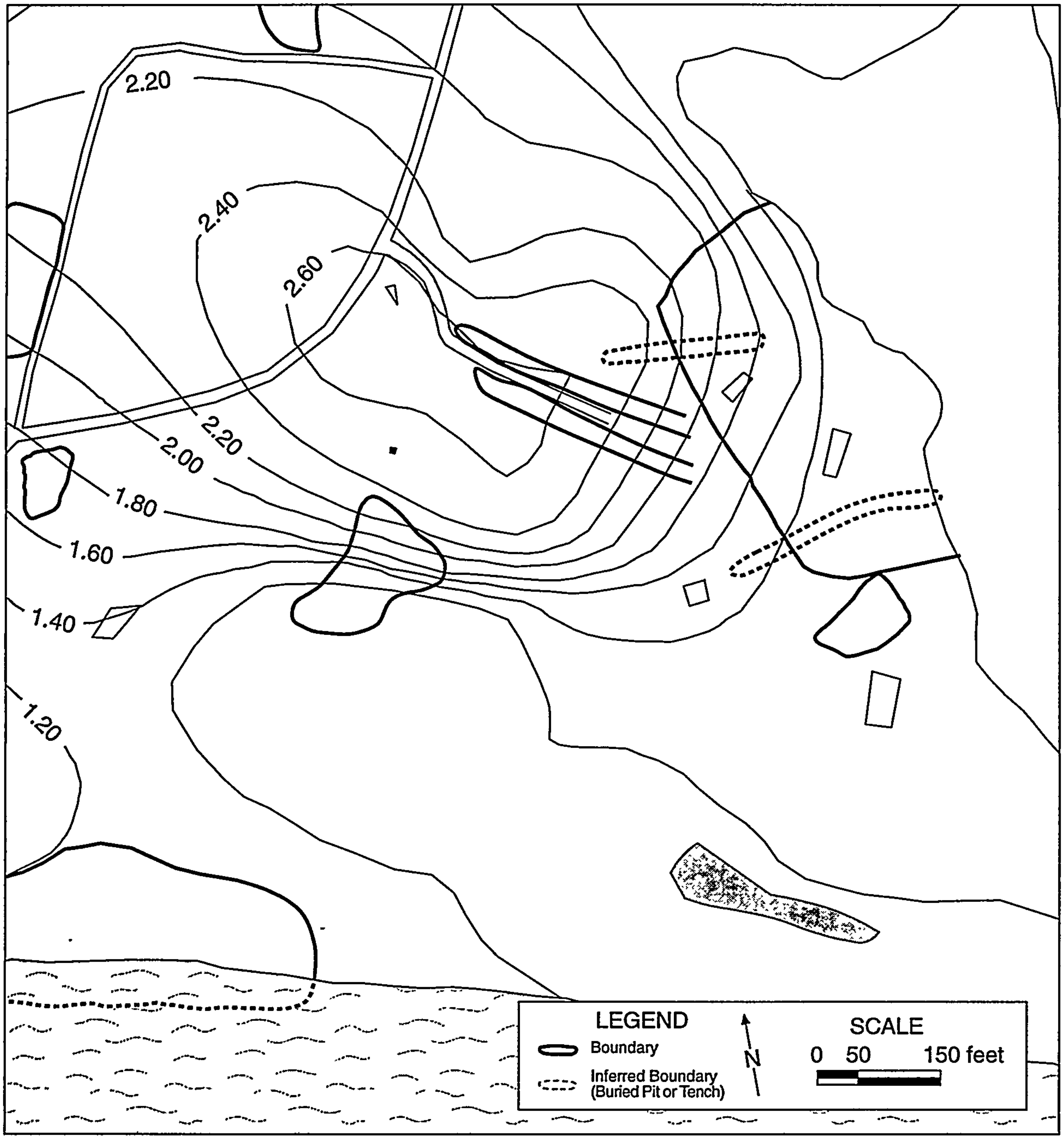


FIGURE 4.2 Water Table Contour of the Surficial Aquifer at the Toxic Burning Pits AOC: December 1994

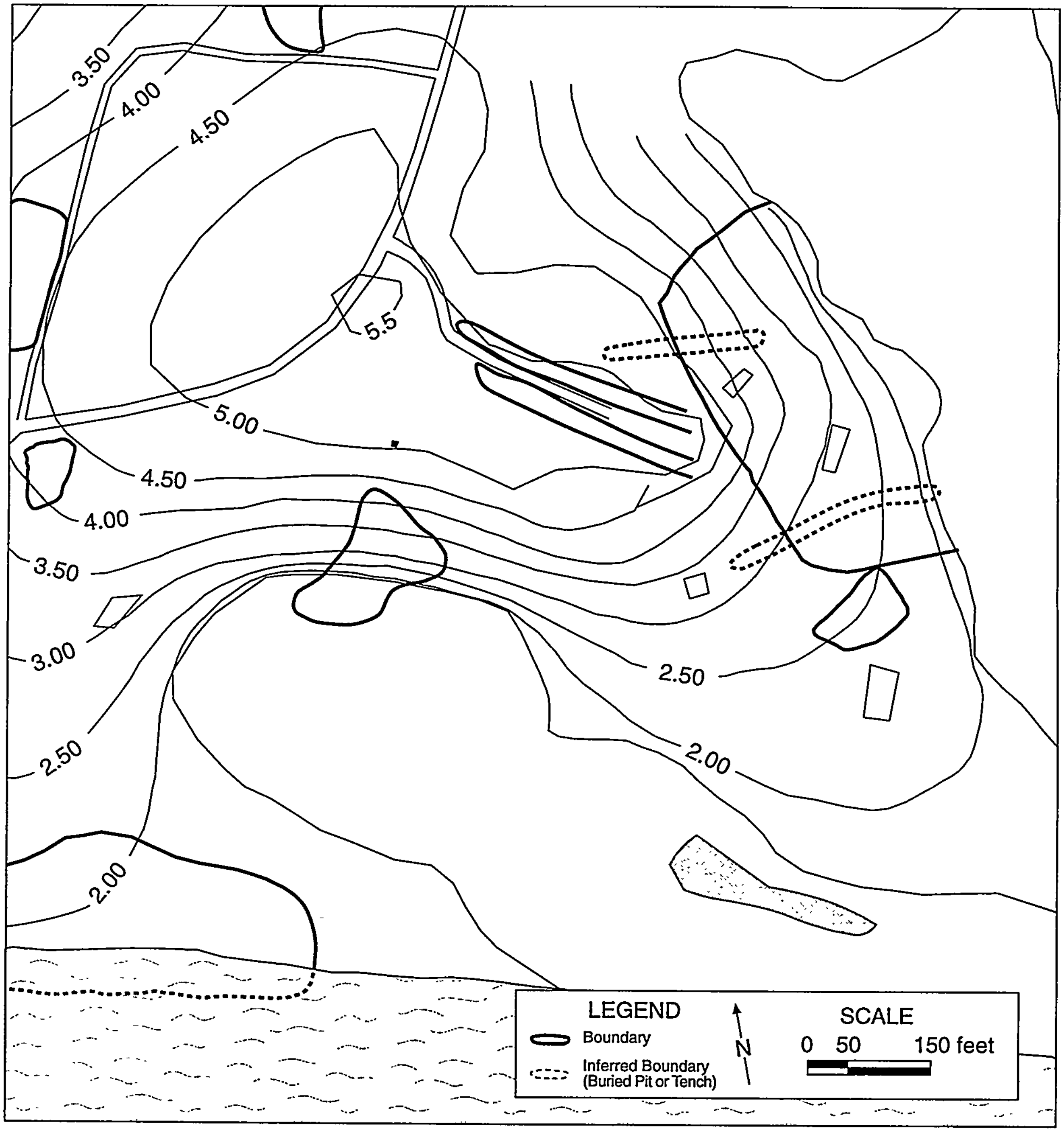


FIGURE 4.3 Water Table Contour of the Surficial Aquifer at the Toxic Burning Pits AOC: May 1995

outward from the main recharge area (around well P1) toward the south, southeast, and northeast (Figure 4.2). Because the water table lowers by 2-3 ft in the fall, a perched aquifer may form in the clayey fine-grained sand lenses within the upper part of the surficial aquifer, especially near the eastern part of the TBP AOC (e.g., east of well P4). The perched aquifer could recharge the groundwater in the deeper part of the surficial aquifer; however, the general flow direction of the groundwater in the deeper part of the surficial aquifer would remain the same (Figure 4.3).

To characterize the behavior of the surficial aquifer, a pump test was performed in the southeastern part of TBP AOC at well JF183 in December 1994 (Quinn 1995). The aquifer behaved slightly differently during the pumping and recovery phases of the test. The hydraulic conductivities of the aquifer were 1.5×10^{-3} and 2.4×10^{3} cm/s, for the pumping and recovery phases, respectively. The difference is minor, and both values are typical of silty sand. The storability values were 0.005 and 0.006 for the pumping and recovery phases, respectively. The storability values suggest some degree of aquifer confining effects in the surficial aquifer (Quinn 1995).

Sites of contaminant source areas in the TBP AOC are decribed in the following subsections.

4.1.1 Main Burning Pits

The Main Burning Pits are open pits and include a Northern Pit and a Southern Pit (Figure 4.1). They were the first pits used in the field and were active until 1980 (McNamara 1994). Each pit is about 15 ft wide and extends about 300 ft into a marsh area southeast of the AOC. The procedures used for open burning in all the burning pits at this AOC (the two main pits, the VX Pit, and the Mustard Pit) were similar (Nemeth 1989). The procedures involved placing 3–4 ft of wood dunnage in the pits, placing the material to be burned on top of the dunnage, adding fuel oil, and igniting it. Scrap metal was either removed and reburned in another pit or reburned in the same pit in the same manner. Large metal items were recovered from the pits as scrap metal. The pits were maintained by pushing burned residue out the end of the pits toward the marsh surrounding the AOC. This "pushout" of residue from the pits has extended the edge of the adjacent marsh eastward more than 100 ft (Nemeth 1989). The estimated Pushout Area is shown in Figure 4.1.

The materials disposed of in the TBP included munitions filled with chemical agent, drummed chemical wastes, and materials potentially contaminated with chemical agents. The chemical agents included nerve agents, mustard, and riot control agents. Appendix C provides a sample of the documentation that exists on the total quantities or types of agent disposed of in the TBP. A variety of other chemicals were also disposed of here, including chlorinated solvents (Nemeth 1989). Drummed chemical wastes were sent here for disposal from chemical research laboratories, process laboratories, pilot plants, and machine and maintenance shops.

The toxic chemical agents burned in the J-Field pits were flammable, and the total quantities disposed of in each burn were relatively small (Nemeth 1989). Monitoring of the site after burns showed that the operational procedures were effective in disposing of these materials. However, open-pit burning of drummed chemical wastes would have been less effective because the quantities were typically larger, the chemicals were less flammable, and they consisted of wet materials or aqueous solutions or mixtures. No detailed records of disposal operations at J-Field exist, and the quantities of chemicals disposed of in the TBP, or elsewhere, are unknown.

4.1.2 VX and Mustard Burning Pits

The VX and Mustard Burning Pits are filled in and have been delineated by aerial photographic analysis and by Stage I geophysical surveys (Daudt et al. 1994) and more focused Stage II geophysical surveys (Davies et al. 1995). The VX Pit is on the northern side of the Main Burning Pits, and the Mustard Pit is southeast of the Main Burning Pits (Figure 4.1). The pits were probably used primarily for disposal of VX and mustard agents by burning with the same procedure used in the Main Burning Pits. Nemeth (1989) reported that burial was never used as a disposal method. Other types of wastes or decontaminating agents may also have been disposed of in the pit, as evidenced by chlorinated solvents found in groundwater. The specific types and quantities of the waste disposed of in the two pits are unknown.

4.1.3 Storage Area

It is unclear what type of material was stored in the Storage Area. However, historical aerial photographs show road tracks leading from the Storage Area to the SBDG in the marsh south of the TBP AOC. It is not known if the Storage Area served the various burning pits in the AOC or was used for some other function.

4.1.4 Liquid Smoke Disposal Pit

The exact location of the Liquid Smoke Disposal Pit is not certain. It is generally believed that the pit is small and located on the southern side of the Main Burning Pits (Nemeth 1989). The pit was not identified in the field. However, it is possible that a small pit (the Square Pit) located on the southern side of the AOC is the Liquid Smoke Disposal Pit.

The Liquid Smoke Disposal Pit was briefly used for disposing of liquid smoke materials, probably titanium tetrachloride and/or sulfur trioxide and chlorosulfonic acid (Nemeth 1989). To reduce costs, titanium tetrachloride is sometimes mixed with 1,2-dichloroethene (12DCE) for use in training munitions.

4.1.5 Southwestern Suspect Burning Area

The Southwestern Suspect Burning Area appears in aerial photographs from the 1960s (U.S. Army 1965) and is probably one of several old disposal sites at J-Field. A mound of scrap metal was observed in the central portion of the site. Qualitative metal measurements by field XRF indicated elevated levels of lead and zinc on the surface soil near the mound. This area was not documented previously (Yuen 1994), and its use is unknown.

4.1.6 Square Pit

The Square Pit is small, measuring about 3.5 × 4.25 ft. It is located north of the Southwestern Suspect Burning Area (Figure 4.1) and has a metallic liner. The sediment inside the pit is whitish. According to XRF field screening tests, the titanium content in the sediment inside the pit is about 25 times higher than that in the sediment outside the pit. Because titanium tetrachloride is a liquid smoke material used in the past, it is suspected that the Square Pit was used for liquid smoke disposal (Yuen 1994). This pit may be the Liquid Smoke Disposal Pit referred to above (Section 4.1.4).

4.1.7 High Explosives Demolition Ground

The HE Demolition Ground is near the southeastern part of the TBP AOC (Figure 4.1). Its location was determined from aerial photographs (Yuen 1994). The site was used for the disposal of high-explosive munitions by detonation (Nemeth 1989). At least a portion of the demolition work involved destruction of U.S. Navy ordnance items. Historical aerial photographs indicate that the site was active in the mid-1960s.

4.2 WHITE PHOSPHORUS BURNING PITS AOC

The WPP AOC is located near the Gunpowder River in the western portion of J-Field (Figure 1.3). The WPP AOC is divided into two parts. One part includes two open pits and a feature suspected of being a filled trench in the center of the AOC (Figure 4.4). This part of the AOC was excluded from the RI because the two open pits are still used for emergency disposal operations and the suspected filled trench is very close to the open pits. The pits were previously used for disposal (by detonation and burning) of white phosphorus, plasticized white phosphorus, munitions filled with white phosphorus, and materials contaminated with white phosphorus. After materials were burned and reburned in the pits, debris and soil were pushed out. Some of the materials disposed of at this site probably contain other types of waste in addition to white phosphorus. The types and

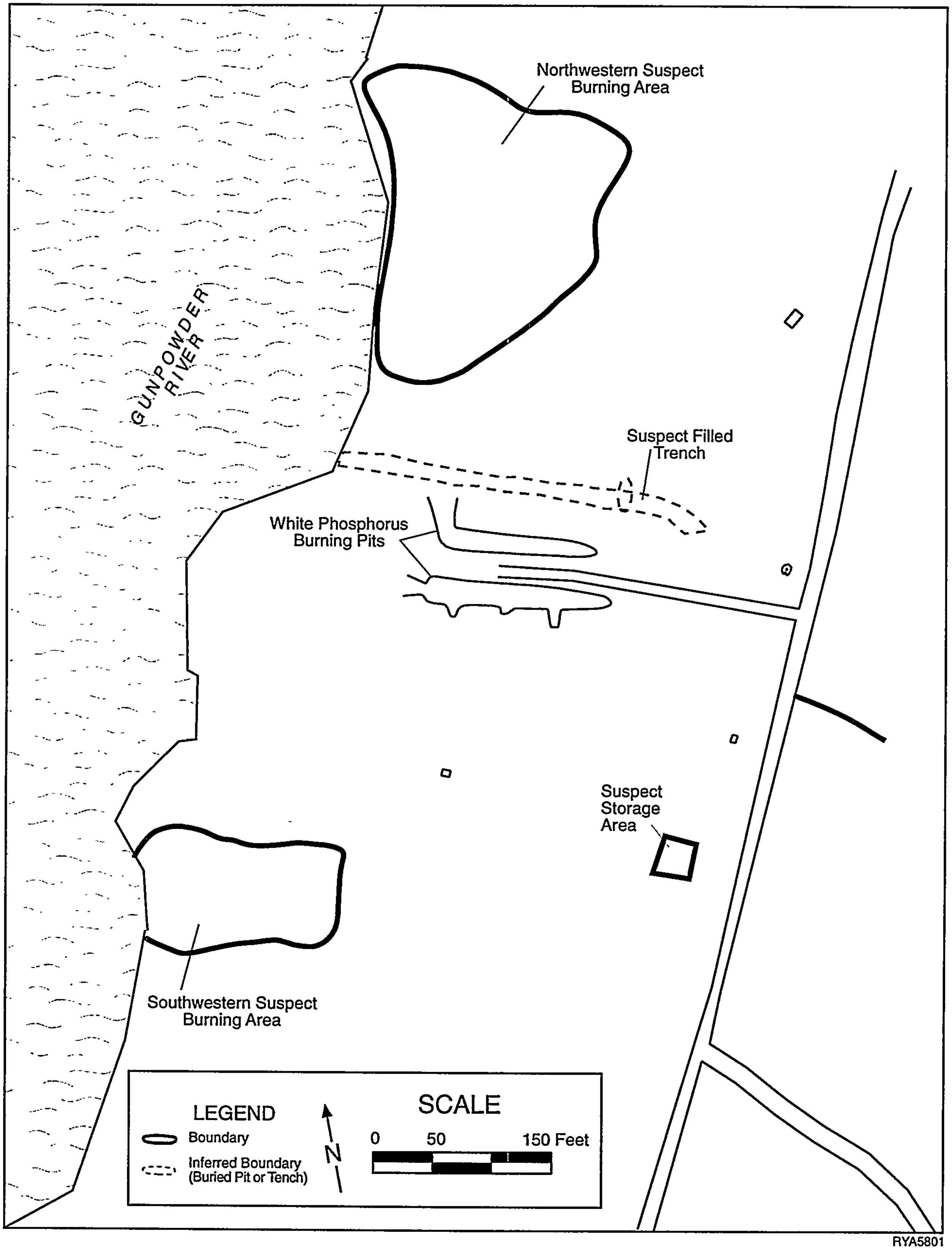


FIGURE 4.4 Map of the White Phosphorus Burning Pits AOC and Nearby PAOCs

quantities of these other wastes are unknown, although personal interviews indicate that riot control agents may have been disposed of here (Nemeth 1989).

The second part of the WPP AOC includes two suspect burning areas and one suspect storage area. This part of the AOC was evaluated in the RI. The suspect burning areas were identified from aerial photographs (Yuen 1994) and are evidenced by melted metals and melted glass debris exposed in the field. The areas are located in the northwestern and southwestern corners of the AOC (Figure 4.4). The suspect burning areas were not documented in previous environmental assessments (Nemeth 1989), and their specific uses are unknown.

The Suspect Storage Area is in the southeastern corner of the WPP AOC (Figure 4.4). The area was identified by analysis of historical aerial photographs (Yuen 1994) and geophysically surveyed (by ground-penetrating radar [GPR] and electromagnetic and magnetic methods) in early 1995 (Davies et al. 1995). Small dirt mounds are present in the Suspect Storage Area. The geophysical survey indicated that a cable or utility line may have been buried in the southern part of this area. The existence of a buried cable is inferred by a linear structure-of-conductivity anomaly in the electromagnetic survey. This feature can be traced to an exposed utility post (Davies et al. 1995). No other structure-related geophysical anomalies were found.

Surface water from the WPP AOC drains west into the Gunpowder River. Soils are a brownish-yellow, silty fine sand at the surface, grading to a bluish-grey silty fine sand below a depth of 14 ft (Princeton Aqua Science 1984).

Data on groundwater collected by the USGS in December 1994 (Figure 4.5) and May 1995 (Figure 4.6) indicate that the groundwater flow in the surficial aquifer changes seasonally. In December, the Gunpowder River recharges the surficial aquifer, causing the groundwater to flow to the east and northeast (Figure 4.5). In May, the aquifer is recharged primarily from precipitation falling on the land surface. Water percolates downward through the vadose zone to the water table in the surficial aquifer and flows to the west toward the Gunpowder River (Figure 4.6).

4.3 RIOT CONTROL BURNING PIT AOC

The RCP AOC is located in a heavily wooded area in the southwestern portion of J-Field (Figure 1.3). Except for a small area in the northeastern part of the site, the area is overgrown with vegetation. Near the Gunpowder River, shore erosion is very active. Examination of historical aerial photographs (U.S. Army 1965) indicates that since the mid-1960s, the shoreline near the RCP AOC has receded about 50 ft because of erosion.

A trench was excavated in the area at some time between 1957 and 1960 and was later extended southwest to the Gunpowder River to provide drainage from the burning pit. Between 1960

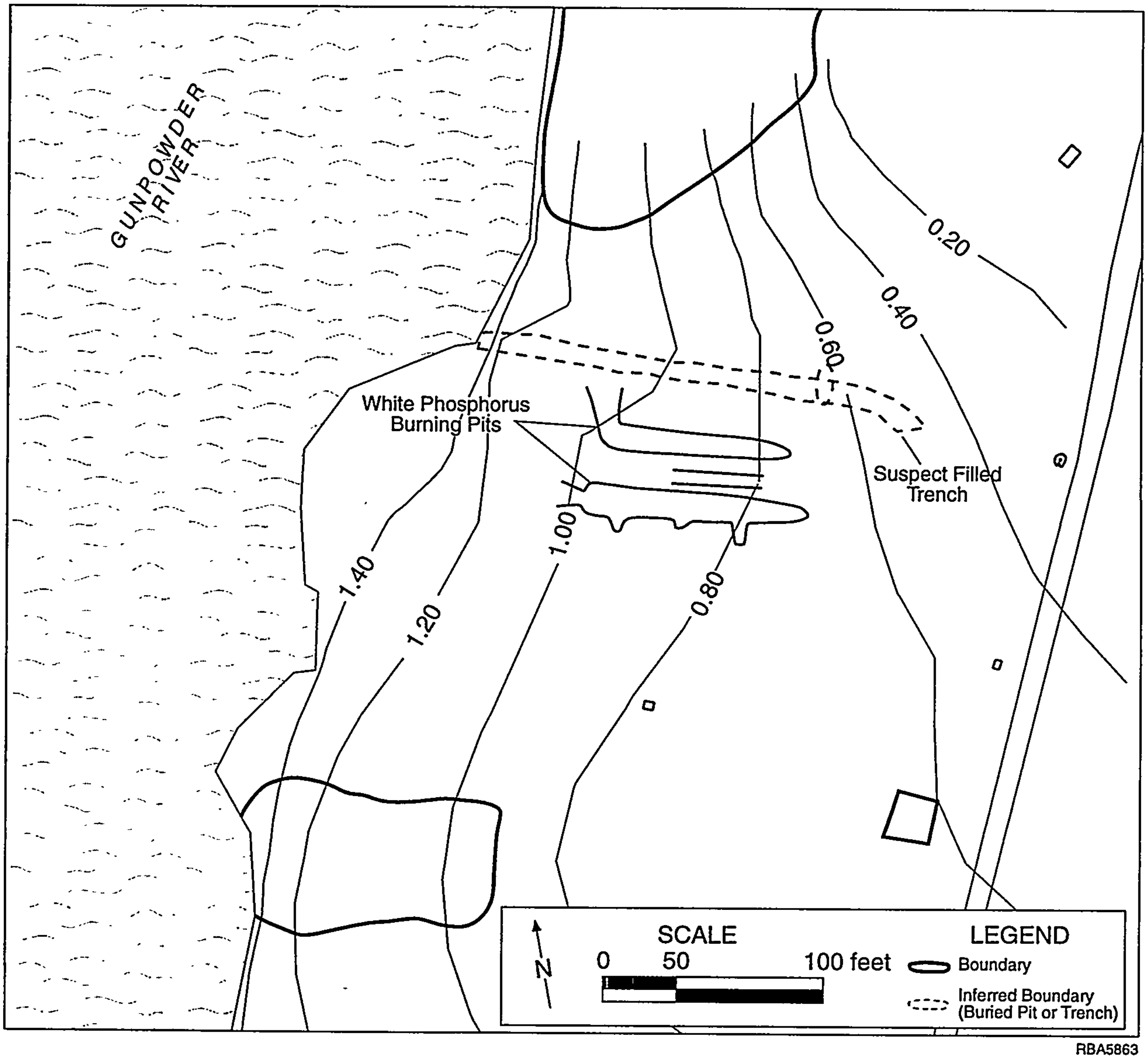


FIGURE 4.5 Water Table Contour of the Surficial Aquifer at the White Phosphorus Burning Pits AOC: December 1994

and the early 1970s, the trench was used for burning riot control agents, munitions filled with riot control agents, and material contaminated with these agents (Nemeth 1989). The principal chemical agent disposed of there was the tear agent CS; some CN was also disposed of there (Sonntag 1991). The CN was commonly used in solution with benzene chloroform, carbon tetrachloride, and sometimes chloropicrin (Nemeth 1989).

The configuration of trenches in the RCP AOC may have changed with time. According to aerial photographs from the 1960s, a minor trench branched from the middle of the main trench and extended westward to a marsh (Figure 4.7). Today, that western branch is not obvious.

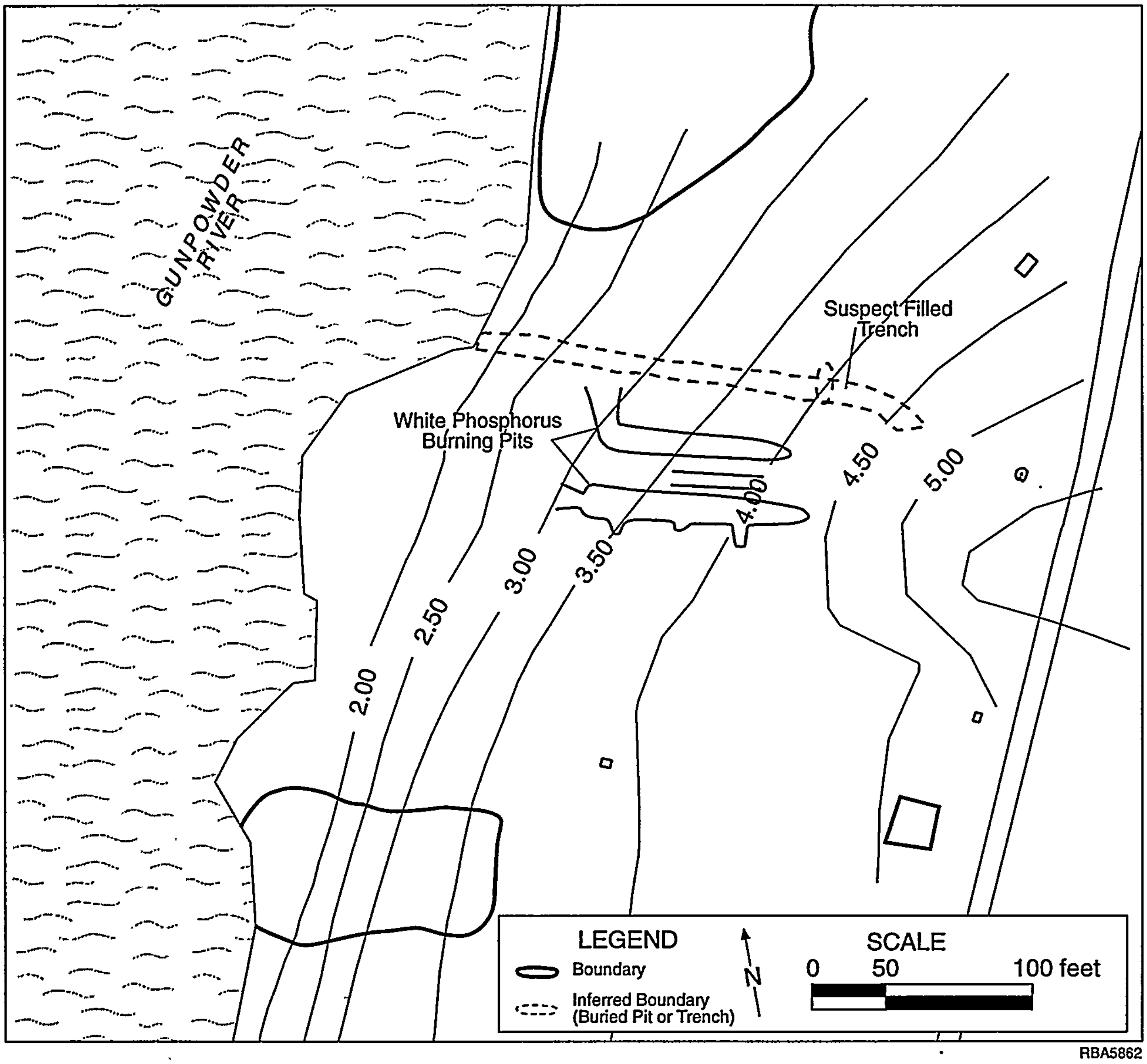


FIGURE 4.6 Water Table Contour of the Surficial Aquifer at the White Phosphorus Burning Pits AOC: May 1995

Currently, two trenches extending parallel to each other are exposed in the field. They are divided by a narrow berm (about 3 ft wide). The two trenches visibly merge at the southwestern end of the main trench. It has been inferred that they also merge at the northeastern end of the main trench (Figure 4.7).

Historical aerial photographs show that major disposal activities in the 1960s occurred near the northeastern end of the RCP. This part of the trench is filled and was covered with vegetation, mainly small trees and brushes, until recently. The vegetation was removed in January 1995 so that Stage II geophysical surveys (Davies et al. 1995) could be performed. The filled trench was located

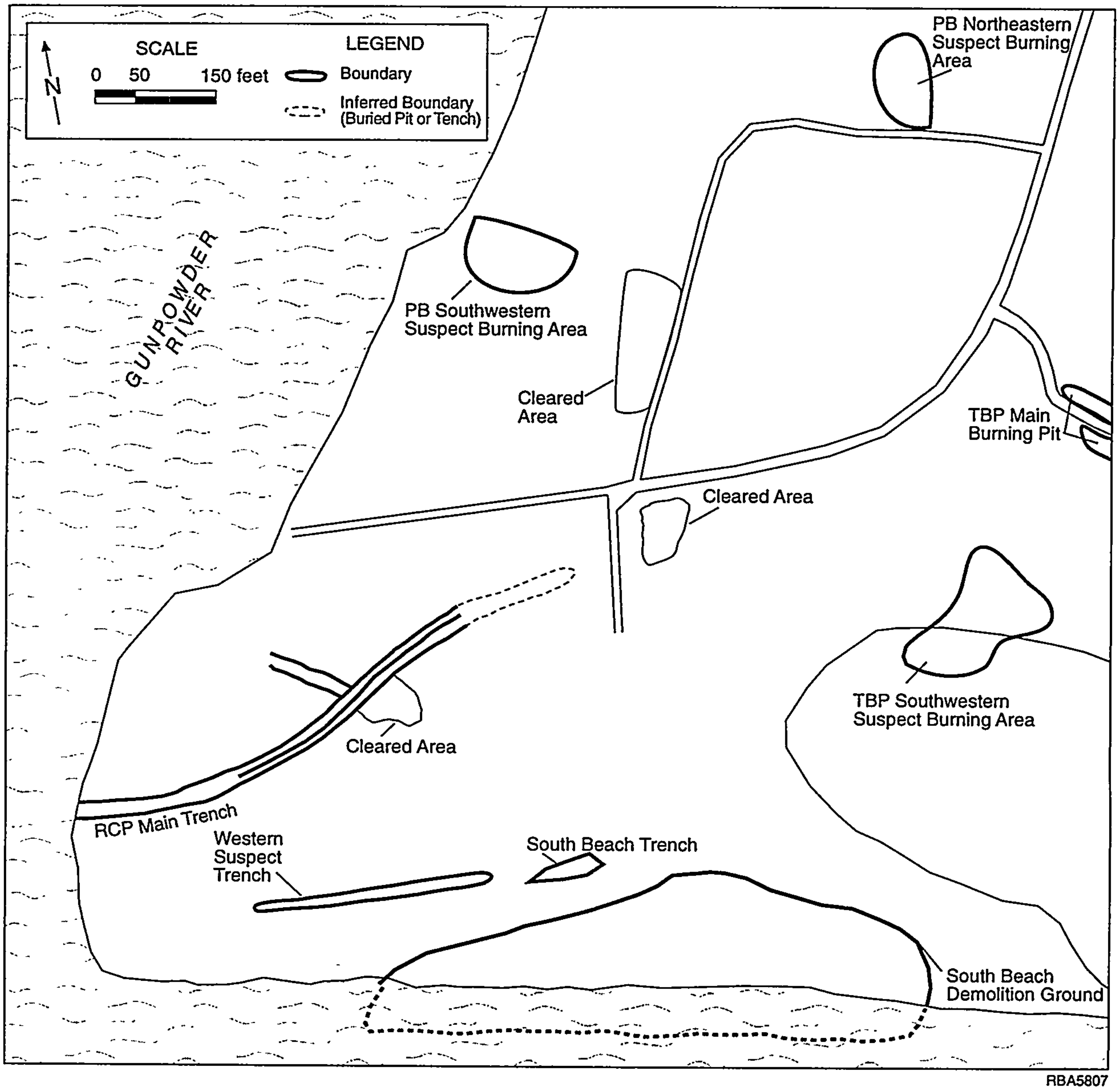


FIGURE 4.7 Map of the Riot Control Burning Pit AOC

by GPR and electromagnetic and magnetic methods during the surveys. Its location is consistent with the trench shown in the historical aerial photographs. The locations of the geophysical surveys and the filled trench are shown in Figure 1.3. Detailed descriptions of the surveys and the results are provided by Davies et al. (1995).

The topography in the RCP AOC is relatively flat, with a slightly elevated area in the northeast and a marsh in the southwest. The shallow soil is predominantly clayey sandy silt (Nemeth 1989) and is not well drained.

Analysis of groundwater data collected in 1994 (Figure 4.8) and 1995 (Figure 4.9) by the USGS indicates that the direction of groundwater flow in the surficial aquifer at the RCP AOC changes seasonally. In the winter, the water table declines about 2 ft. The marsh southwest of the pit becomes a groundwater discharge zone of the surficial aquifer. The groundwater flow direction at RCP is to the south and southwest (Figure 4.8). In both spring and late fall, the aquifer is recharged from precipitation on the land surface. The recharge center is near the eastern part of the PB AOC. In the spring, the marsh west of the pit is a groundwater discharge zone. The groundwater flow direction at RCP is west-southwest, following the general direction of the pit (Figure 4.9).

4.4 PROTOTYPE BUILDING AOC

The PB AOC is in the southwestern portion of J-Field, northwest of the TBP AOC and north of the RCP AOC (Figure 1.3). The open-sided, three-level reinforced concrete structure was constructed during World War II and originally was used for testing the effectiveness of bombs. Since World War II, the PB and the areas to the west and north have been intermittently used for temporary storage of solid waste (Nemeth 1989).

Two suspected burning areas have been identified in historical aerial photographs (Yuen 1994) near the northeastern and southwestern corners of the PB (Figure 4.10). The Northeastern Suspect Burning Area is covered with grass and is free of scrap metals on the ground surface. A grill-like structure, with pieces of charcoal and silver-like melted metals in ash, remains near the site. The Southwestern Suspect Burning Area is marked by piles of soil about 200 ft west of the PB. A few pieces of scrap metal were found on the ground surface. A clear area (Figure 4.10) near the southwestern part of the PB AOC was observed in historical aerial photographs (Yuen 1994). No evidence of waste disposal operations was found in the area.

The area around the PB is fairly flat. Surface water drains primarily west toward the Gunpowder River. Drainage in parts of the site is toward lower-lying areas southwest and northwest of the site (Nemeth 1989). Data from a USGS study (Hughes 1993) and 1994–1995 data collected by the USGS indicate that groundwater in the surficial aquifer flows west to northwest, toward the Gunpowder River (Figures 4.8 and 4.9). The shallow soils are predominantly silty and clayey sand, with greater amounts of clay and silt near the surface (Nemeth 1989).

4.5 SOUTH BEACH DEMOLITION GROUND AOC

The SBDG AOC is located along the southern beach of J-Field (Figures 1.3 and 4.11). The area was used as a demolition site for HE munitions during the 1960s and 1970s, and possibly during the 1950s (Nemeth 1989). Munitions were detonated either on the ground surface or under several feet of soil. Aerial photographs taken in the mid-1960s (U.S. Army 1965) indicate that most of the

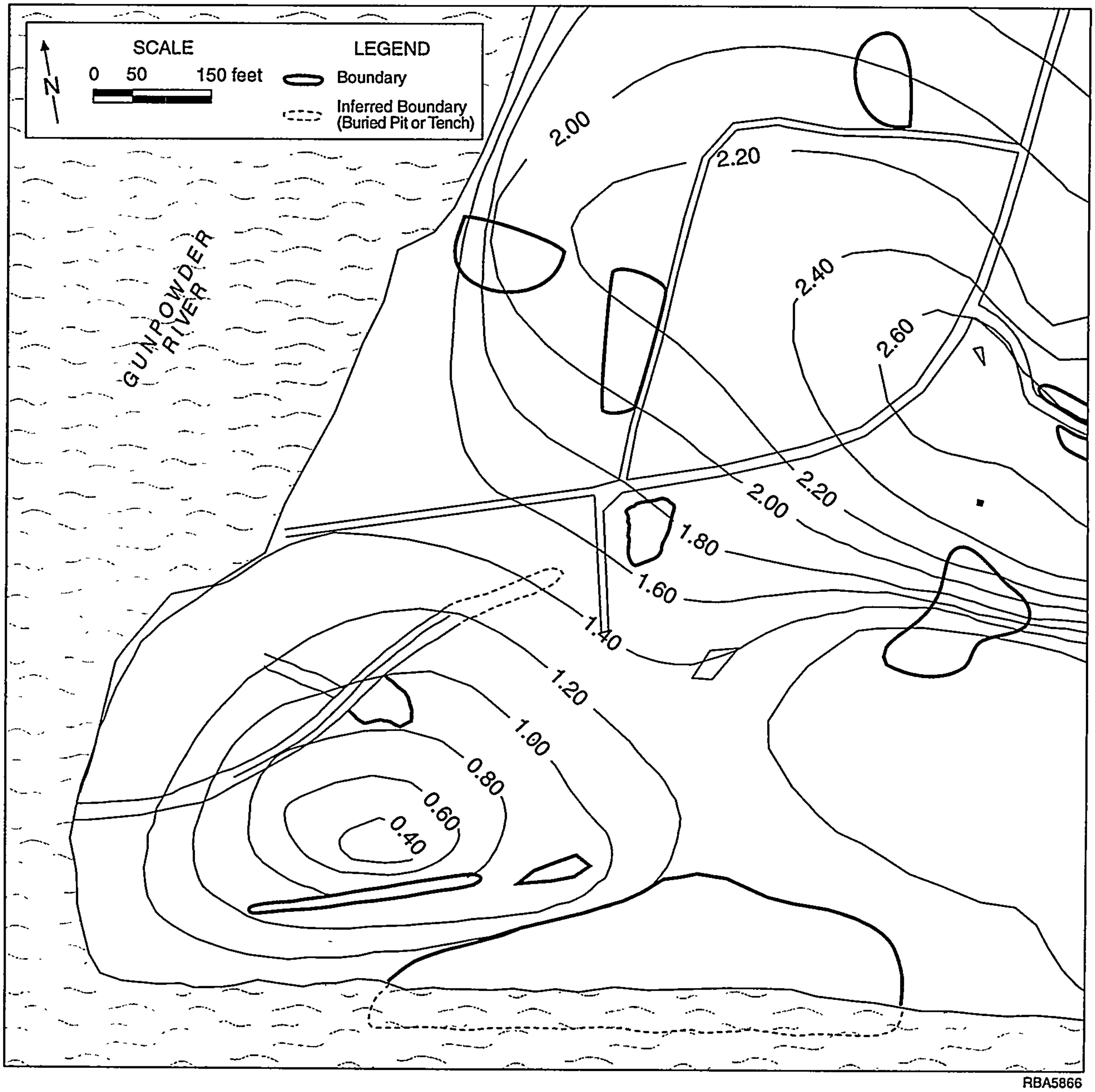


FIGURE 4.8 Water Table Contour of the Surficial Aquifer at the Riot Control Burning Pit AOC: December 1994

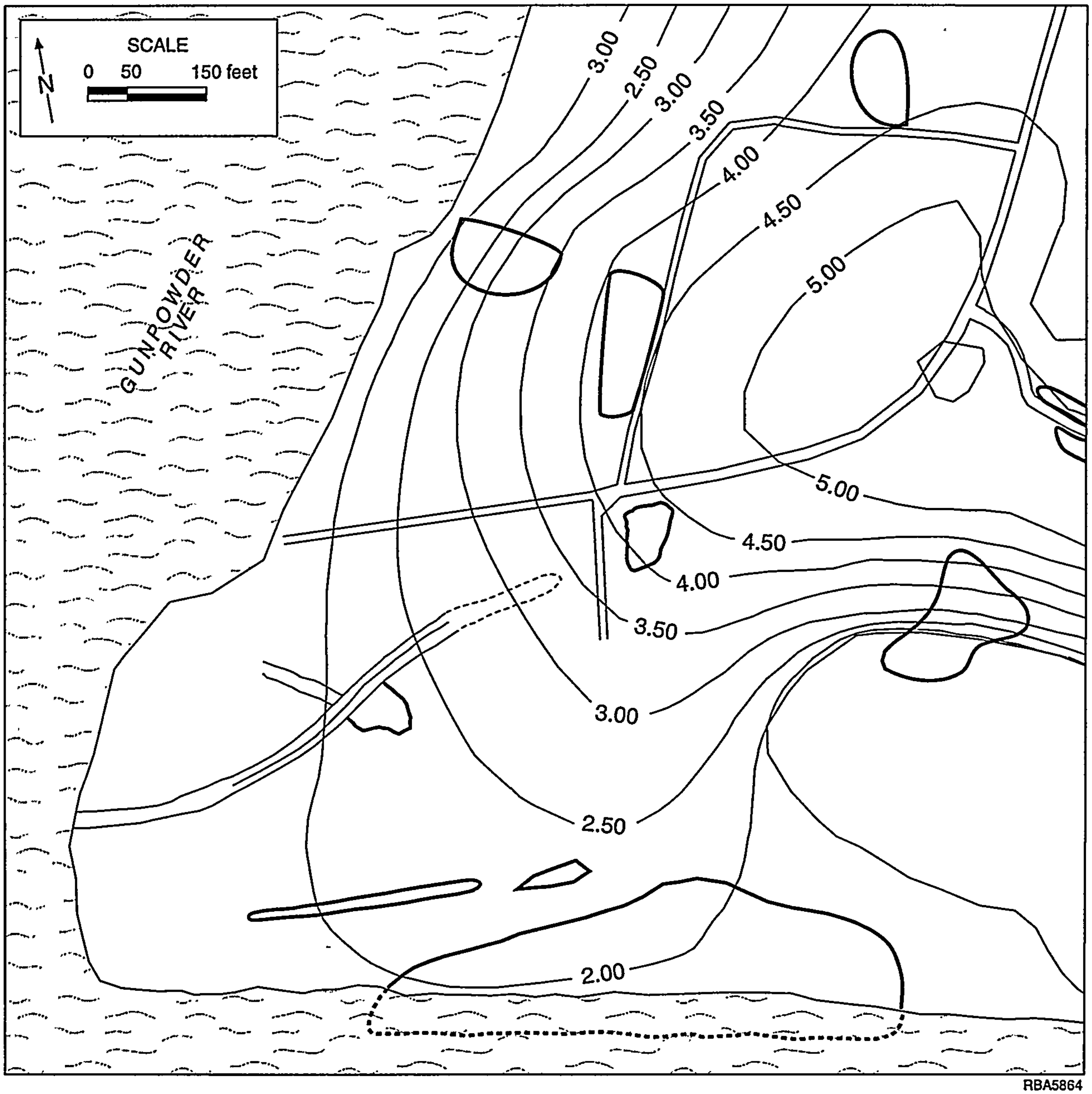


FIGURE 4.9 Water Table Contour of the Surficial Aquifer at the Riot Control Burning Pit AOC: May 1995

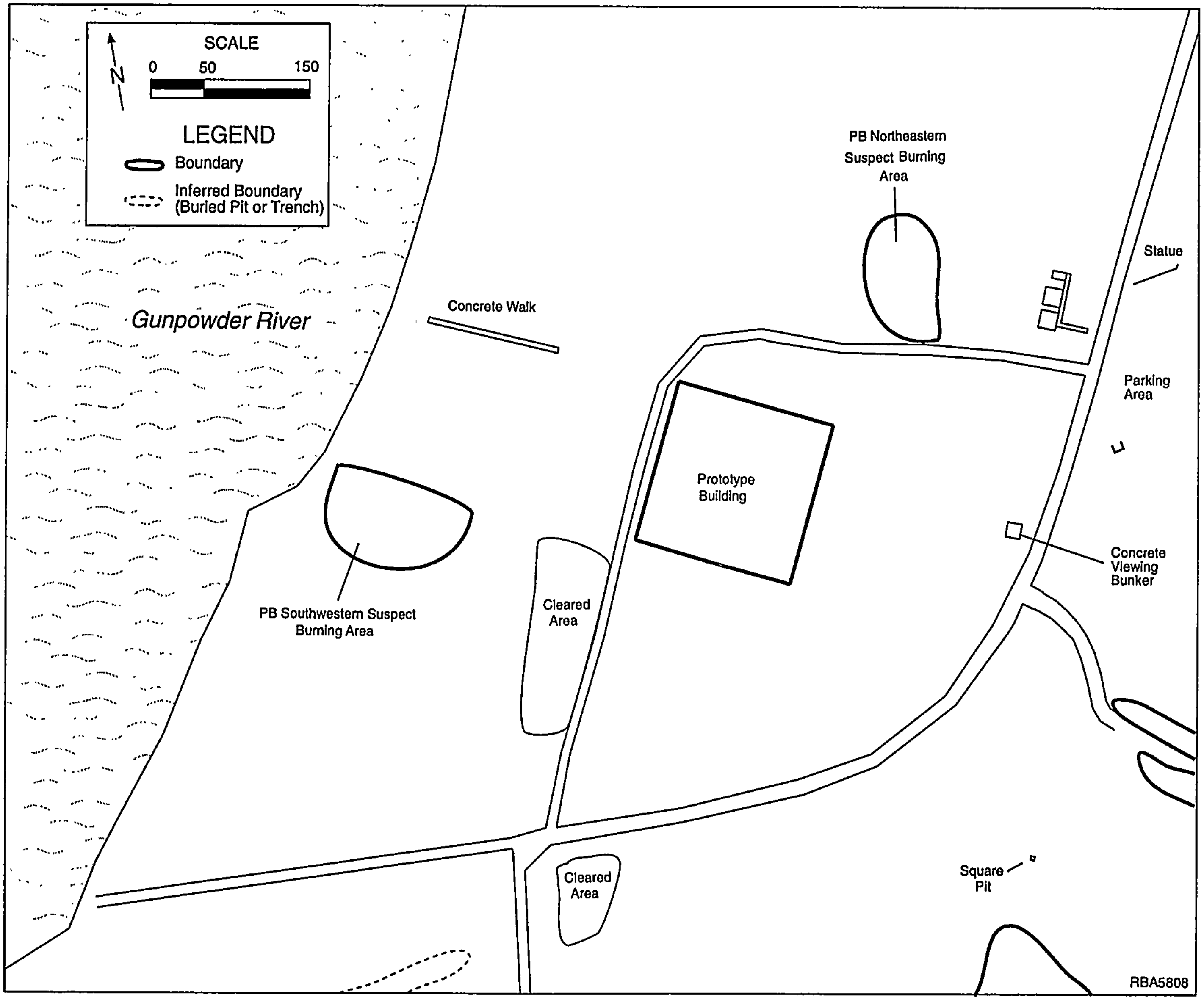


FIGURE 4.10 Map of the Prototype Building AOC

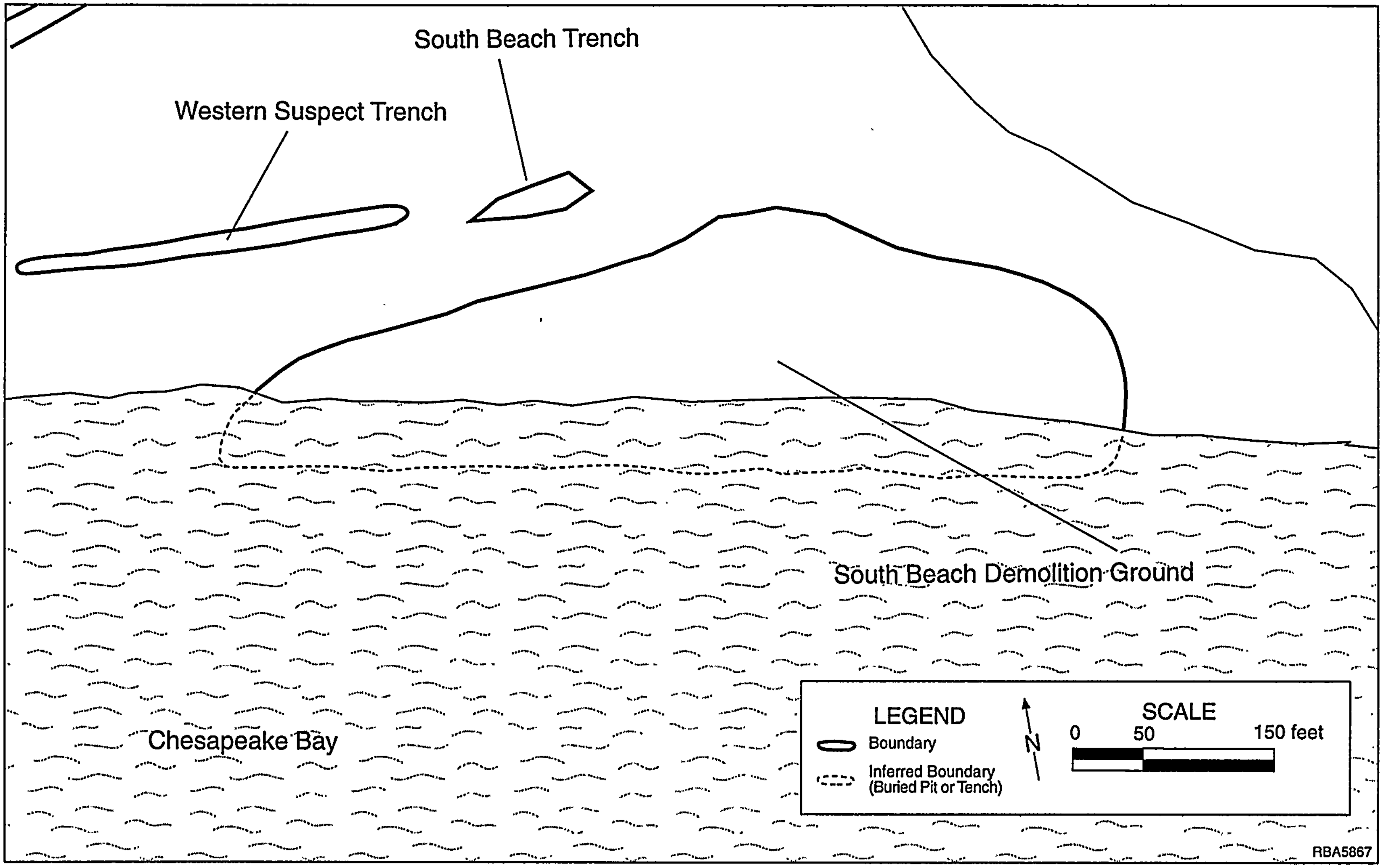


FIGURE 4.11 Map of South Beach Demolition Ground AOC and South Beach Trench AOC

demolition was conducted on the beach, in an area that extended for more than 400 ft along the shoreline. Because of shore erosion (Figure 1.3), the previous beach is now under water. It is reported that remnants of munitions are visible about 100 ft offshore during low tide. At high tide, most of the demolition ground is 1-2 ft below water. A few bomb craters are visible on the land east of the access road to the SBDG.

Surface water from the remnants of the SBDG most likely drains south toward Chesapeake Bay. The direction of groundwater flow in the surficial aquifer is also likely toward the bay. The nature of the shallow soils in the SBDG is undocumented; they are most likely composed of sandy silt.

4.6 SOUTH BEACH TRENCH AOC

The SBT AOC is located near the southern beach of J-Field, southeast of the RCP area (Figures 1.3 and 4.11). The trench is about 75 ft long, 4 ft deep, and 12 ft wide and was probably excavated between 1957 and 1960. Aerial photographs reveal a road or trench leading into and out of the SBT (U.S. Army 1965). In particular, a feature west of the SBT appears to be a trench and is referred to as the "western trench." The western trench is about 300 ft long. No information has been found regarding past chemical or hazardous material disposal in this area; however, chemical analyses of soil samples collected from the trench during the RFA showed low levels of chlordane and naphthalene (Nemeth 1989).

Because it is a depression, little or no surface water drains from the SBT; rather, precipitation and surface water runoff tend to collect there. Groundwater in the surficial aquifer flows toward Chesapeake Bay (Figures 4.8 and 4.9). Shallow soils are predominantly sandy silt (Prasad 1993a).

4.7 ROBINS POINT DEMOLITION GROUND AOC

The RPDG AOC is in the eastern portion of J-Field close to the Bush River (Figures 1.3 and 4.12). The site was first used during the late 1970s for the destruction of HE and HE-filled munitions. The site was also reportedly used during the 1980s for destruction of small amounts of sensitive and unstable chemicals by detonation with explosives (Nemeth 1989).

The original site, now inactive, was a small clearing near the edge of the adjacent marsh. In 1985, the clearing was enlarged, and a berm was built on the western edge of the clearing (Figure 4.1). The berm prevented surface runoff from entering the marsh (Nemeth 1989); this area has remained active and continues to be used for disposal operations. Therefore, only the area east of the berm is considered in this RI.

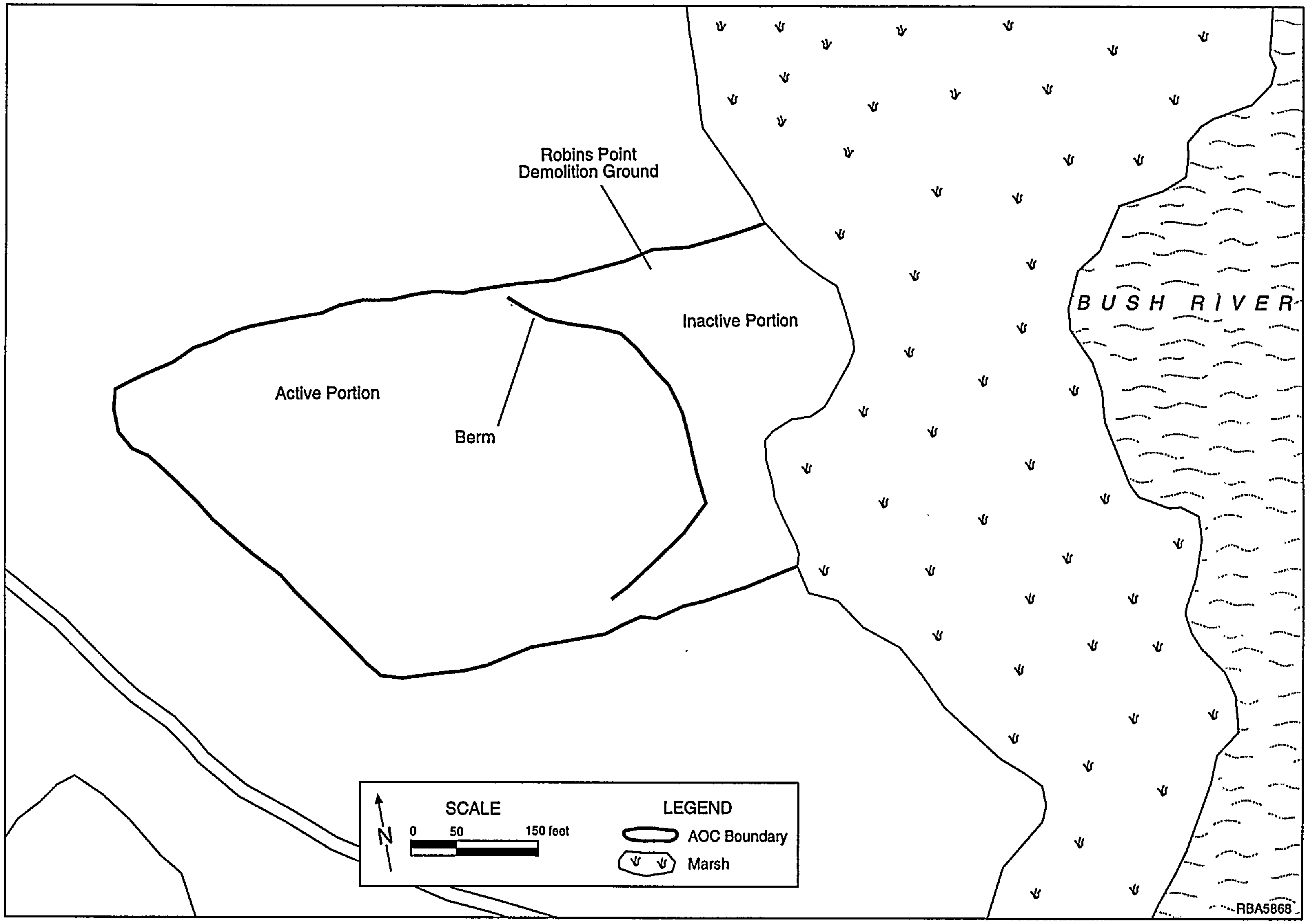


FIGURE 4.12 Map of Robins Point Demolition Ground AOC

Before 1985, surface water drainage from the RPDG flowed directly into the adjacent marsh to the east. The berm now prevents runoff from directly entering the marsh; however, water that ponds west of the berm seeps through the berm to the inactive portion of the RPDG. Groundwater in the surficial aquifer probably flows to the east toward the marsh. Shallow soils in the RPDG consist predominantly of clayey silt (Nemeth 1989).

4.8 ROBINS POINT TOWER SITE AOC

The RPTS AOC is located near Robins Point at the southeastern tip of the Gunpowder Peninsula (Figures 1.3 and 4.13). The wooden observation tower there was built between 1957 and 1960. The access road connecting Robins Point and Rickett's Point Road has existed since about 1917, when APG became an Army installation. Aerial photographs, however, suggest that the area was not used until the 1950s. The RPTS AOC was used for launching and observing rockets (Nemeth 1989).

Around 1959, the RPTS AOC may have been used for at least one test burn of wood contaminated with radioactive material (including radium and strontium). According to Nemeth (1989), the test burn was to take place in a trench (20 ft long, 5 ft wide, and 5 ft deep), and not more than 500 lb of material was to be burned in small increments. A 1959 U.S. Army Environmental Hygiene Agency (USAEHA) report recommended that the routine burning of radioactively contaminated materials be conducted in a closed incinerator; correspondence in the USAEHA project file indicates that this recommendation was accepted (Nemeth 1989). The possibility remains, however, that a test burn of radioactively contaminated wood did occur at either the RPDG or the RPTS. Records do not indicate which site was used. However, it is likely that the RPTS was used because RPDG was wooded and not yet in use in 1959.

Surface water drainage from the RPTS probably flows east toward Bush River and south toward the adjacent marsh. The direction of groundwater flow in the surficial aquifer is probably also toward Bush River and the marsh. Shallow soils are predominantly fine- to medium-grained sand near the ground surface, according to well log data near the site (Hughes 1993).

4.9 SITE X1 PAOC

Site X1 was identified in the RFA (Nemeth 1989). It is in the northwestern part of J-Field (Figures 1.3 and 4.14), about 300 ft southwest of the intersection of Rickett's Point Road and the access road to Area B (Ford's Point Firing Position). According to aerial photographs (U.S. Army 1965), it appears that the site was a cleared area of about 120 × 100 ft. An access road starting from Rickett's Point Road ended at the site. The access road bed is still discernible in the field.

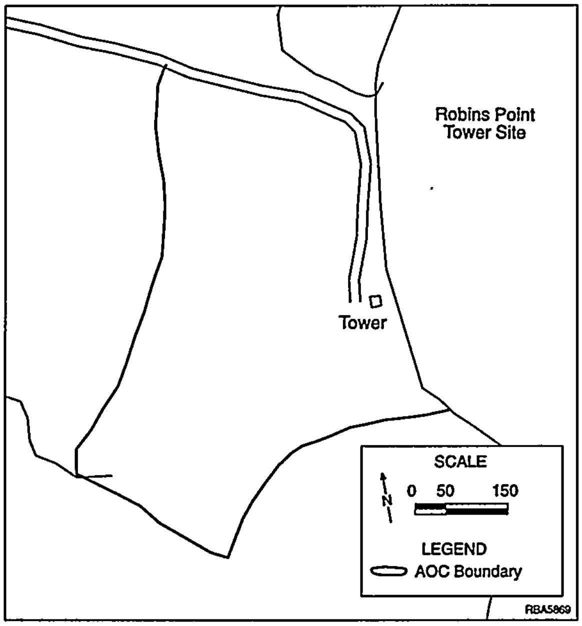


FIGURE 4.13 Map of Robins Point Tower Site AOC

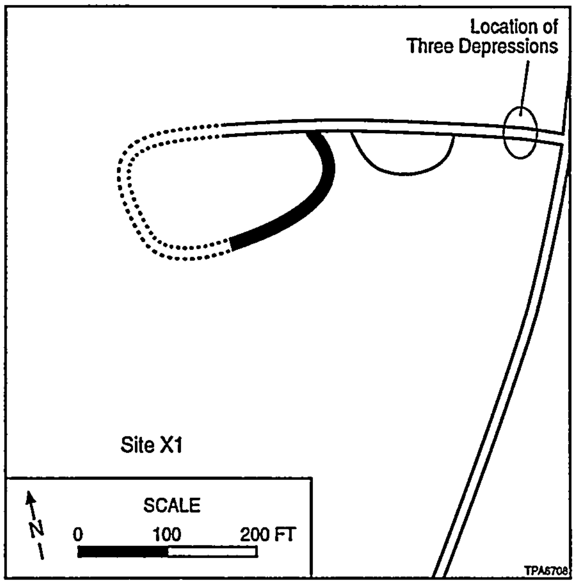


FIGURE 4.14 Map of Site X1 PAOC

Site XI includes two ruins separated by about 100 ft. Collapsed concrete columns lie on the ground surface at both ruins. Both are surrounded by a ridge of soil piles; the vegetation is much younger inside the ruins than in the surrounding areas. A brick foundation is visible in the eastern ruins. A small drum emerges from a soil pile in the western ruin. No bomb craters are visible near Site XI.

Three very shallow depressions with seasonally ponded water were identified near the access road. The first shallow depression is about 100 ft from the entrance of the access road and is perpendicular to it. The other depressions are parallel to the access road, near the first one. Each depression is rectangular and about 6 ft wide; their origins are not known. Site X1 has been present since as early as 1951 (Nemeth 1989). Its past use is unknown.

4.10 AREA A PAOC

Area A is located in the northern part of J-Field (Figure 1.3). Area A was first identified as a PAOC when the Maryland Department of the Environment asked APG to expand the J-Field RI/FS beyond the scope of the solid waste management units identified in the RFA (Nemeth 1989). Because Area A was not a subject of the RFA, no sampling or analysis data were available, and little archival information existed for the site. During field inspection, the site was found to be swampy, and portions of the trenches located there were filled with water. Several water-filled trenches are also prominent in aerial photographs. Area A is also characterized by features that appear as linear grids in aerial photographs. This grid pattern may be caused by drainage features used to drain wetlands in this region.

As shown in Figure 4.15, one S-shaped trench (Trench A-1) and one straight trench (Trench A-2) are present within the drainage grid. Trench A-1 is located near the access road to Area B (Fords Point Firing Position). It is separated from Trench A-2 by a dirt pile. Both trenches are 6–7 ft wide and 1–2 ft deep and are filled with water in the spring. No scrap metal has been found on the ground surface nearby. Magnetometry surveys conducted before sampling to avoid UXO revealed that the subsurface soil and sediment near the trenches do not contain scrap metal. The past use of the trenches is unclear, but the trenches may have functioned as part of a system to drain wet areas or to drain water away from Fords Point Firing Position Road.

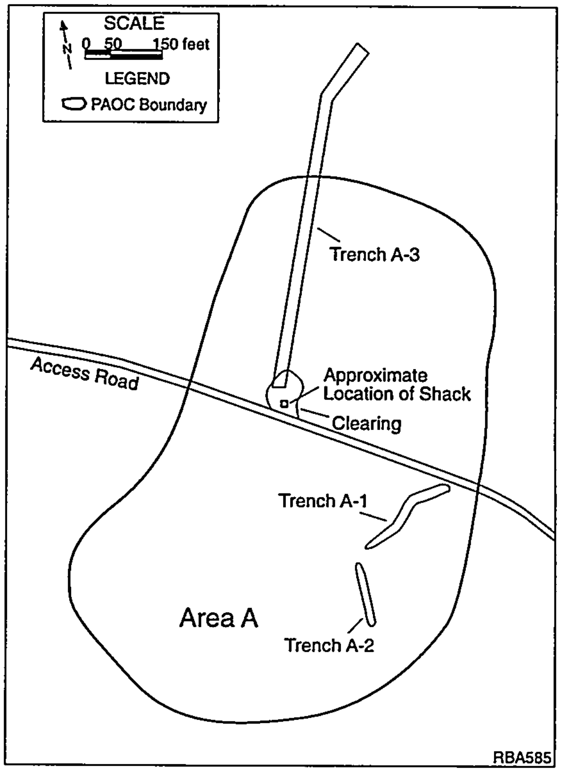


FIGURE 4.15 Map of Area A PAOC

Remains of the foundation of an old building are located about 400 ft northwest of Trench A-1 and to the north of the access road (Figure 4.15). This may be the location of the small shack that appears at this site in 1965 aerial photographs (U.S. Army 1965). The ground in this area is now scattered with a few glass bottles and ceramic shards. Soil piles surround the site. A prominent, straight drainage trench (Trench A-3) about 6 ft wide extends over 700 ft from behind the site of the shack to a swamp located north of J-Field. This trench has a north-south trend and is readily noticeable in aerial photographs.

4.11 AREA B PAOC

Area B (Fords Point Firing Position) is a large open area near the Bush River at the eastern end of an access road in the northern part of J-Field (Figures 1.3 and 4.16). Aerial photographs show that it has existed at least since 1951 (Nemeth 1989). The site is covered with reed grass (*Phragmites*). Concrete slabs are piled up near the shore of the Bush River, most likely for protection against erosion. A pile of concrete chunks embedded with hollow pipes is present near the southern part of the site. Soil mounds are present near the western boundary of the site, and two small scrap drums were found on the ground surface near the soil mounds. The past use of the site is unknown.

4.12 AREA C PAOC

Area C is a ruins site at Rickett's Point Road and the entrance of the access road to Area B (Fords Point Firing Position) (Figures 1.3 and 4.17). Historical aerial photographs (U.S. Army 1965) show two buildings near the intersection of the access road and Rickett's Point Road and a wall near the eastern part of the site. Later aerial photographs show that the buildings were destroyed before 1968. Remnants of a standing concrete wall and bricks on the ground surface remain. Bomb craters are visible near the site. The destroyed buildings probably were used for access control to the Fords Point Firing Position, and the concrete wall in the eastern part of the site was probably a test site for bombing.

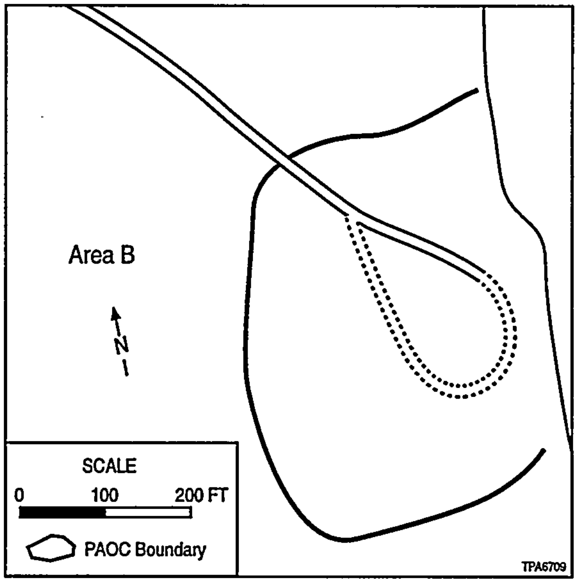


FIGURE 4.16 Map of Area B PAOC

4.13 RUINS SITE PAOC ACROSS FROM THE WHITE PHOSPHORUS BURNING PITS AOC

The Ruins Site located across Rickett's Point Road from the WPP (Figures 1.3 and 4.18) includes two building ruins, two connected artificial ponds, four retaining wall structures, and a suspected filled trench. These features are discernible in the 1965 aerial photographs. The western part of the site, where the building ruins are located, is flooded seasonally.

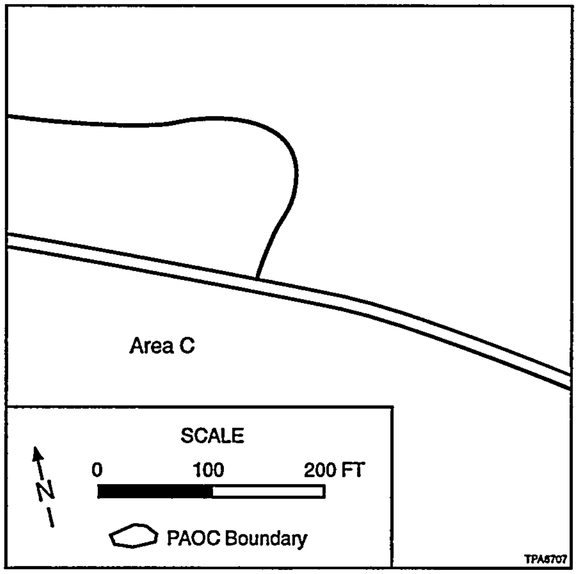


FIGURE 4.17 Map of Area C PAOC

The site was used for munitions testing in World War II (Nemeth 1989). Bomb craters are common, especially near the four retaining wall structures. Probably because of bombing, only remnants of buttressed columns and partially destroyed steel-reinforced walls remain in the field. No visible metal scrap was found on the ground surface.

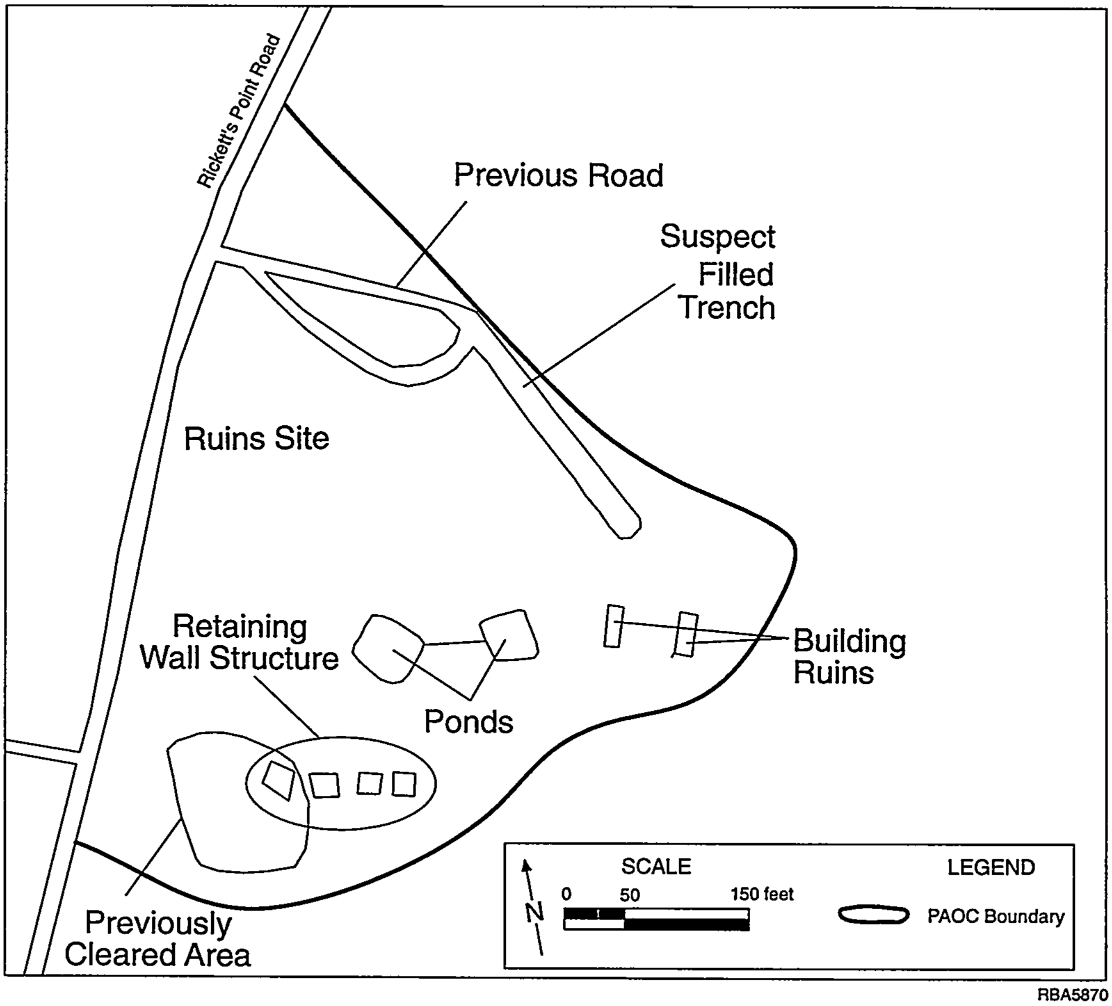


FIGURE 4.18 Map of the Ruins Site PAOC

The building ruins are in the eastern part of the site (Figure 4.18). One is a steel-reinforced concrete building, and the other is a steel-reinforced brick building. Circular scars are common on the outside walls of the building.

Two small ponds connected by a ditch are near the southern part of the site. One of the ponds is rectangular, and the other is irregularly shaped. The past use of the ponds is unknown.

A suspected filled trench (or an old road), about 7–8 ft wide, was discernible in an area about 80 ft northwest of the building ruins. It is partially ponded with water. The suspected filled trench extends northwest for more than 200 ft. Traces of road bed, which extended to Rickett's Point Road, are discernible near its end. A steel tube with a cylinder inside was found next to a pile of soil between the suspected filled trench and the two building ruins.

Aerial photographs from 1965 show a dark-toned area in the southwestern part of the site. This area was inspected in the field and found to be flat and covered with vegetation that is younger than that in the surrounding area. No scrap metal was found on the ground surface. The previous use of this area is unknown.

4.14 AREA D PAOC

Area D, located about 400 ft east of the Ruins Site (Figure 1.3), is a flooded, swampy area dotted with many craters. It appears in a dark tone on aerial photographs. No road extends to Area D. It was probably used for either bomb testing or targeting.

4.15 CRATERS PAOC

Hundreds of craters are scattered around the J-Field area (Figure 4.19). They are the result of bomb and projectile testing and in-place detonation of ordnance. The craters exist in ruins, woods, marshes, and areas with no access roads. Craters of different sizes are distributed throughout the J-Field site. Some are a few feet in diameter, while others are more than 20 ft in diameter and visible in large-scale historical aerial photographs (U.S. Army 1965).

J-Field was reportedly used for field testing of ordnance during World War II (Nemeth 1989). Steel-reinforced concrete structures, including prototype buildings in the PB AOC and simple slab walls in Site X1 and the Ruins Site, were used as targets, which explains the occurrence of craters clustered around the Ruins Site east of the WPP AOC and around the PB AOC. In addition, numerous craters are clustered in the woods and marshes near demolition areas at the RPDG, TBP, and SBDG AOCs.

Conventional munitions were reportedly used for most of the targets (Nemeth 1989). Most of the craters were probably caused by conventional munitions; however, some may have resulted from testing of chemical agent munitions.

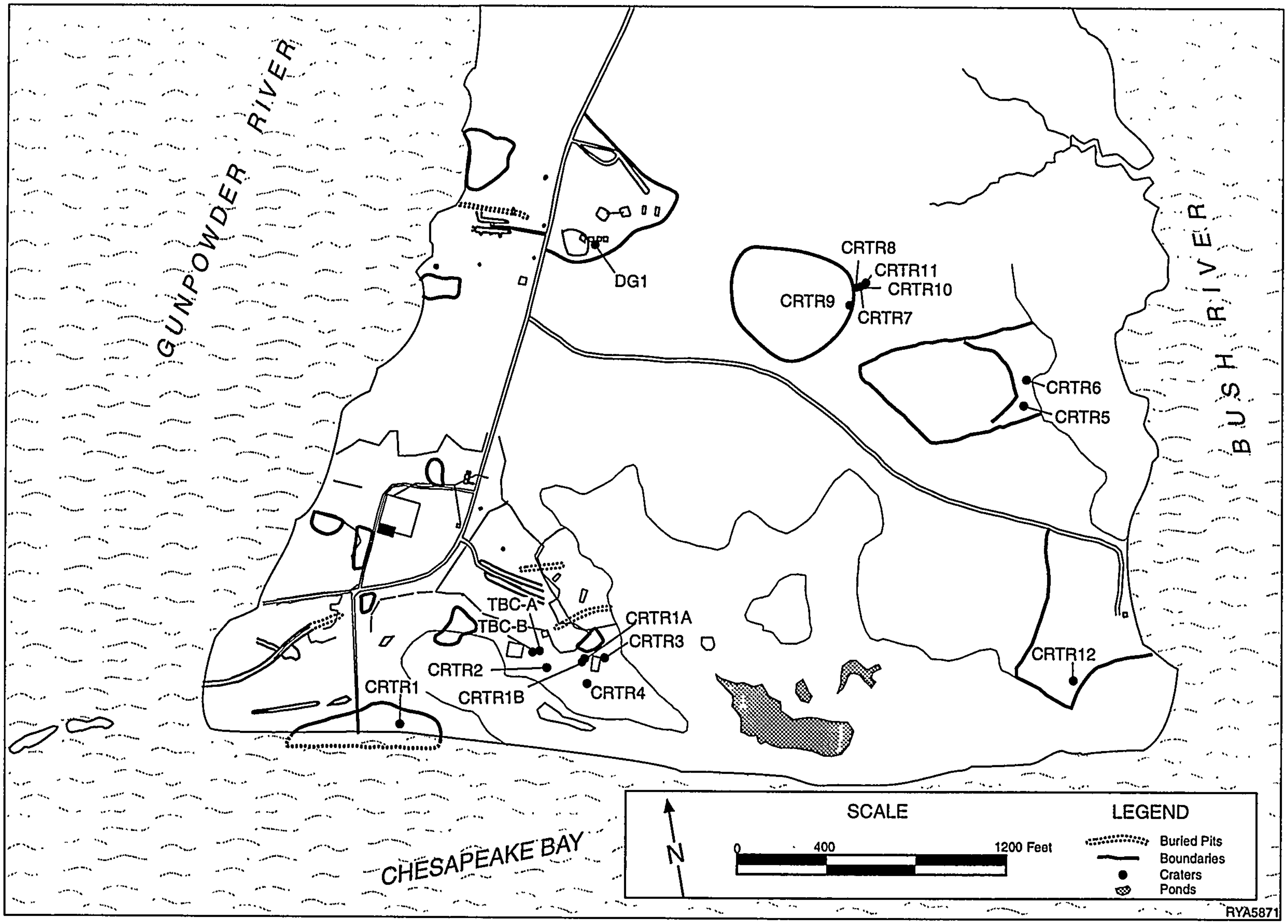


FIGURE 4.19 Map Showing Locations of Craters That Constitute the Craters PAOC

5 DATA EVALUATION

This section provides a brief evaluation of data for each of the AOCs and PAOCs. For easy reference, a list of RI samples collected by medium has been included for each AOC and PAOC. The evaluation is based on the detailed data summary presented in Appendix A.

5.1 TOXIC BURNING PITS AOC

5.1.1 Soil

5.1.1.1 Main Burning Pits

Subsurface soil samples were collected from 11 borings at and near the northern and southern Main Burning Pits (Table 5.1). The analytical results indicate that the soil at the pits, underlying the pits, and near both end of the pits is contaminated with heavy metals (mainly arsenic, cadmium, chromium, copper, lead, and zinc), chlorinated solvents (mainly ethanes and ethenes), phthalates, SVOCs related to petroleum products, PCBs, and pesticides. The magnitude and nature of the contamination vary spatially (Figure 5.1).

In the Northern Main Pit, high levels of arsenic, cadmium, chromium, copper, mercury, nickel, antimony, and zinc were found in the central and western sections, especially in the upper 4 ft of soil underlying the pit. Moderate levels of these metals extend more than 10 ft deep. Low levels of chlorinated methane, ethanes, and ethenes (11DCE, trans-12DCE, 12DCE, chloroform, TCLEA, TCLEE, and trichloroethene [TRCLE]); low levels of dioxins and furans; and high levels of petroleum-related products (chlorobenzene, ethylbenzene, toluene, and xylenes) were also found, mostly at a depth less than 8 ft below the bottom of the pit. Low levels of petroleum-related SVOCs, phthalates, and PCBs were detected in subsurface soils, mostly less than 4 ft deep. In the eastern section and near the northern edge of the pit, low levels of contaminants (arsenic, copper, lead, zinc, TRCLE, benzene, 2,4,6-trichloroaniline, phenol, and PCBs) were detected in soils near the ground surface.

In the Southern Main Pit, PCBs and chlorinated ethanes and ethylenes are prominent. The chlorinated ethanes and ethylenes include 1,1,2-trichloroethane (112TCE), 12DCE, TCLEA, TCLEE, TRCLE, and vinyl chloride. The concentrations increase with depth. The contamination occurs primarily in the eastern part of the pit. The highest concentrations are as follows: 3,270 mg/kg of TCLEA, 263 mg/kg of TRCLE, and 143 mg/kg of Aroclor 1248 (a PCB). On the other hand, only low levels of petroleum-related VOCs and phthalates were detected in the surface soil samples.

TABLE 5.1 Summary of RI Samples Collected at the TBP AOC

Date	Medium	Sample Numbers	Analytical Suite	RI Report Section (Data Table)
1993	Surface soil	OT1–OT4, OT17, OT18	VOCs SVOCs Metals	A.1.2.1.1 (A.8 and A.9)
1994	Subsurface soil	TBPNPBOR1–TBPNPBOR3	VOCs SVOCs Metals Cyanide PCBs/pesticides Dioxins CSM/CSM degradation products Explosives-related compounds	A.1.2.1.2 (A.13-A.17)
1994	Subsurface soil	TBPSPBOR1, TBPSPBOR2	VOCs SVOCs Metals PCBs/pesticides TPH PAH Explosives-related compounds	A.1.2.1.2 (A.19-A.22)
1993	Surface soil	OT16, OT19	VOCs SVOCs Metals	A.1.2.2.1 (A.24)
1994	Subsurface soil	VXBOR1–VXBOR5	VOCs SVOCs Metals	A.1.2.2.2 (A.26-A.30)

TABLE 5.1 (Cont.)

Date	Medium	Sample Numbers	Analytical Suite	RI Report Section (Data Table)
1993	Surface soil	OT29–OT32	VOCs SVOCs Metals	A.1.2.3.1 (A.34)
1994	Surface soil	CLP1–CLP9	VOCs SVOCs Metals PCBs/pesticides TPH PAHs Explosives-related compounds	A.1.2.3.1 (A.35-A.38) A.1.2.4.1 (A.41 and A.42)
1995	Surface soil	TBDGS1–TBDGS3	Metals Cyanide	A.1.2.3.1 (A.39)
1994	Subsurface soil	FTBOR1	Metals PCBs/pesticides	A.1.2.3.2 (A.40 and A.41)
1994	Subsurface soil	HBOR1, HBOR2, HBOR4	VOCs SVOCs (subset) Metals Cyanide (subset) PCBs/pesticides (subset) TPH PAHs CSM/CSM degradation products (subset) Explosives-related compounds	A.1.2.4.2 (A.44-A.47)
1994	Surface soil	TPDGS4, TPDGS5	Metals Cyanide Explosives-related compounds	A.1.2.5.1

TABLE 5.1 (Cont.)

Date	Medium	Sample Numbers	Analytical Suite	RI Report Section (Data Table)
1994	Surface soil	SQPS1–SQPS9	Metals Cyanide Explosives-related compounds (subset)	A.1.2.6.1 (A.48)
1995	Subsurface soil	SA1	VOCs	A.1.2.7.1
1993	Surface soil	OT6–OT15, OT20	VOCs SVOCs Metals PCBs/pesticides (subset) TPH (subset) PAHs (subset) Explosives-related compounds (subset)	A.1.2.8.1 (A.49 and A.50)
1994	Groundwater	P1-P9, JF43, JF51,JF52, JF53, JF61, JF62, JF63, JF71, JF72, JF73, JF81, JF82, JF83, JF173, JF183, JFPM1–JFPM5	VOCs SVOCs Metals General chemistry CSM/CSM degradation products Explosives-related compounds Gross alpha/beta activity	A.1.3 (A.59-A.66)
1997	Groundwater	P1, P3-P9, JF41, JF42, JF43, JF51,JF52, JF53, JF61, JF62, JF63, JF71, JF72, JF73, JF81, JF82, JF83, JF173, JF183, JF201, JF203, JFPM1-JFPM5, JFP1–JFP4, JFL2, JFL4	VOCs SVOCs (subset) Metals TOC CSM/CSM degradation products Explosives-related compounds	A.1.3 (A.67-A.69)
1994	Surface water	SW20	VOCs	A.1.4.1

TABLE 5.1 (Cont.)

Date	Medium	Sample Numbers	Analytical Suite	RI Report Section (Data Table)
1994	Surface water	SW7, SW10–SW12	VOCs SVOCs Metals General chemistry PCBs/pesticides CSM/CSM degradation products Explosives-related compounds	A.1.4.2
1994	Surface water	SW21, Q55SW, Q56SW, Q58SW–Q60SW, Q62SW, Q64SW, Q65SW, Q93SW, Q95SW	VOCs	A.1.4.2 (A.73 and A.74)
1994-1995	Sediment	SEDBOR1–SEDBOR8, TPSED1–TPSED8	VOCs SVOCs (subset) Metals Cyanide (subset) PCBs/pesticides (subset) CSM/CSM degradation products (subset) Explosives-related compounds (subset)	A.1.4.2 (A.75-A.78)

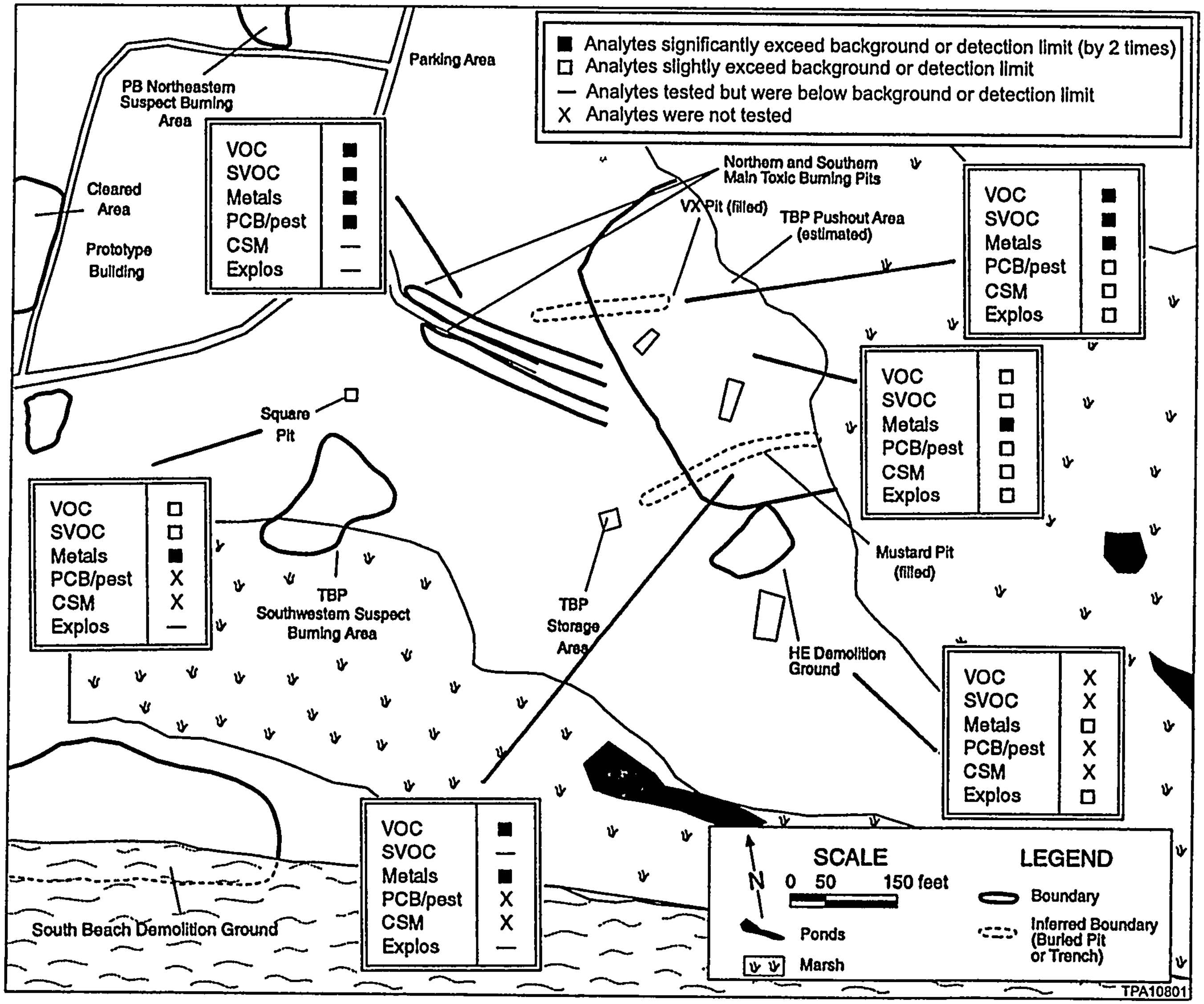


FIGURE 5.1 General Distribution of Major Contaminants in Soil and Sediment at the TBP AOC

Metal contamination (arsenic, copper, lead, and zinc) is moderate in the soils underlying the Southern Main Pit and near the ground surface. The concentrations are substantially lower than those in the soil underlying the Northern Main Pit.

5.1.1.2 VX and Mustard Burning Pits

The VX Pit is not exposed and was delineated in geophysical surveys in the spring of 1995 (Davies et al. 1995). The location of the filled pit is shown in Figure 5.1. Five borings were installed at and near the pit. Two borings (VXBOR3 and VXBOR4) were to be installed at the suggested pit center, where disposal activities were observed in historical aerial photographs. However, the borings could not be drilled more than 6 ft deep for safety reasons, because metal (and thus potential UXO) was detected in the subsurface soil. This situation impeded a full characterization of the nature and vertical extent of contamination at the center of the VX Pit.

Nevertheless, the information from the borings and a few surface soil samples shows the extent of contamination in the surface soil (and limited subsurface soil) at and near the VX Pit. Generally, the magnitude and extent of soil contamination are related to the specific location of the previous disposal site and the Pushout Area (Figure 5.1). At the suggested disposal center, where borings VXBOR3 and VXBOR4 are located, the surface soil is contaminated with moderate to high levels of heavy metals (including antimony, arsenic, copper, lead, mercury, nickel, and zinc), and it contains low levels of chlorinated ethanes and ethenes, petroleum-related compounds, pesticides, dioxins and furans, 1,4 dithiane (a mustard degradation product), and phthalates. The vertical extent of the contamination is estimated to be deeper than 6 ft. Near the disposal center, in areas near the western end of the pit and toward the east, metal contamination is limited to the upper 2 ft of surface soil, while organic contamination is minimal. However, the TPH content is high in the deeper soil east of the disposal center. Farther to the east, in the Pushout Area, the same contaminants as those found in the disposal center were detected, such as heavy metals, petroleum-related compounds, pesticides, dioxins and furans, and 1,4-dithiane. The concentrations are generally lower than those in the disposal center. The vertical extent of the contamination in the Pushout Area increases toward the east, probably reflecting the thickness of the pushout material.

The Mustard Pit is not exposed and was delineated from geophysical surveys in early 1995. Figure 5.1 shows its location. An effort was made to fully characterize the nature and the vertical extent of the contamination at the pit. Three borings were drilled near and at the pit. Unfortunately, the detection of metal contacts in subsurface soil prevented drilling at the inferred previous disposal center for safety reasons. A full characterization of the nature of contamination at the pit was therefore impossible. As a result, three borings were installed near the edges of the pit and at an area downgradient from the previous disposal center.

Heavy metals, such as antimony, arsenic, cadmium, copper, lead, and zinc, are commonly found in the soil, especially in the upper 2 ft. The levels can be as high as 15.7 mg/kg for arsenic, 4,960 mg/kg for lead, and 890 mg/kg for zinc. Contamination decreases with depth and was not detected below 6 ft in three borings. Very low levels of petroleum-related compounds and phthalates were detected in the upper 2 ft of soil. Low levels of chlorinated ethanes and ethenes (111TCE, TCLEA, and TRCLE) were detected in surface and subsurface soil. Low levels of two CSM degradation products, diisopropylmethyl phosphonate and 1,4-dithiane, were detected in two subsurface soil samples taken more than 6 ft below the ground in a boring (HBOR4) next to the pit.

5.1.1.3 Storage Area

The Storage Area was identified in historical aerial photographs and confirmed in the field. In 1995, two soil samples at depths of 2–4 and 6–8 ft were collected from a boring (SA1) at the Storage Area and analyzed for VOCs (Figure 5.1). A trace amount of TCLEA (3 ug/kg) was found in the deeper soil sample. Low levels of two other VOCs, methylene chloride and acetone, were found in two samples. Because both methylene chloride and acetone are common laboratory contaminants, the detection of low levels of these VOCs is not considered significant. The Storage Area is therefore not considered contaminated.

5.1.1.4 Pushout Area

The Pushout Area is delimited by the Northern Main Pit, the Southern Main Pit, the VX Pit, and the Mustard Pit. The eastern end of each burning pit merges into the Pushout Area, making it difficult to distinguish between the pits and the Pushout Area. Figure 5.1 shows the approximate boundary of the Pushout Area, which is based on historical aerial photograph analysis.

Heavy-metal contamination is the most prominent feature in the Pushout Area, especially in the area bounded by the VX Pit, the Mustard Pit, the eastern ends of the two Main Burning Pits, and the marsh. The contamination is not uniform in type or level of contamination. Pockets of uncontaminated areas are possible (such as at boring FTBOR1). Consistent metal contaminants found in the Pushout Area include moderate to high levels of copper, lead, and zinc. The lead and zinc concentrations in some soil samples can be more than 8%. The presence of other metals (antimony, arsenic, and cadmium) depends on the location. The vertical extent of the contamination is more than 4 ft in the low-lying area near the eastern part of the Pushout Area. Higher levels are found in the upper 2 ft of surface soil. The vertical extent of metal contamination in soil probably is related to the thickness of the pushout material.

Chlorinated methanes, ethanes and ethenes (112TCE, TCLEA, TCLEE, TRCLE, chloroform), and petroleum-related compounds are present at low levels, except at a few locations near the boundary between the Southern Main Pit and the Pushout Area, where elevated levels of PCBs and pesticides were detected in the surface soil. Locally, chlorinated ethanes and ethenes were detected at depths of 4 and 6 ft (in boring JSDPC). The origin of these organic compounds is not clear. They may have been caused by spills during past disposal activities. No explosives-related compounds or cyanide were detected in the surface soil samples.

5.1.1.5 Square Pit and Southwestern Suspect Burning Area

The Square Pit and the Southwestern Suspect Burning Area were identified in historical aerial photographs and confirmed in the field. Field XRF measurements indicate that the titanium content in soil from the Square Pit is 25 times higher than that in the soil nearby. Since titanium tetrachloride is a major component of liquid smoke, the Square Pit is believed to be the Liquid Smoke Disposal Pit.

Nine surface soil samples were collected in the Suspect Burning Area. The analytical results of the samples indicate that the site is contaminated with heavy metals, including arsenic, barium, cadmium, chromium, copper, lead, mercury, silver, and zinc. The distribution of the contamination is not uniform; higher metal contamination exists in the Square Pit and the southern part of the site next to the marsh. Metal debris was observed on the ground near the northern boundary and in the southern part of the site.

Analytical results do not support the idea that the site was a burning disposal site. Only three types of VOCs (acetone, methylene chloride, and carbon disulfide) and one SVOC (benzo[k]fluoranthene) were detected in the soil samples, and they were detected at insignificantly low levels. Acetone and methylene chloride are common laboratory contaminants.

On the basis of these results, it is inferred that the site could have been used as a demolition site, probably before the 1960s. The extent of the site has not been verified in the field, and the lateral extent of contamination has not been fully characterized. An engineering evaluation/cost analysis (EE/CA) of the Liquid Smoke Disposal Pit conducted in 1997 evaluated removal action alternatives and recommended that "no action" be taken at the site.

5.1.1.6 High Explosives Demolition Ground

The HE Demolition Ground was delineated by historical aerial photographs. On the basis of XRF field measurements and the analytical results of four surface soil samples, the site is insignificantly and locally contaminated with metal. Cadmium was the only metal found at a level slightly above the calculated background. One of the four samples showed an elevated level of an explosive (15.3 mg/kg of nitroglycerin). The HE Demolition Ground is not considered a contamination source. However, the pushout material from the demolition ground, which is estimated to be near the marsh, may be contaminated.

5.1.1.7 Other Areas

Several surface soil samples were collected in the northwestern part of the TBP AOC. Slightly elevated levels of 1,1-dichloroethene and metals, including arsenic, copper, lead, and zinc, were found sporadically in the area. Elevated levels of PAHs, TPH, and metals were also detected immediately to the northeast of the Pushout Area.

5.1.2 Groundwater

5.1.2.1 Surficial Aquifer

Groundwater data on the surficial aquifer collected by the USGS and Argonne in 1994 support a previous study by Hughes (1993). In summary, the area near the two Main Burning Pits serves as a groundwater recharge area for the surficial aquifer. The center of the recharge area was at the Main Burning Pits in the spring and fall (Figures 4.2 and 4.3). Groundwater flows out from the recharge area in directions ranging from south-southeast to northeast, spreading contaminants (especially VOCs). This flow pattern is supported by the chemical data of groundwater collected from different wells at the TBP AOC.

The surficial aquifer under the eastern portion of the TBP AOC is significantly contaminated with chlorinated methanes, ethanes, and ethenes (Figure 5.2). Very high concentrations of 112TCE, 12DCE, TCLEA, TCLEE, and TRCLE have consistently been detected in groundwater monitoring wells P4, JF53, JF63, JF73, JF83, JF173, and JF183 since 1986 as well as in four piezometers installed in the marsh east of the AOC. The high levels of chlorinated compounds in groundwater suggest the potential presence of free-phased, dense nonaqueous-phase liquids (DNAPLs) in the subsurface. Other VOCs, such as vinyl chloride and chloroform, were also detected, but at lower concentrations. Groundwater near the Main Burning Pits is also contaminated with heavy metals, including arsenic, cadmium, chromium, lead, mercury, and zinc. The cadmium, chromium, mercury, and lead levels exceed AWQC or MCL standards locally, especially near the two Main Burning Pits.

Low levels of three CSM degradation products — 1,4-diathiane, 1,4-oxathiane, and diisopropylmethyl phosphonate — were detected in four wells (JF63, JF73, JF83, and P3). Significant levels of nitrate were found in wells P2 and P9. Well P9 also had elevated levels of lead and nitrocellulose.

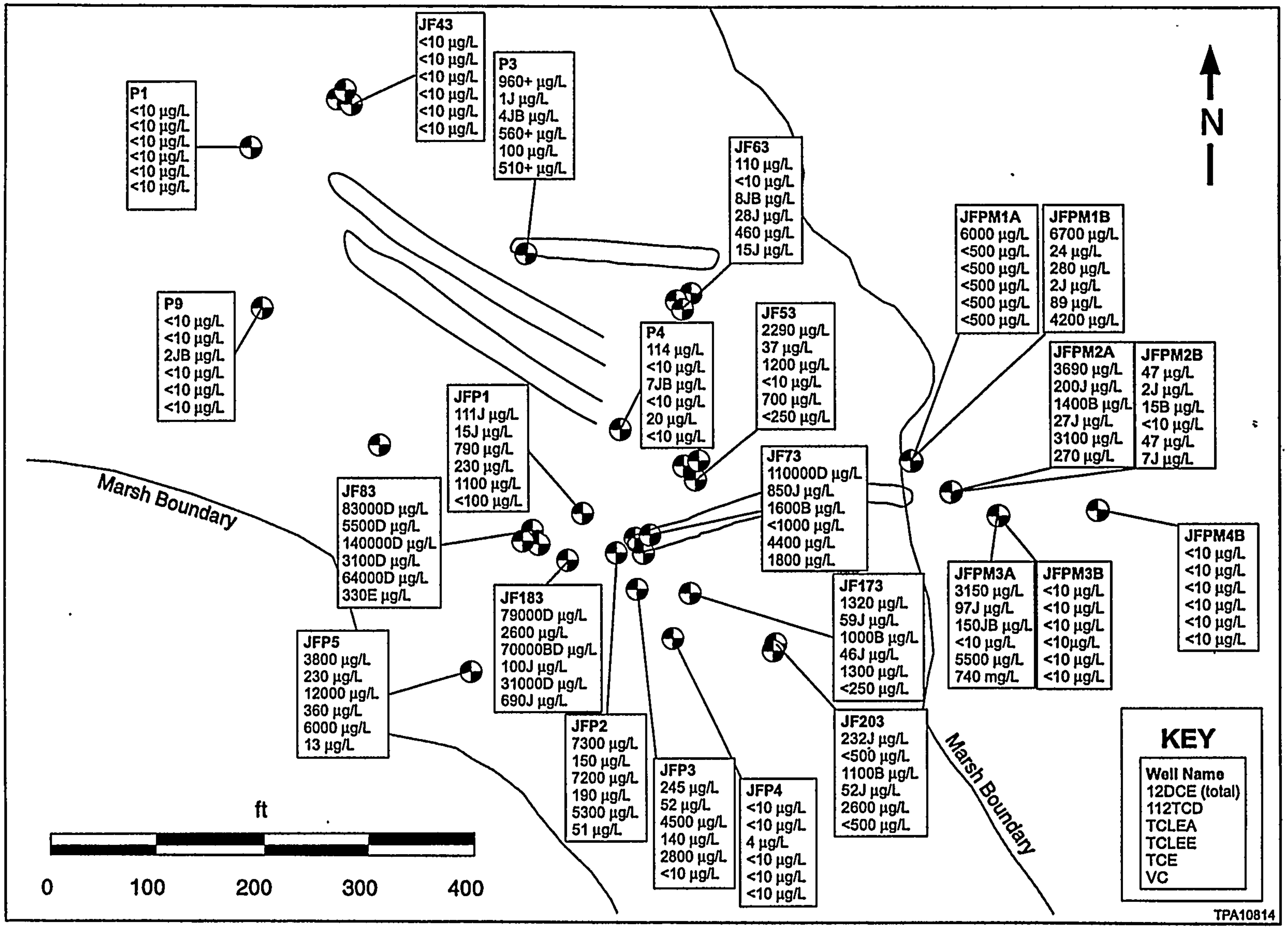


FIGURE 5.2 General Distribution of VOCs in Groundwater in the Surficial Aquifer at the TBP AOC

The sources of the VOC and metal contamination in groundwater under the eastern part of the TBP AOC are believed to be the two Main Burning Pits, the VX Pit, and the Mustard Pit. The very high levels of VOCs in wells JF73, JF83, JF173, and JF183 correlate well with the high levels of similar VOCs in soils under the eastern section of the Southern Main Pit. The high arsenic content in the subsurface soil of the Northern Main Pit is the only known subsurface source of arsenic in the groundwater. (The other potential source would be the VX Pit, but this could not be verified because of the limited depths of borings in this area). Elevated levels of arsenic were found in wells P3 and JF83, both located downgradient of the groundwater recharge zone at the Main Burning Pits. In addition, the groundwater flow regime, as depicted Figures 4.2 and 4.3, indicates that contaminants from the two Main Burning Pits can spread to the eastern part of the TBP AOC.

On the basis of groundwater data from the piezometers in the eastern marsh and surface water data from the southern marsh, the plume of contaminated groundwater has reached both marshes in the east and in the south. The extent of the plume has not been delineated because of the absence of monitoring wells east of the Mustard Pit. The eastern boundary is tentatively estimated to be between piezometers 3A and 4A in the eastern marsh. The boundary in the southern marsh could not be estimated because no piezometers have been installed in that area.

The arsenic and the three CSM degradation products found in the groundwater from well P3 can be attributed to either the VX Pit or the Northern Main Pit, while the 1,4-diathiane and 1,4-oxathiane found in well JF63 come either from the pushout material or the VX Pit through subsurface migration.

The presence of lead, nitrate, and explosives in well P9 shows that demolition activities may have taken place in the Southwestern Suspect Burning Area. Because the screen of well P9 starts at only a few feet below the ground surface, lead (which is not mobile), explosives, and nitrate may have infiltrated from disturbed surface soil to groundwater. The anomalous nitrate levels detected in well P2 are likely to be related to demolition operations. This interpretation is consistent with the discovery of metal debris near well P9 and in the southern part of the Southwestern Suspect Burning Area.

5.1.3.2 Confined Aquifer

Low to moderate levels of 12DCE, 112TCE, and TRCLE were detected in several monitoring wells in the confined aquifer (mainly JF51 and JF81). Since 1990, the levels have increased.

Because of concern that VOCs detected in the confined aquifer beneath the TBP AOC may affect water quality in the region, the confined aquifer was evaluated through a modeling analysis (Quinn et al. 1998). The model focused on TCE as the main contaminant of concern. Because of the absence of chemical and geological data in offshore areas, the model relied on an extremely conservative approach (i.e., promoting the spread of contaminants) in order to provide a worst-case scenario of contaminant transport to a hypothetical receptor. The results from this conservative evaluation indicate that the simulated contaminant plume extends into offshore areas from J-Field, but it decays before reaching a receptor well. The 5 contour of 5 parts per billion (ppb), for example, stagnates approximately 3 mi from the source. Because recent field analyses document that complete biodegradation is occurring directly below the TBP AOC, the likelihood of VOCs reaching a pumping well appears to be negligible.

5.1.3 Surface Water and Sediment

Contamination of surface water and sediments at the TBP AOC is largely confined to two areas: the marsh immediately south of the Main Burning Pits and the boundary between the Pushout Area and the marsh east of the pits. Surface water contamination south of the pits is characterized by elevated levels of heavy metals. During the 1993 and 1995 sampling periods, abnormally low pH levels were found. Although the sediments do not show metal concentrations higher than background levels, it is possible that the acidic conditions in the marsh are sufficient to mobilize heavy metals in the sediments, resulting in increased metal concentrations in surface water. The cause of the periodically observed acidic conditions in the south marsh is unknown. Contamination by PAHs in sediment boring samples appears confined to the shallow subsurface (2–4 ft). The origin of the PAHs is not clear. These contaminants were not found in any other sediments. It is possible that the location may represent an isolated, relict disposal area where wastes were burned. Alternatively, the SVOCs present could be the result of fires that have occurred periodically on the Gunpowder Peninsula. The contaminants do not appear to have migrated from other areas.

The contaminated area east of the Pushout Area appears to be associated with past disposal activities in the burning pits. Sediment and surface water samples collected there had significantly elevated levels of heavy metals and low levels of residual munitions contamination and pesticides. Surface water collected adjacent to and south of the Pushout Area had high levels of chlorinated organic compounds (such as 12DCE, TRCLE, 112TCE, and TCLEA) and low levels of CSM degradation products. The chlorinated organic compounds in the surface water may come from the seepage of contaminated groundwater. The heavy-metal contamination (arsenic, lead, and mercury) of both surface water and sediment next to the Pushout Area correlate well with the contaminants in the Pushout Area. The high levels of iron, copper, and zinc from these locations are consistent with contamination derived from the rusting of metal casings. Although the surface water contamination is associated with contaminated sediments, surface water runoff from within the Pushout Area itself may also be a significant source of contamination. Sediment contamination appears to be confined largely to the surface sediments. Certain mobile species (e.g., barium, manganese, and zinc) found in the surface water in the far eastern areas of the TBP AOC may have migrated via surface water flow from the Pushout Area or from sediment reservoirs in the east end of the marsh. No sediment samples have been taken in this area. The origin of the high manganese concentrations in the surface water is not clear. No elevated manganese levels have been found in any sediments. However, manganese mobility depends on pH and Eh, and it is possible that the levels are a result of natural processes. The manganese data alone are not sufficient to demonstrate contamination by anthropogenic sources.

Surface water and sediment samples taken near the southeastern tip of the TBP peninsula did not contain VOCs. This finding does not support the results of the passive soil gas survey, in which low levels of VOCs were reported. However, a surface water sample from the southwestern corner of the pond southeast of the TPB peninsula did show low levels of TCLEA and TRCLE, confirming the result of the soil gas survey at that location. The origin of the VOCs in the pond is unknown. Potential sources include the Pushout Area and contaminated groundwater discharging into the marsh. Both are capable of dispersing VOCs to the ponds.

5.2 WHITE PHOSPHORUS BURNING PITS AOC

5.2.1 Soil

Soil gas and XRF data were collected around the three main suspected contamination sources at the WPP AOC: the Northwestern Suspect Burning Area, the Southwestern Suspect Burning Area, and the Suspect Storage Area. Because the two burning pits at the WPP AOC are still active, no sampling was conducted in that area. The results of the field screening tests indicated the presence of acetone, styrene, and chloromethane in the two suspect burning areas. The acetone and styrene are considered to occur naturally in these areas. Acetone is also a common laboratory contaminant. However, the low level of chloromethane, found just outside the boundary of the Southwestern Suspect Burning Area, may represent actual contamination associated with the area. Strontium was the only elevated metal detected by XRF in the Northwestern Suspect Burning Area and the Southwestern Suspect Burning Area. Exploratory geophysical surveys (seismic refraction, seismic reflection, electrical resistivity, electromagnetic, magnetic, and GPR) found no anomalies.

Surface soil samples were collected from each of the three areas (Table 5.2). The highest levels of SVOCs and metals were found in samples from the Northwestern Suspect Burning Area, although they were detected in several of the other samples as well (Figure 5.3). SVOCs detected in this area included benzo[a]athrancene, benzo[b]fluoranthene, chrysene, and fluoranthene. Several metals, including barium, cadmium, copper, lead, mercury, selenium, and zinc, were found at levels exceeding the calculated background. Cyanide was not detected.

Low levels of acetone and methylene chloride were found in the sample from the Suspect Storage Area (the only sample analyzed for VOCs). All metals in the surface soil in this area were

TABLE 5.2 Summary of RI Samples Collected at the WPP AOC

Date	Medium	Sample Numbers	Analytical Suite	RI Report Section (Data Table)
1994	Surface soil	CLPW99 (0–6 in.), CLPW99 (6–12 in.)	VOCs SVOCs Metals	A.2.2.1 (Table A.2-1)
1995	Surface soil	WPNWS1–WPNWS3, WPSWS1, WPSWS2, WPSTS1	VOCs (subset) SVOCs Metals Cyanide General chemistry	A.2.2.1 (Table A.2-2)
1995	Surface soil	SA2 (0–2 ft)	Metals	A.2.2.1 (Table A.2-2)
1995	Subsurface soil	SA2 (2–4 ft), SA2 (4–6 ft)	VOCs TPH	A.2.2.1
1994	Groundwater	P5–P8, TH1, TH3, JF91, JF93, JF101, JF111, JF121, JF123	VOCs Metals General chemistry Explosives-related compounds	A.2.3 (Tables A.2-3 and A.2-4)
1994	Surface water	WPP-A, WPP-C	VOCs SVOCs Metals TOX PCBs/pesticides CSM/CSM degradation products	A.2.4 (Table A.2-5)
1995	Surface water	WPSW2–WPSW4	Metals Cyanide CSM/CSM degradation products Explosives-related compounds	A.2.4 (Table A.2-6)

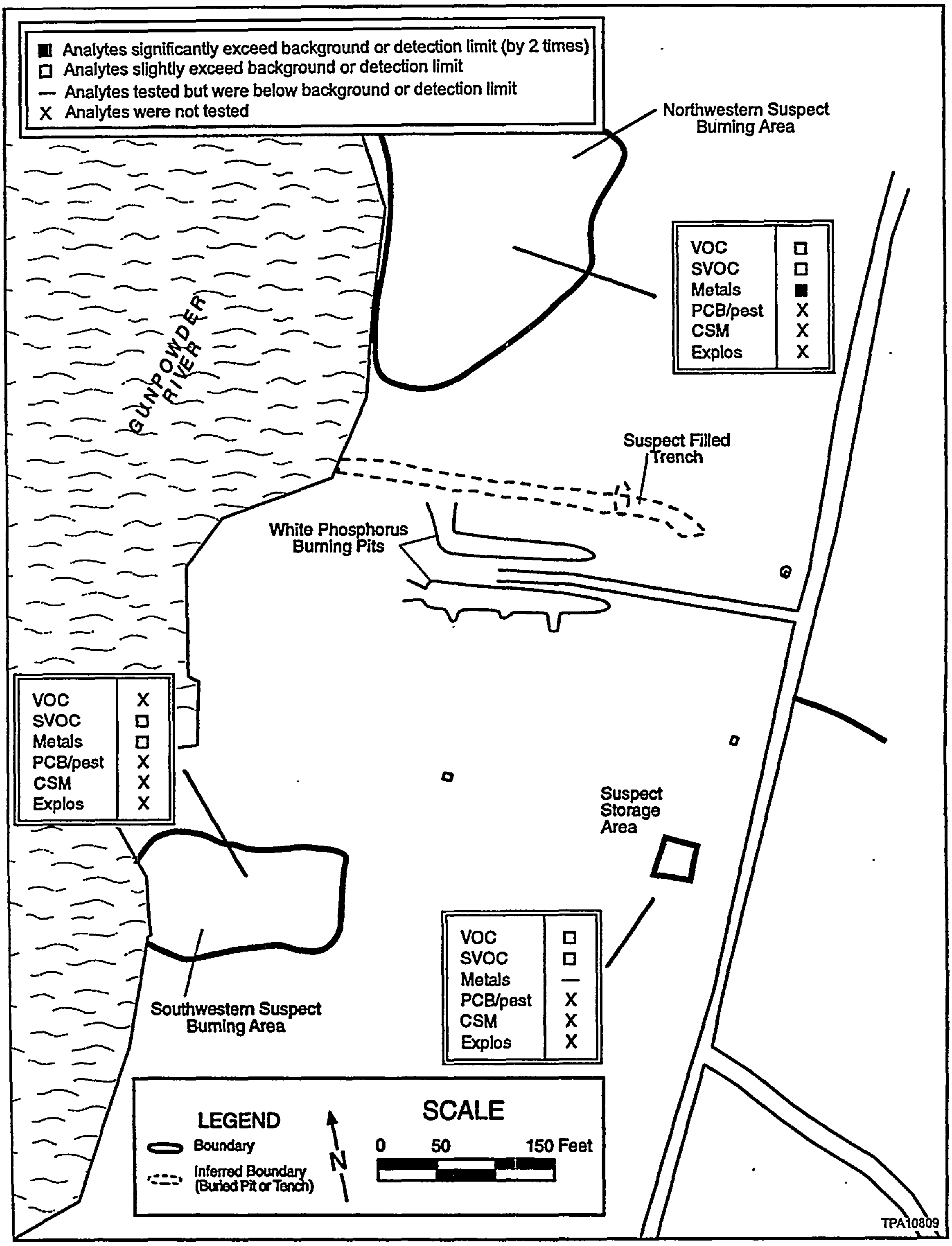


FIGURE 5.3 General Distribution of Major Contaminants in Soil at the WPP AOC

found at levels below the calculated background; however, arsenic exceeded the calculated background in the 2-ft soil sample. Low levels of VOCs were detected up to 8 ft in the Suspect Storage Area; these included acetone, methylene chloride, and TCLEE. No TPHs were detected.

5.2.2 Groundwater

Groundwater was sampled in 1994 as part of the RI and analyzed for VOCs, metals, general chemistry, and explosives-related compounds (Table 5.2). The only VOC detected at a level above the MCL was TRCLE. Iron and manganese exceeded the MCLS in both filtered and unfiltered fractions. The levels of iron and magnesium do not pose an environmental problem.

5.2.3 Surface Water and Sediment

Two surface water samples collected near the burning pits contained several metals, including arsenic, lead, and zinc, at levels above the calculated background. The explosive RDX was detected in both samples. Metals were also detected in surface water samples collected from the marsh adjacent to the Northwestern Suspect Burning Area and adjacent (offshore) to the Southwestern Suspect Burning Area; however, only iron, lead, and zinc were found to exceed the calculated background levels. These results are consistent with the soil sample data. Cyanide, CSM/CSM degradation products, and explosives-related compounds were not detected in any of the surface water samples.

5.3 RIOT CONTROL BURNING PIT AOC

5.3.1 Soil

Soil gas surveys conducted at the RCP AOC found elevated levels of VOCs, including benzene, 11DCE, 12DCE, isooctane, methylene chloride, TCLEE, and TRCLE in several locations. Most of the contaminants were clustered around the northeastern end of the RCP and along the southern side of Rickett's Point Road. Soil along the length of the partially buried trench was also sampled in the field by XRF, which showed several metals to be present at elevated levels: copper and strontium at the northeastern end and middle section of the pit, zinc in the middle section and southwestern end of the pit, and lead in the middle section of the pit. A focused geophysical survey (electromagnetic conductivity, electromagnetic induction, magnetics, and GPR) delineated the filled section of the pit at the northeastern end.

Surface soils collected along the length of the pit and within the Suspect Old Trench and open area near its middle section confirmed the presence of several metals (Table 5.3). These included arsenic, cadmium, copper, lead, nickel, and zinc. Levels were highest in samples collected from within the pit. Samples from the Suspect Old Trench had metals concentrations only slightly higher than the calculated background, suggesting that the Suspect Old Trench may actually be an access road and not a former disposal pit. The only VOC detected was methylene chloride, a common laboratory contaminant. No SVOCs were detected (Figure 5.4).

Low levels of VOCs were detected in most of the subsurface soil samples; however, with the exception of acetone and carbon disulfide, none were at levels above the detection limit. Several SVOCs were also detected at very low levels in the northern branch near the disposal center. Metals, including arsenic, cadmium, copper, lead, and zinc, were also highest in subsurface soil from the disposal center. No other significant contamination was found. Contamination was found to decrease with depth. The subsurface soil at the disposal center in the filled portion of the pit could not be fully characterized because borings could not be installed for safety reasons. However, soil gas data and data from nearby borings indicate that petroleum-related compounds and chlorinated methane, ethane, and ethene compounds are likely to be present in the subsurface in this area.

5.3.2 Groundwater

Groundwater in the surficial aquifer and leaky confining unit was sampled in 1994 as part of the RI. Samples from the surficial aquifer were analyzed for general chemistry and VOCs, SVOCs, metals, PCBs, and pesticides. Samples from the leaky confining unit were sampled for general chemistry and VOCs only. No contaminants were found in the leaky confining unit. Groundwater from the downgradient surficial aquifer well contained levels of benzene that exceeded the MCL. Two SVOCs, bis(2-ethyhexyl)phthalate and phenol, were also detected. The only metals detected were iron and lead; iron exceeded the AWQC and MCL values. However, it is not considered a problem in this environment. No PCBs or pesticides were detected.

5.3.3 Surface Water and Sediment

Surface water collected from the middle section of the pit had detectable levels of copper. No other contaminants were present. Offshore samples had slightly elevated levels of chromium, nickel, and zinc. No other contaminants were present. No contaminants were found in the sediment samples from these locations.

TABLE 5.3 Summary of RI Samples Collected at the RCP AOC

Date	Medium	Sample Numbers	Analytical Suite	RI Report Section (Data Table)
1993	Surface soil	ORCP1–ORCP6	VOCs SVOCs Metals	A.3.2.1 (Table A.3-4)
1995	Surface soil	RCPS1–RCPS14	Metals	A.3.2.1 (Table A.3-5)
1994	Subsurface soil	RCPBOR1, RCPBOR2, RCPBOR4	VOCs SVOCs Metals	A.3.2.2 (Table A.3.9 and A.3.10)
1995	Subsurface soil	RCPBOR5–RCPBOR7	VOCs SVOCs Metals Cyanide PCBs/pesticides Dioxins CSM/CSM degradation products Explosives-related compounds	A.3.2.2 (Tables A.3.9 and A.3.10)
1994	Groundwater	JF12, JF13, JF22, JF23, JF143	VOCs General chemistry PCBs/pesticides (subset)	A.3.3
1995	Surface water	RCPSW1–RCPSW3	VOCs SVOCs Metals PCBs/pesticides CSM/CSM degradation products Explosives-related compounds	A.3.4

TABLE 5.3 (Cont.)

Date	Medium	Sample Numbers	Analytical Suite	RI Report Section (Data Table)
1995	Sediment	RCPSW1–RCPSW3	VOCs SVOCs Metals PCBs/pesticides CSM/CSM degradation products Explosives-related compounds	A.3.4

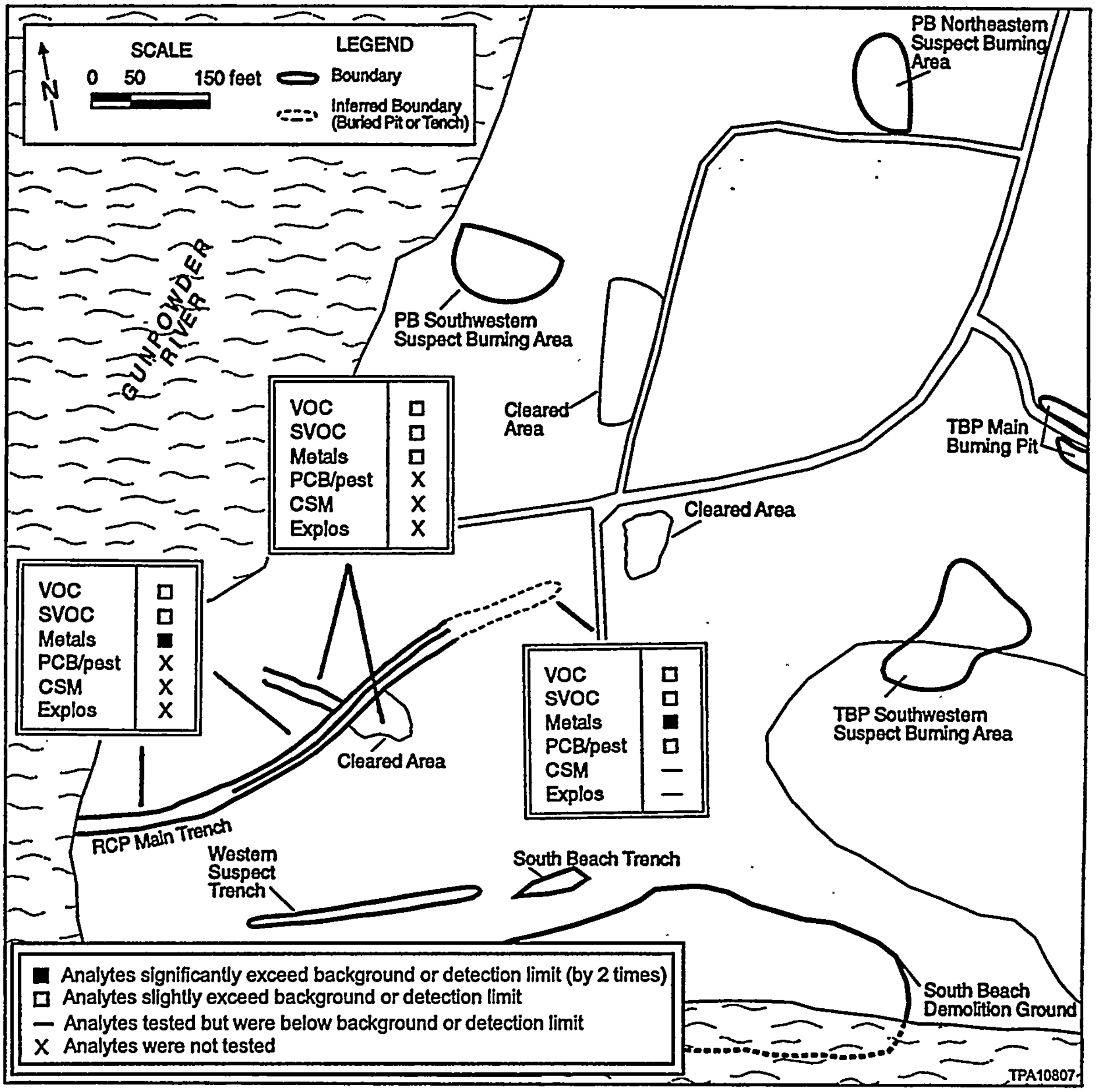


FIGURE 5.4 General Distribution of Major Contaminants in Soil and Sediment at the RCP AOC

5.4 PROTOTYPE BUILDING AOC

5.4.1 Soil

Soil gas and XRF data were collected around the PB and in the Northeastern and Southwestern Suspect Burning Areas. The results of these field screening tests indicated the presence of VOCs (e.g., TCLEE, acetone, benzene, xylene, and toluene) in areas around the PB and the Southwestern Suspect Burning Area. Elevated levels of zinc and lead were also detected around the building. Surface soils collected in these areas for laboratory analysis (Table 5.4) confirmed the presence of metals, especially cadmium, copper, lead, mercury, silver, and zinc, around the PB. No VOCs or CSM/CSM degradation products were detected; however, low levels of SVOCs, including bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, fluoranthene, and pyrene, were found in samples from each area (Figure 5.5).

Low levels of pesticides were detected in soil in areas east, north, and south of the building. Their low levels and distribution pattern suggest the presence of pesticides may be the result of normal use in the past.

5.4.2 Groundwater

Groundwater was sampled in 1994 as part of the RI and analyzed for VOCs, metals, and explosives-related compounds (Table 5.4). No VOCs or explosives-related compounds were detected. Total iron, total lead, and dissolved lead were the only metals found in groundwater to exceed the AWQC. Although low levels of hydrocarbon (in 1988) and of benzene and methylisobutyl ketone (in 1990) were detected in well TH8 in previous investigations, they were not detected in the 1994 sampling event.

5.4.3 Surface Water and Sediments

Two surface water samples collected offshore were analyzed for metals; none were detected above the calculated background level. Sampling prior to the RI indicated the presence of organic compounds; these contaminants may reflect the past use of the site for bomb testing.

TABLE 5.4 Summary of RI Samples Collected at the PB AOC

Date	Medium	Sample Numbers	Analytical Suite	RI Report Section (Data Table)
1994	Surface soil	PTB1–PTB6	VOCs SVOCs Metals Cyanide Pesticides CSM/CSM degradation products	A.4.2.1 (Table A.4-1)
1995	Surface soil	PTNES1, PTNES2, PTSWS1– PTSWS4	VOCs Metals	A.4.2.1 (Table A.4-2)
1994	Groundwater	TH8, JF31–JF33	VOCs General chemistry	A.4.3
1995	Surface water	PTSW1, PTSW2	Metals	A.4.4 (Table A.4-3)

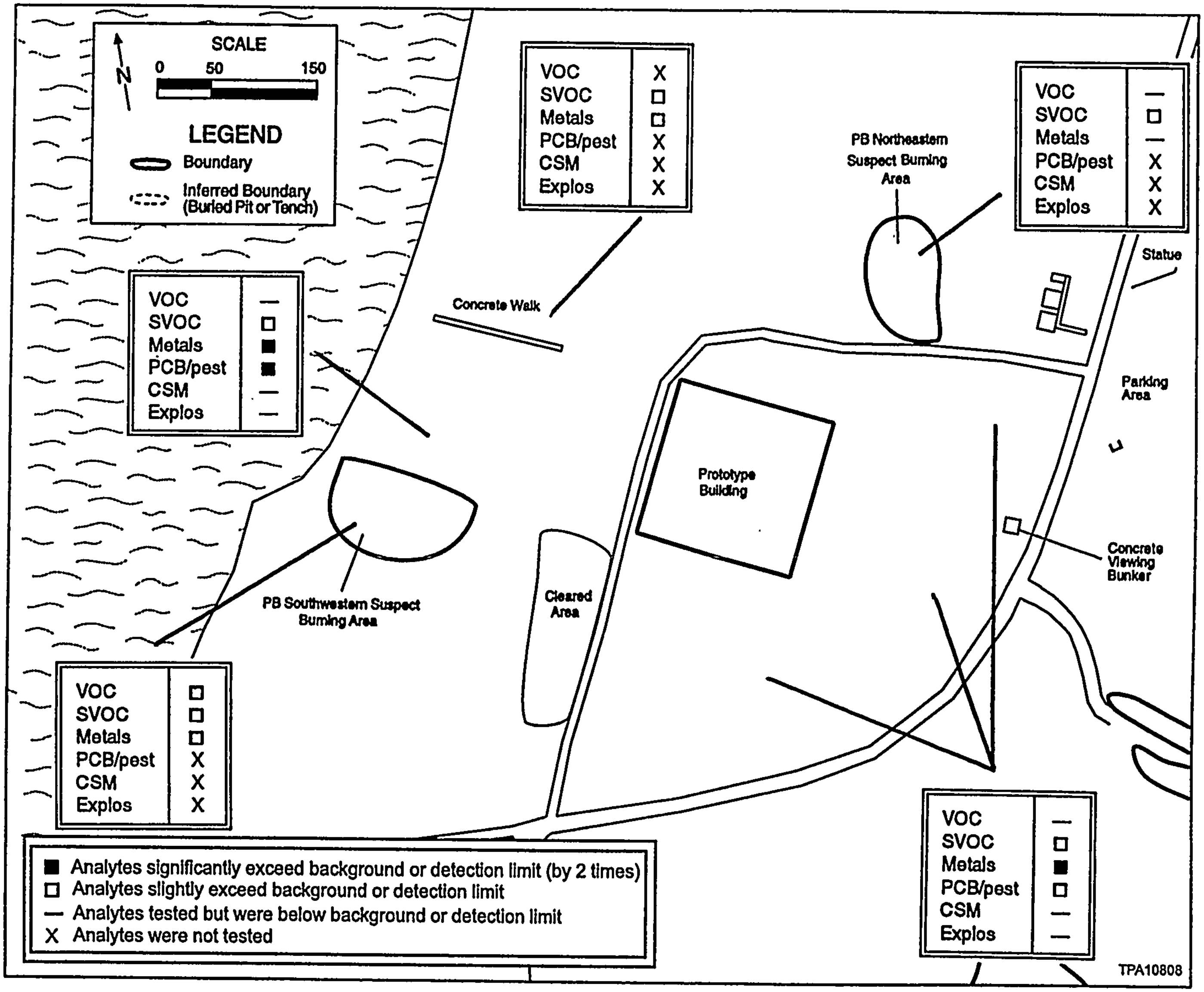


FIGURE 5.5 General Distribution of Major Contaminants in Soil at the PB AOC

5.5 SOUTH BEACH DEMOLITION GROUND AOC

Surface water (both onshore and offshore) and sediment were the only media sampled at the SBDG AOC (Table 5.5). VOC contaminants detected included acetone (offshore) and methylene chloride (onshore and offshore); these were found at very low levels and probably represent laboratory contamination, since they were also detected in the laboratory blank samples. Several metals were detected in the crater, including iron, magnesium, lead, and zinc; however, none were found at levels exceeding the calculated background. Iron, magnesium, and zinc were also found in the offshore surface water, although none were present at levels exceeding the calculated background. Cyanide and explosives-related compounds were not detected in the sediment sample collected from the on-site crater. One offshore sediment sample collected by investigators from the University of Maryland, however, contained low levels of explosives-related compounds (Figure 5.6).

5.6 SOUTH BEACH TRENCH AOC

5.6.1 Soil

Soil gas and XRF data were collected around and within the SBT. The results of these field screening tests indicated the presence of VOCs (acetone and styrene) to the north of the SBT. These compounds are considered to occur naturally in marsh areas (a conclusion based on the level of terpenes also present in the samples). Elevated levels of copper and zinc were also detected in the SBT. Exploratory geophysical (electromagnetic conductivity, electromagnetic induction, and magnetic) profiles were taken along parallel south-to-north transects within the Western Suspect Trench. Several analomalies were detected, indicating the presence of buried metallic objects along each profile.

A boring drilled into the Western Suspect Trench found low levels of one SVOC, di-n-butylphthalate, which was estimated to be present at concentrations less than the detection limit. These concentrations probably represent laboratory contamination since they were also detected in the laboratory blank samples. No VOCs or CSM/CSM degradation products were detected. All metals were found at levels below the calculated background. Although mercury was not detected, its detection limit was slightly above the calculated background. As a result, it is unknown whether the mercury concentrations from the boring samples were above the calculated background level (Figure 5.6).

TABLE 5.5 Summary of RI Samples Collected at the SBDG AOC

Date	Medium	Sample Numbers	Analytical Suite	RI Report Section (Data Table)
1994	Groundwater	JF133	General chemistry	A.5.3
1995	Surface water	SBDGSW1–SBDGSW3	VOCs Metals Cyanide General chemistry Explosives-related compounds	A.5.4 (Tables A.5-1 and A.5-2)
1995	Sediment	CRTR1	Metals Explosives-related compounds	A.5.4 (Table A.5-3)

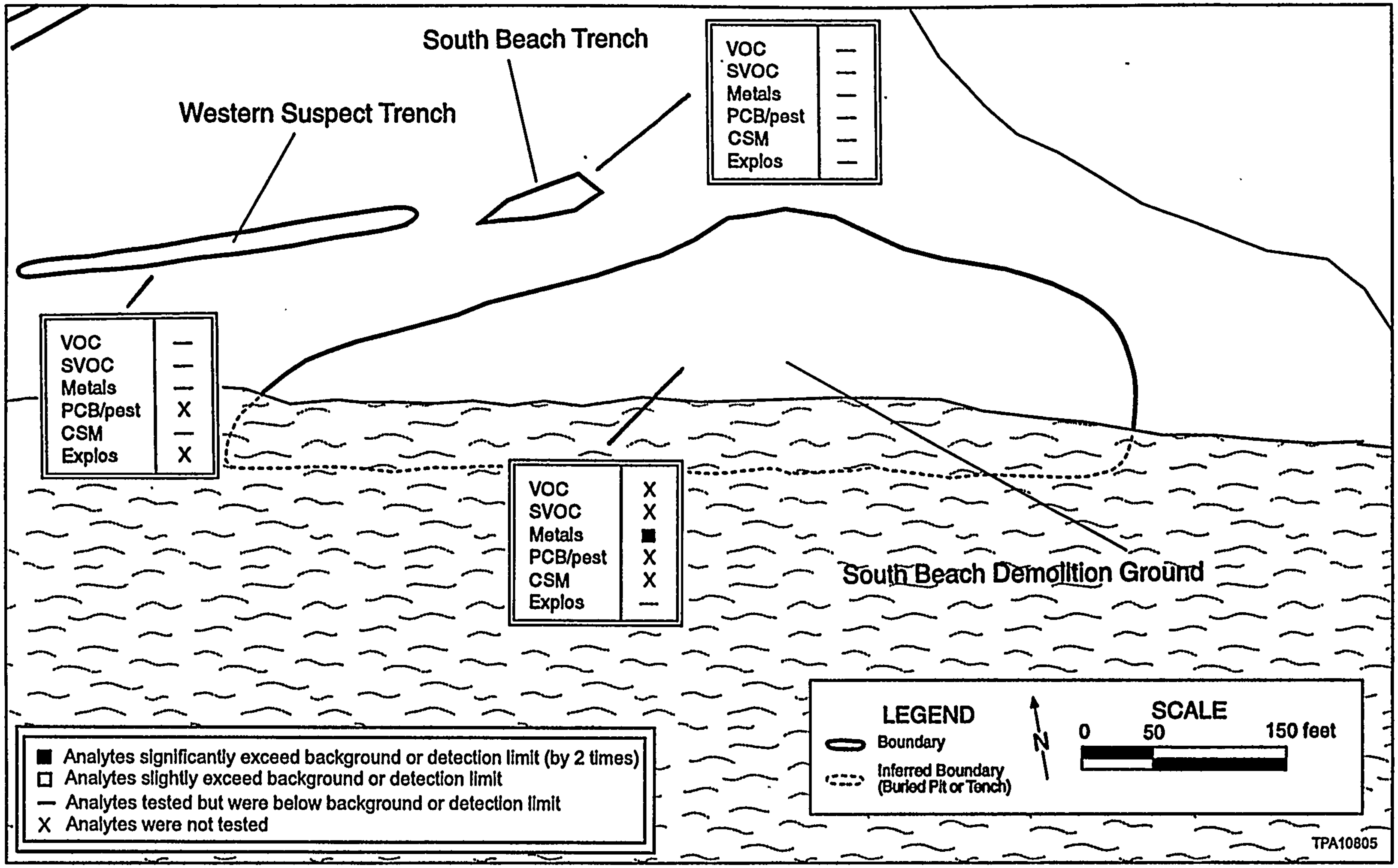


FIGURE 5.6 General Distribution of Major Contaminants in Soil and Sediment at the SBDG and SBT AOCs

5.6.2 Groundwater

Groundwater was sampled in 1994 as part of the RI and analyzed for VOCs, metals (total and dissolved), and general chemistry (Table 5.6). No VOCs were detected. Only iron was found to exceed the hardness-dependent AWQC for total metals. However, it is not considered to be a problem in this environment.

5.6.3 Surface Water and Sediment

Surface water and sediment samples were collected from within the SBT (Table 5.6). No VOCs (except TRCLE at 3.0 µg/L), SVOCs, PCBs, pesticides, CSM/CSM degradation products, or explosives-related compounds were detected in the surface water or sediment samples. Only zinc was detected at a level slightly higher than the calculated background in surface water. In the sediment samples, several metals, including chromium, iron, lead, and zinc, were detected at levels exceeding the calculated background (Figure 5.6).

5.7 ROBINS POINT DEMOLITION GROUND AOC

5.7.1 Soil

Soil XRF data were collected in the eastern (inactive) portion of the RPDG AOC. The results of this field screening test indicated that elevated levels of silver and zinc were present near the marsh boundary. Surface soils collected in these areas (Table 5.7) for laboratory analysis did not contain these metals at levels above the calculated background. Only mercury and silver were detected (at other locations) at levels slightly above the calculated background (Figure 5.7). Cyanide and CSM/CSM degradation products were not detected. Low levels of 2,4-DNT, an explosive, were found in one location. Gross alpha and gross beta activity were found to be lower than the mean background.

5.7.2 Groundwater

Two monitoring wells were installed and sampled in the active portion of the RPDG AOC (Table 5.7). No VOCs were detected in the groundwater samples. Low levels of total organic halides (TOX) were detected in one well. Except for iron, none of the metals detected in the groundwater samples exceeded the AWQC or MCLs.

TABLE 5.6 Summary of RI Samples Collected at the SBT AOC

Date	Medium	Sample Numbers	Analytical Suite	RI Report Section (Data Table)
1994	Subsurface soil	RCPBOR3	VOCs SVOCs Metals CSM/CSM degradation products	A.6.2.2
1994	Groundwater	TH10, JF143	VOCs Metals General chemistry	A.6.3
1994	Surface water	94SWSBT	VOCs SVOCs Metals TOX PCBs/pesticides CSM/CSM degradation products Explosives-related compounds	A.6.4 (Table A.6-2)
1994	Sediment	SBT1, SBT2	VOCs SVOCs Metals Cyanide PCBs/pesticides CSM/CSM degradation products Explosives-related compounds	A.6.4 (Table A.6-3)

TABLE 5.7 Summary of RI Samples Collected at the RPDG AOC

Date	Medium	Sample Numbers	Analytical Suite	RI Report Section (Data Table)
1994	Surface soil	RPDG2–RPDG5, RPDG7, RPDG9, RPDG16	Metals Cyanide CSM Explosives-related compounds Gross alpha and beta activity (subset)	A.7.2.1 (Table A.7-1)
1994	Groundwater	JF153, JF163	VOCs Metals General chemistry TOX	A.7.3
1993	Surface water	JFSW17–JFSW-19	VOCs SVOCs Metals General chemistry PCBs/pesticides CSM/CSM degradation products (subset) Explosives-related compounds (subset) Cesium-137 (subset)	A.7.4 (Table A.7-3)
1995	Surface water	DGD1, DGD2, RPDGSW–RPDGSW6	VOCs (subset) SVOCs (subset) Metals Cyanide PCBs/pesticides (subset) General chemistry TOX (subset) CSM/CSM degradation products (subset) Explosives-related compounds	A.7.4 (Table A.7-4)

TABLE 5.7 (Cont.)

Date	Medium	Sample Numbers	Analytical Suite	RI Report Section (Data Table)
1995	Sediment	RPDG17, RPDG18	Metals Cyanide CSM/CSM degradation products Explosives-related compounds	A.7.4 (Table A.7-5)

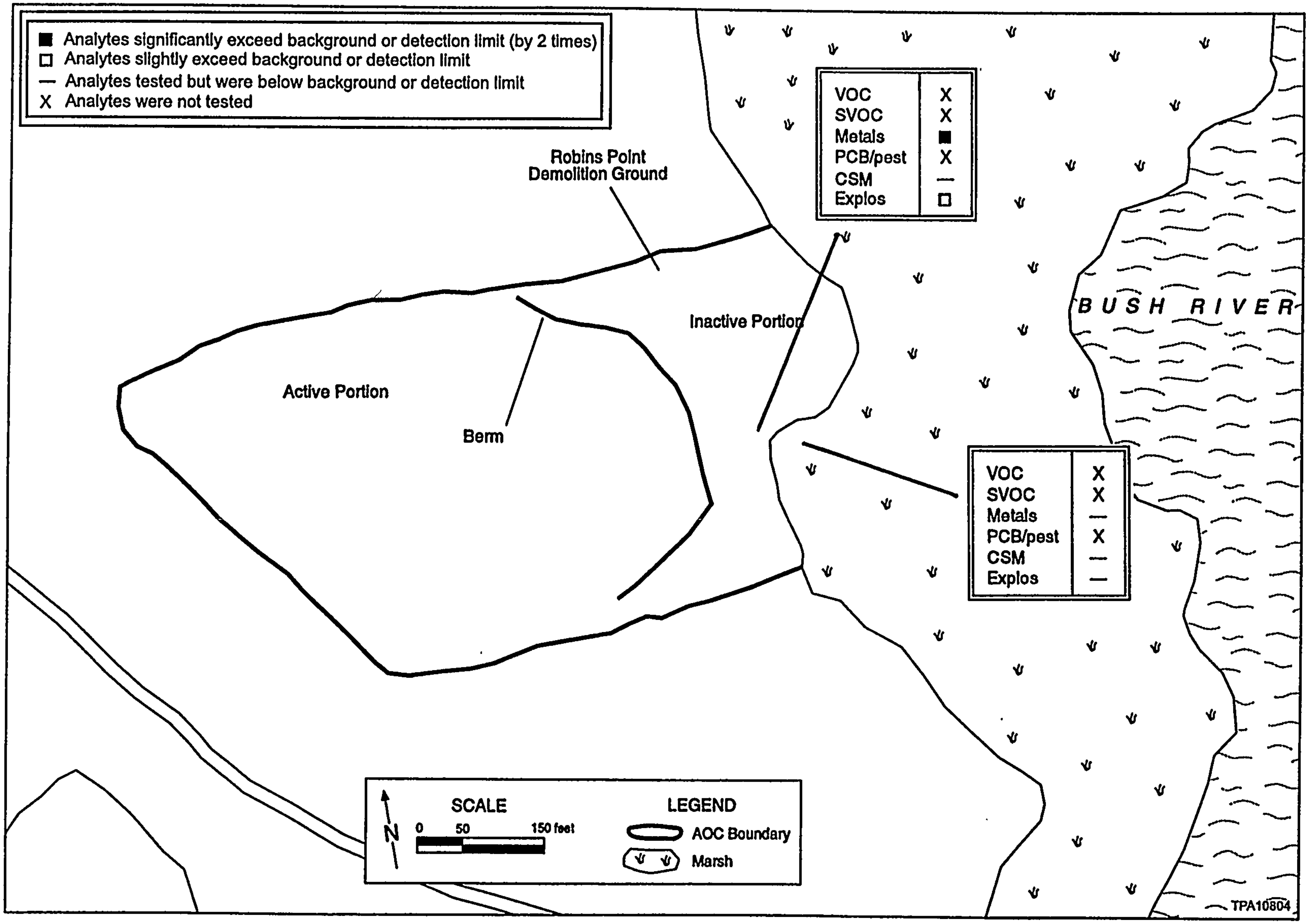


FIGURE 5.7 General Distribution of Major Contaminants in Soil and Sediment at the RPDG AOC

5.7.3 Surface Water and Sediment

Surface water samples were collected from both the active and inactive portions of the RPDG AOC and from the adjacent marsh. These samples were analyzed for VOCs, SVOCs, metals, cyanide, PCBs, pesticides, and CSM/CSM degradation products (Table 5.7). No VOCs, SVOCs, PCBs, pesticides, CSM/CSM degradation products, or cesium-137 were detected. Metals were present in most samples at levels exceeding the calculated background; the highest levels were in samples taken from the marsh. The metals that consistently exceeded background levels were copper and zinc. Metals did not, however, exceed the calculated background in the sediment samples.

5.8 ROBINS POINT TOWER SITE AOC

5.8.1 Soil

Soil XRF data were collected in the three areas at the RPTS AOC, a northern area, a southwestern area, and a southeastern area. The results of this field screening test indicated that no elevated levels of metals were present in the surface soil. A radioactivity field survey was conducted in areas identified as disturbed sites on the basis of a report that a test burn of radioactively contaminated wood might have taken place at the site. Most of the sampling points were within the background range of 60–70 counts per minute (cpm). Surface soil samples were later analyzed for SVOCs, metals, and gross alpha and gross beta activity (Table 5.8). SVOCs were not detected in most samples; however, benzo(b)fluoranthene and bis(2-ethylhexyl)phthalate were detected. The phthalate concentration was very low and probably a result of laboratory contamination. Low levels of mercury and selenium were detected in samples collected from the southwestern part of the AOC (Figure 5.8). Gross alpha and gross beta activity were below the mean background in all samples.

5.8.2 Groundwater

Two monitoring wells were installed west of the tower and sampled for VOCs and explosives-related compounds (Table 5.8). No VOCs or explosives-related compounds were detected in the groundwater samples.

5.8.3 Surface Water and Sediment

Two surface water samples were collected at the RPTS AOC; one was collected from a relict crater, and the other was collected offshore (Table 5.8). Only low levels of acetone and methylene chloride were detected in the samples. Lead was detected at levels exceeding the

TABLE 5.8 Summary of RI Samples Collected at the RPTS AOC

Date	Medium	Sample Numbers	Analytical Suite	RI Report Section (Data Table)
1994	Surface soil	RPTS1, RPTS6–RPTS9, RPTS12	SVOCs (subset) Metals General chemistry	A.8.2.1 (Table A.8-1)
1994	Groundwater	TH1, JF1	VOCs General chemistry Explosives-related compounds	A.8.3
1995	Surface water	RPTSW2, RPTSW3	VOCs Metals Cyanide	A.8.4 (Table A.8-2)

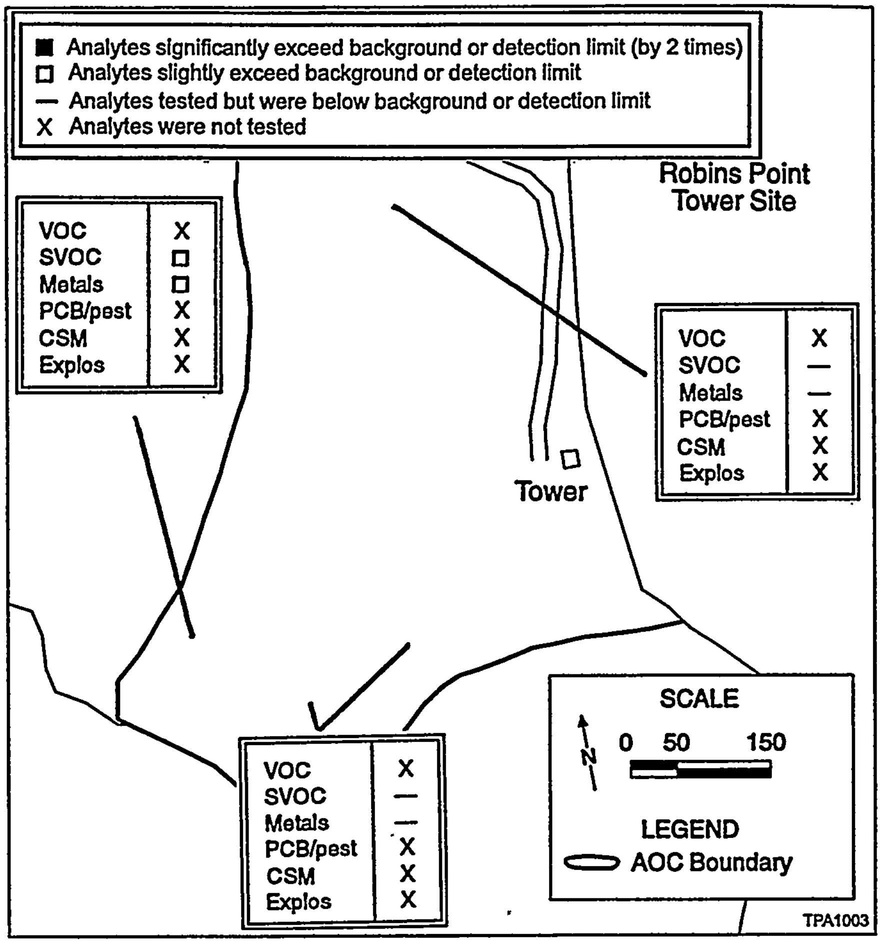


FIGURE 5.8 General Distribution of Major Contaminants in Soil at the RPTS AOC

calculated background in the crater sample. Zinc exceeded the calculated background in both samples. Cyanide was not detected in either sample.

5.9 OTHER SITES

The following sections present an evaluation of the data collected at the J-Field PAOCs during the RI. Table 5.9 provides a summary of samples collected at these sites during the RI.

5.9.1 Site X1 PAOC

The main concern at the Site X1 PAOC was the nature of the disturbed areas of ground, including three shallow depressions, along the main road. Exploratory geophysical (electromagnetic,

TABLE 5.9 Summary of Samples Collected at the Site X1, Area A, Area B, Area C, Ruins Site, and Craters PAOCs

Date	Medium	Sample Numbers	Analytical Suite	RI Report Section (Data Table)
Site X1				
1996	Surface soil	X1S1–X1S9	Metals	A.9.2 (Table A.9-1)
Area A				
1995	Sediment	ARASED1–ARASED7	VOCs SVOCs Metals	A.10.4
Area B				
1996	Surface soil	ARBS1–ARBS10	Metals	A.11.4 (Table A.11-1)
Area C				
1996	Surface soil	ARCS1–ARCS4	Metals	A.12.2 (Table A.12-1)
Ruins Site				
1995	Surface soil	RUNS1, RUNS2	Metals	A.13.2 (Table A.13-1)
1995	Sediment	RUNS3–RUNS14, RUNSED1–RUNSED8	Metals	A.13.4 (Tables A.13-2 and A.13-3)
Craters				
1995	Sediment	DG-1, CRTR1A, CRTR1B, CRTR1–CRTR12, TBC-A, TBC-B	Metals Explosives-related compounds (subset)	A.15

GPR, and magnetic) profiles were taken at two of the three depressions (the two westernmost) that exhibited ground disturbance. No anomalies were found. Soil samples were collected in areas of disturbed soil. Metals, including lead, mercury, and selenium, were found at levels exceeding the calculated background in samples from the disturbed areas (Figure 5.9).

5.9.2 Area A PAOC

The targets of investigation at Area A were the three trenches (A-1, A-2, and A-3). Soil gas samples were collected along the length of each trench. Although the soil gas survey detected low emission rates for several organic compounds in each trench, most are compounds that occur naturally in these areas (a conclusion based on the level of terpenes also present in the samples). However, two compounds that were detected do not occur naturally: TCLEE (in only one sample from trench 3) and TRCLE (found in several samples from trenches A-1 and A-2).

Because soil gas data revealed no significant contamination in trench 3, surface sediment samples were collected from trenches A-1 and A-2 only and analyzed for VOCs, SVOCs, and

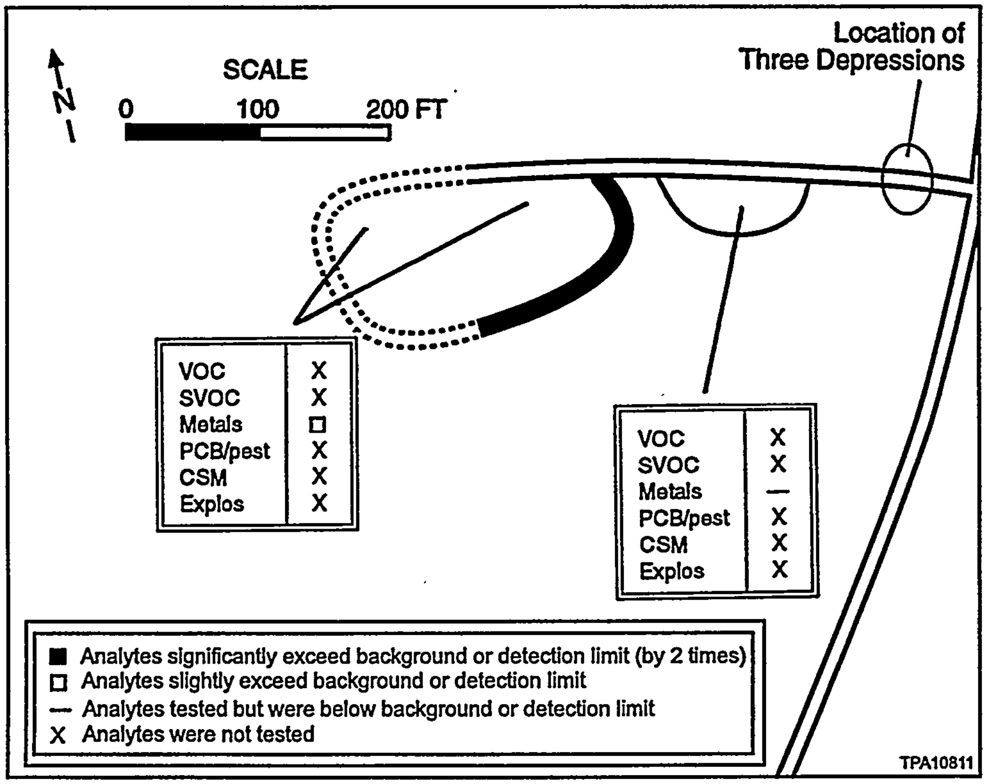


FIGURE 5.9 General Distribution of Major Contaminants in Soil at the Site X1 PAOC

metals. Two organic compounds, acetone and 2-butanone, were detected at levels below 1,000 μg/kg and may be present as a result of laboratory contamination. TRCLE, although present in the soil gas from the two trenches, was not found in the sediments collected. All metals were found at levels below the calculated background (Figure 5.10). Groundwater was not investigated at Area A.

5.9.3 Area B PAOC

Surface soil samples collected in the area of mounded soil and across the disturbed areas were analyzed for metals. Metals, including cadmium, copper, lead, nickel, and zinc, were found a levels exceeding the calculated background in samples from the central and southern portions of the site (Figure 5.11). Groundwater was not investigated at Area B.

5.9.4 Area C PAOC

Surface soil samples collected from areas of disturbed soil at Area C were analyzed for metals. Both mercury and lead were found at levels exceeding the calculated background. Mercury was detected above background in all samples, and lead was above background in one sample (Figure 5.12). Groundwater was not investigated at Area C.

5.9.5 Ruins Site PAOC across from the White Phosphorus Burning Pits AOC

One of the main concerns at the Ruins Site PAOC was the nature of the linear feature identified as the Suspect Filled Trench (Figure 5.13). Soil gas samples were collected along the length of the feature, and geophysical (electromagnetic) surveys were conducted along three profiles perpendicular to it. Although the soil gas survey detected low emission rates for several organic compounds (e.g., acetone, 2-butanone, chloromethane, benzene, styrene, toluene, and xylene), the emission rates were low enough and of the kind to conclude that the compounds were naturally occurring. The geophysical surveys did not reveal patterns typical of a trench; it was inferred, therefore, that the linear feature was most likely an old road bed.

Soil to the southwest of the retaining wall structure was sampled first in the field by XRF; samples were later collected for laboratory analysis of metals. No metals were found to exceed the calculated background. Sediment samples collected from the ponds and around the building ruins were also analyzed for metals. Elevated levels of barium, chromium, copper, and lead were found in a sample taken from the southern side of the easternmost building remnant. Only cadmium was slightly elevated in the samples collected from the ponds (Figure 5.13). The contamination is likely related to ammunition testing on the buildings. Barium sulfate and lead monoxide were used as inert fillers for projectiles (Conley 1994). These compounds may have been used in smaller ammunitions

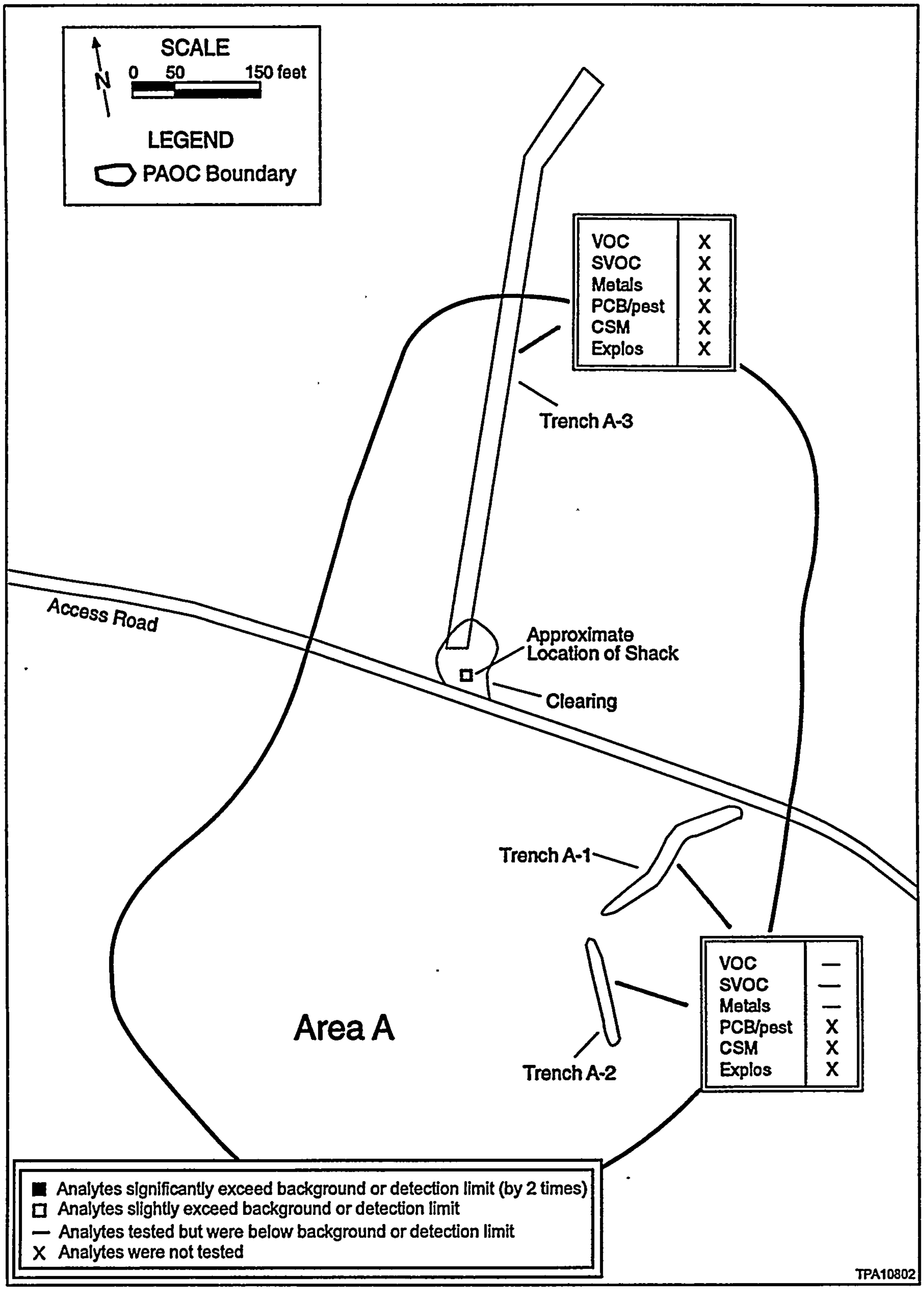


FIGURE 5.10 General Distribution of Major Contaminants in Sediment at the Area A PAOC

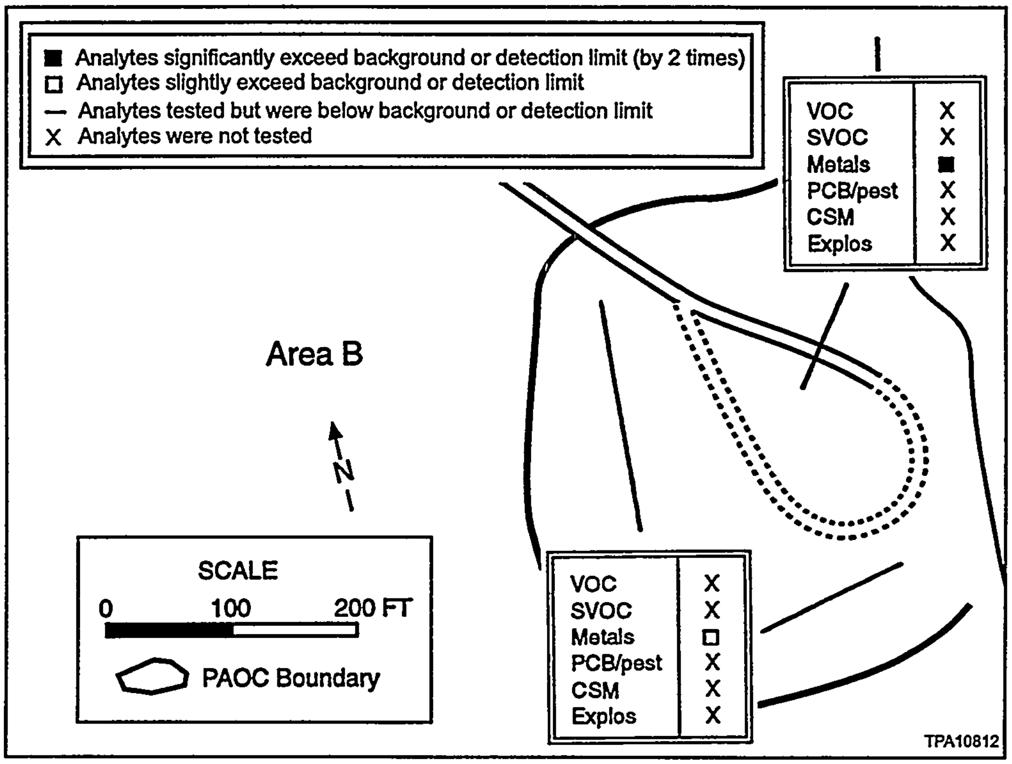


FIGURE 5.11 General Distribution of Major Contaminants in Soil at the Area B PAOC

for testing. The slightly elevated cadmium, chromium, and copper levels indicate residue from metal munitions casings. The origin of the slightly elevated levels of cadmium in one pond sediment sample may also be related to the ammunition testing of the site. Groundwater was not investigated at the Ruins Site.

5.9.6 Area D

The major concern at Area D is the impact of the craters on the environment. Area D has been incorporated into the sitewide crater study and is discussed below in Section 5.9.7 (see also Section A.15). No separate evaluation is provided in this section.

5.9.7 Craters PAOC

Surface sediments collected from each of the 17 craters at J-Field were analyzed for metals; a subset of these samples was also tested for explosives-related compounds (Figure 5.14). Only three metals (barium, copper, and silver) were detected in five (check) craters at levels exceeding the

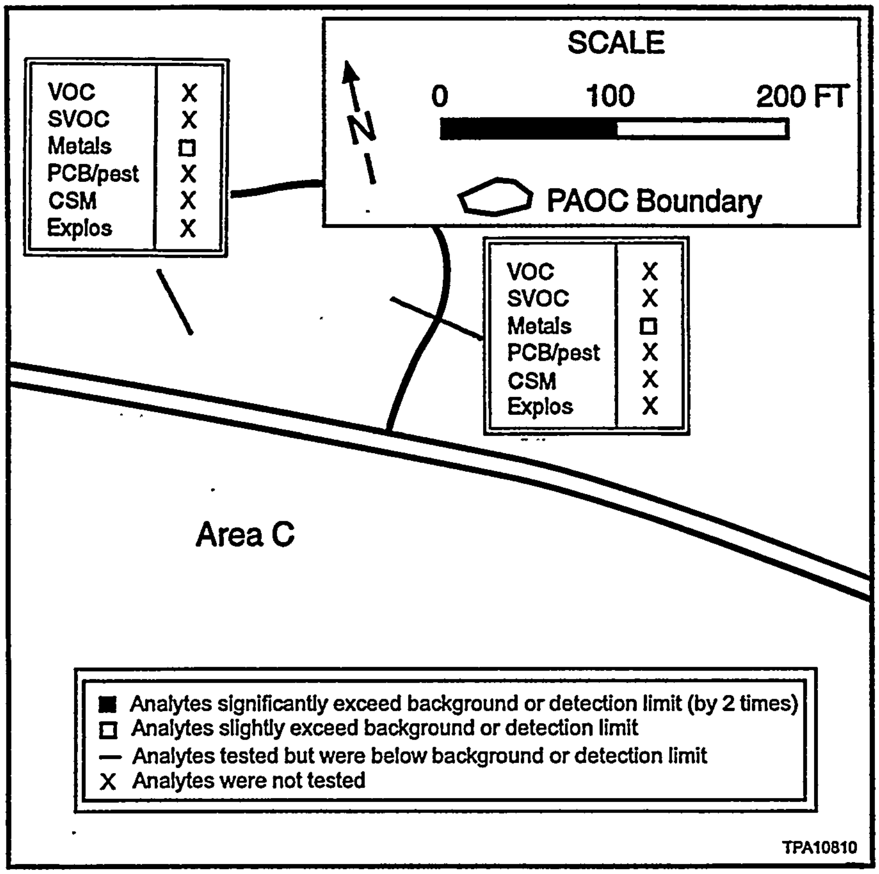


FIGURE 5.12 General Distribution of Major Contaminants in Soil at the Area C PAOC

calculated background (see Section A.15). No explosives-related compounds were found. The metals contamination present may be a result of operations of nearby demolition grounds (e.g., contaminants may have been transported and deposited by wind).

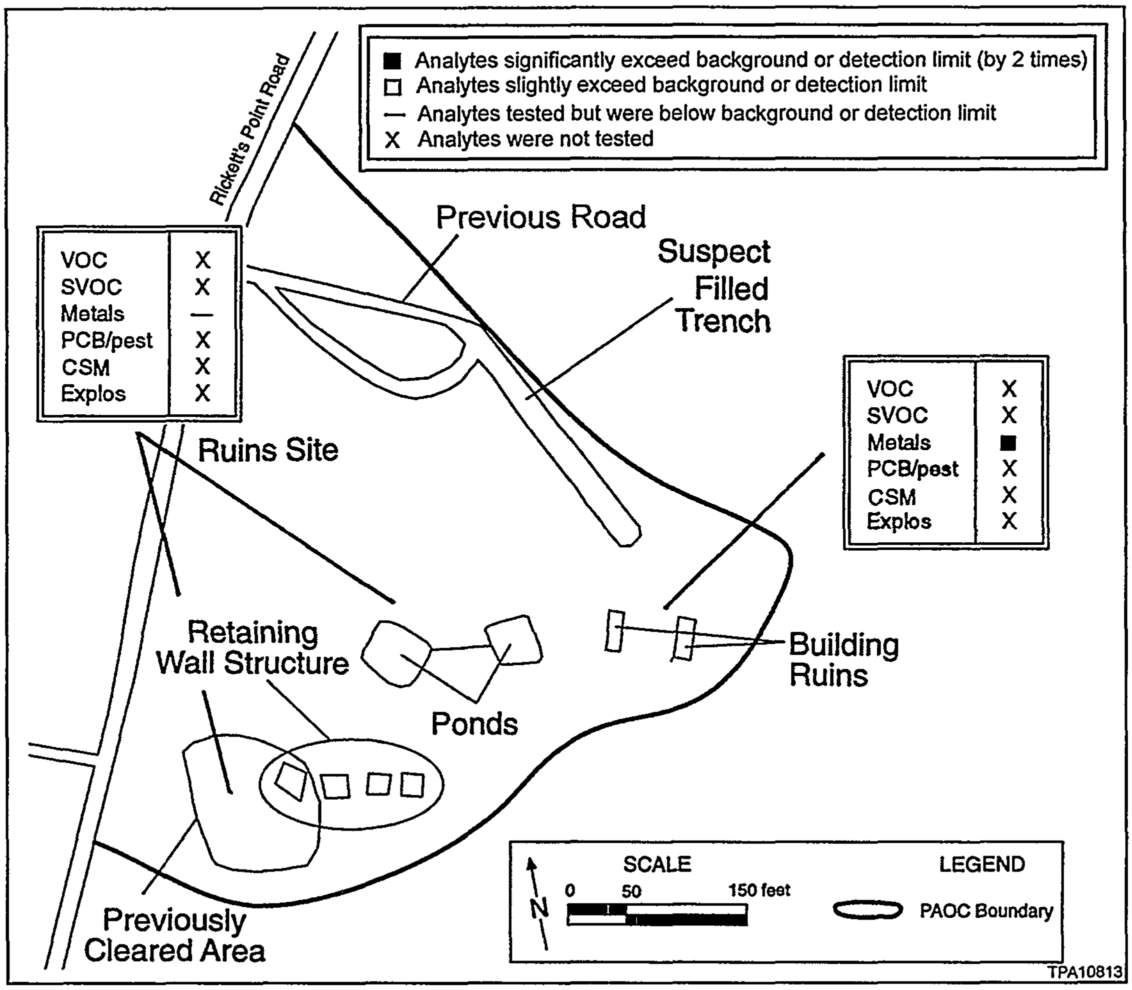


FIGURE 5.13 General Distribution of Major Contaminants in Soil at the Ruins Site PAOC

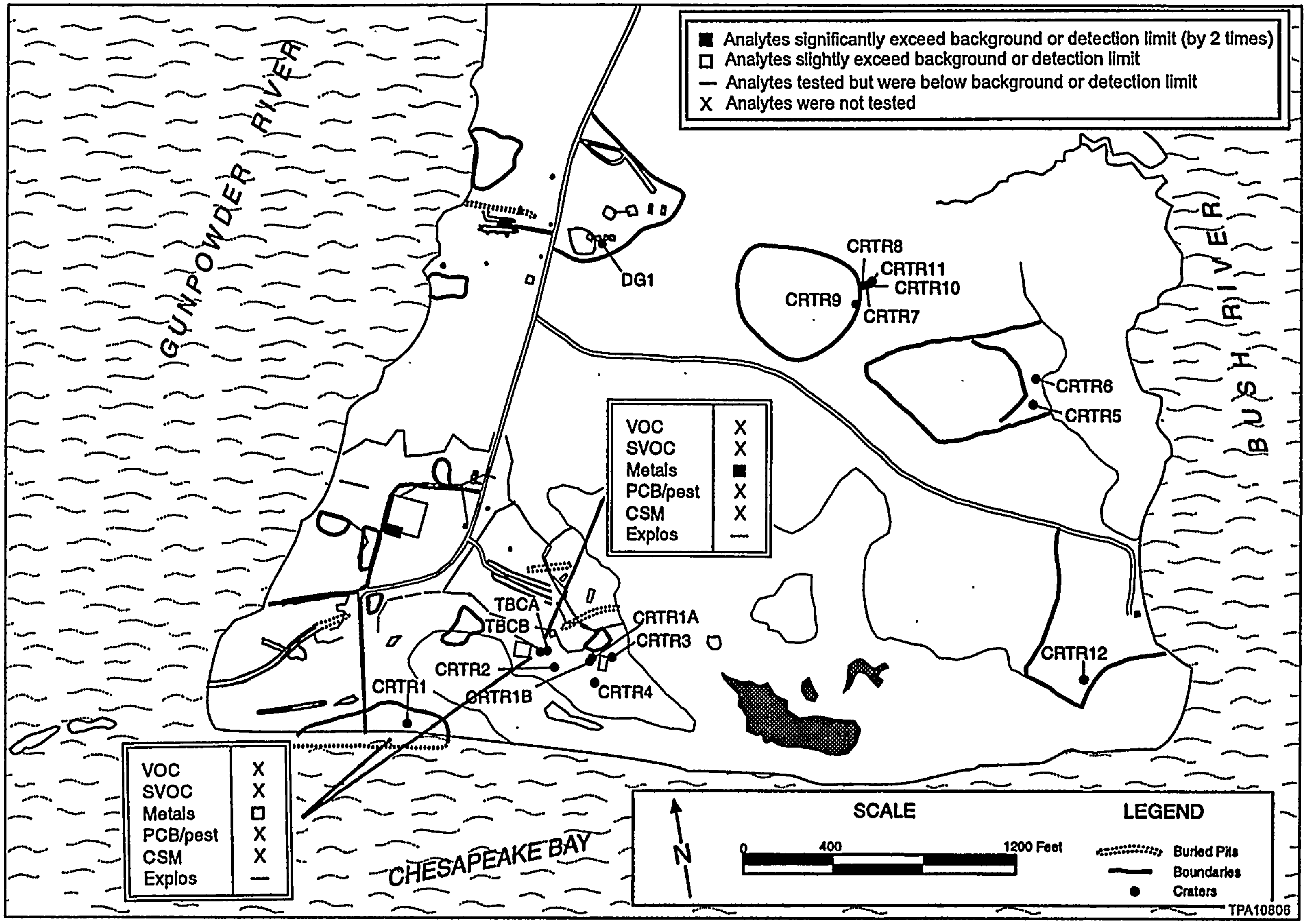


FIGURE 5.14 General Distribution of Major Contaminants in Sediment at the Craters PAOC

6 CONCEPTUAL EXPOSURE MODEL

This section describes a conceptual exposure model for J-Field. The model is based on one presented in the FSP (Benioff et al. 1995b), but it has been modified to reflect the additional information acquired during the RI.

The modified model comprises several exposure components, including the sources of contamination, fate of the contaminants, movement of the contaminants through the environment, and exposure of receptors to those contaminants. The first component (sources of contamination) is described in Section 4 and Appendix A and is not repeated here. The remaining components consist of those dealing with (1) the fate of potential contaminants commonly found at J-Field (Section 5.1) and (2) the movement of contaminants through the environment and the exposure pathways to receptors (Section 5.2). The exposure pathways have also been modeled in the human health risk assessment for J-Field (RI Volume 2; Ripplinger et al. 1998) and in the ecological risk assessment for J-Field (RI Volume 3; Hlohowskyj et al. 1999).

6.1 FATE OF THE CONTAMINANTS

The fate of a contaminant depends on both its physicochemical properties and the nature of the environmental medium (i.e., soil, groundwater, surface water, and sediment) to which it is released. Contaminants occurring at J-Field can be categorized into seven groups on the basis of their physical and chemical properties: (1) metals, (2) chloride and nitrite, (3) chlorinated aliphatic hydrocarbons (CAHs), (4) aromatic hydrocarbons, (5) PCBs, (6) chemical agents and their degradation products, and (7) riot control agents. Each of these categories is discussed in the following subsections.

6.1.1 Metals

6.1.1.1 Arsenic

Arsenic can exist in four oxidation states in the natural environment. The oxidized forms As^{+5} and As^{+3} are the most common forms found in aqueous solution. Arsenious acid and arsenic acid are the prevalent forms in aerobic waters. In addition, arsenic can form complexes with many organic compounds (EPA 1979).

Arsenic contamination at the TBP AOC may have resulted from the disposal and decontamination of the agents lewisite and adamsite. Lewisite was developed during World War I and produced in World War II. Interaction of lewisite with sodium hydroxide (a listed decontaminant) or strong oxidizing agents results in the formation of arsenic acid or arsenic salt (Nemeth 1989).

Arsenic moves downward with leaching water in sandy soil near the ground surface (Adriano 1986). Arsenic forms insoluble compounds with aluminum, iron, and calcium (Adriano 1986), and it may be adsorbed onto clays and organic material in the soil. Under most conditions, co-precipitation or sorption of arsenic with hydrous iron oxides (producing insoluble ferric arsenate) is probably the major process in the removal of dissolved arsenic (EPA 1979).

In portions of the TBP AOC where fine-grained sandy soil is present near the surface, downward movement of arsenic with leaching water is likely to occur. In areas where the water table is near the surface, small amounts of arsenic, if present, will enter the groundwater system. However, most of the arsenic will stay bound in the upper few feet of the soil.

6.1.1.2 Cadmium

Cadmium is a common contaminant at munitions demolition sites. It is fairly immobile in soil; the mobility of cadmium decreases with increasing soil pH. Cadmium can be adsorbed onto clays, organic particulates, and hydrous oxides. It coprecipitates with oxides, hydroxides, and hydrous oxides of iron, manganese, and, possibly, aluminum. Cadmium can also precipitate with carbonate and phosphate.

Cadmium is more mobile in the environment than copper, zinc, or lead. Cadmium can be transported in solution as either hydrated cations or an organic or inorganic complex. Organic complexing of cadmium is the most important factor in its aquatic fate and transport (EPA 1979). Although cadmium can be removed from the aquatic environment by adsorption, coprecipitation, and precipitation, it can be remobilized by increasing the salinity of the water and decreasing the pH (EPA 1979).

In the TBP AOC, cadmium contamination of groundwater is localized near well P4 (see Section A.1, Appendix A). The presence of cadmium in that well may be related to the acidic condition (pH = 5.6) and relatively high salinity (total dissolved solids = 2,360 mg/L) of the groundwater in that vicinity. The salinity could have been introduced by the decontamination operations in the Main Burning Pits.

6.1.1.3 Copper

Copper has a strong affinity for hydrous iron and manganese oxides, clays, carbonate minerals, and organic matter. It is one of the least mobile elements (Adriano 1986), except under highly acidic conditions. The adsorption of copper onto clay and mineral surfaces is enhanced by the presence of organic and inorganic ligands. Copper can form soluble complexes with chloride and organic acids; desorption of copper from soil into aqueous media is possible when the aquatic environment has high levels of chloride, a low pH, or both. This condition would enhance the dispersion of copper in solution (Adriano 1986).

The main source of copper contamination at J-Field has been the disintegration of ordnance and other copper-containing metallic waste. Because of its low mobility, copper is expected to stay near its source in soil.

6.1.1.4 Iron and Manganese

The fate of iron and manganese depends on the Eh and pH of the subsurface soil. Ferrous iron is highly mobile in groundwater under reducing and acidic conditions. Above a pH of about 4.8, ferric iron may precipitate as hydrous iron oxide (USATHAMA 1990). The precipitation may also remove various trace elements in the aquatic system.

The chemistry of manganese is similar to that of iron; however, manganese is stable as a bivalent ion over a broader range of Eh and pH values. Carbonate, which is common in the soil, water, and groundwater of J-Field, has a pronounced effect on manganese precipitation. Manganese may also precipitate as an oxide in valences ranging from +4 to less than +3.

Iron and manganese are common contaminants at J-Field. The main sources of these metals are rusting drums, ordnance, and other metallic waste.

6.1.1.5 Lead

Lead is immobile in most natural environments. It accumulates in the soil surface close to its source. Even in severely lead-contaminated areas, lead is effectively immobilized by precipitation with carbonate, sulfate, hydroxide, and sulfide, as well as by sorption with clay, organic materials, and other mineral surfaces (EPA 1979). However, lead can form soluble complexes with chloride, a very mobile and strong complexing agent (Adriano 1986). The adsorption of lead on soil or sediment can be reduced with a decrease in pH (EPA 1979).

Lead is a common contaminant at munition demolition sites. At J-Field, it is widely distributed in the surface soil in the Pushout Area of the TBP AOC.

6.1.1.6 Mercury

Mercury is generally immobile in soil. It can be adsorbed onto organic matter, clays, and oxides of iron and manganese. Many inorganic ligands in soil react with mercury to form mercury compounds with low solubilities (EPA 1979). However, in oxidizing environments, mercury can react with chloride to form a soluble mercuric chloride complex (EPA 1979; Adriano 1986); the chloride ion can also remobilize adsorbed mercury (Adriano 1986). In the aquatic environment, inorganic mercury can be biologically transformed to volatile methylmercury compounds with the assistance of bacterial activity (EPA 1979).

A likely source of mercury at J-Field is the rusting of metallic waste. Most of the mercury leached from metallic waste is expected to stay near its source. In areas where high levels of chloride are present, a soluble mercury chloride complex could form. Mercury could then enter the groundwater and locally contaminate the aquifer.

6.1.1.7 Nickel

Divalent nickel is the most common form of nickel in aquatic systems. Most of the common aqueous ligands (e.g., sulfate, chloride, nitrate, carbonate, oxide, hydroxide) form moderately soluble compounds with nickel, making nickel relatively mobile in soil and groundwater. Precipitation of nickel with carbonate or hydroxide is significant only when the pH of the solution is above 9. Nickel has an affinity for organic matter, as well as hydrous iron and manganese oxides (EPA 1979). Nickel occurs in the subsurface soils in the Main Burning Pits at the TBP AOC.

6.1.1.8 Zinc

Zinc always has a valence of +2 in aqueous solution. It is one of the most mobile heavy metals in soil and groundwater. Common ligands in natural waters can form soluble complexes of zinc in neutral and acidic solutions. Precipitation of zinc as zinc sulfide is significant only under reducing conditions. Although zinc can be adsorbed onto hydrous metal oxides, clay minerals, and organic matter, such sorption is most favorable only when these materials are present in high concentrations and/or the solution is basic. Zinc is a common contaminant in the surface soil at the TBP AOC.

6.1.2 Chloride and Nitrite

Chloride contamination is believed to originate primarily from the widespread use of chlorinated decontaminating agents (such as supertropical bleach, chlorinated lime, and calcium hypochlorite) to decontaminate mustard, lewisite, and nerve agents. Biodegradation of TCLEA and TCLEE would also release chloride. Chloride is unreactive with sediment and would not be retarded by adsorption onto soil. It is mobile in groundwater and may form soluble complexes with other metals.

Nitrite was found in groundwater at the TBP AOC. Nitrite forms during the biological and/or chemical process of denitrification of nitrate or the nitrification of ammonium. It is present as an intermediate product and usually does not accumulate during these processes; however, nitrite accumulation is enhanced when phosphate is applied to soil (Bouwman 1989). Phosphate can be released into the environment as a by-product when VX and other nerve agents are decontaminated. For these reasons, nitrite accumulation is expected in the soil at the VX Pit. Leaching of these chemicals could result in high levels of phosphate and nitrite in the groundwater next to the VX Pit and may be responsible for the relatively high level of phosphate in the groundwater from monitoring well P3 (1.5 mg/L) (see Section A.1, Appendix A). Further denitrification of nitrite would produce nitrogen or oxide of nitrogen, which can be a biological or chemical process.

6.1.3 Chlorinated Aliphatic Hydrocarbons

The CAHs common in the groundwater are predominantly chlorinated methanes (such as chloroform), chlorinated ethanes (such as trichloroethane and TCLEA), and chlorinated ethylenes (such as TCLEE, trichloroethene [TRCLE], dichloroethylene, and vinyl chloride). CAHs are common solvents: TCLEA is a major component of DANC, and TCLEE is a common component in the decontaminant agent S-210 (Nemeth 1989). Degradation of highly CAHs can result in less-chlorinated CAHs. However, CAHs are significant environmental contaminants because of their persistence and their toxic effects on organisms even at low concentrations. CAHs are common contaminants in soil and in the surficial aquifer at the TBP AOC.

Most CAHs are mobile in the subsurface environment because of their physicochemical properties. They have a high vapor pressure, and volatilized CAHs are commonly found in the vadose zone of a contaminated site. Dissolved CAHs may occur in groundwater. Most CAHs have low water solubilities and are denser than water (except for vinyl chloride, which has a density of 0.91). If a large quantity of CAHs is released to the subsurface, the compounds may occur as free-phase liquids and move downward through the ground until they encounter a low-permeability subsurface stratum. Because they are uncharged, nonionic, and nonpolar, CAHs dissolved in the aqueous phase tend to be quite mobile in aquifers that have low organic carbon contents (Barbee 1994).

In the natural environment, CAHs can be transformed both chemically (abiotic) and biologically (biotic) (McCarty and Semprini 1993). The transformation depends on the oxidation state of the CAHs, the local groundwater chemistry, the aerobic or anaerobic conditions in the subsurface, and the presence of microbial populations. Generally, abiotic degradation occurs at a much slower rate than the biologic degradation reactions under natural conditions. The average half-life for abiotic transformation of CAHs ranges from 2 months to more than 10 billion years (Barbee 1994). Table 6.1 shows the average measured half-lives for CAHs undergoing abiotic transformation at 25 °C and pH 7.

Under anaerobic conditions, CAHs with a high degree of chlorination, such as TCLEA, TRCLA, and TCE, can be biodegraded by reductive dehalogenation processes, such as hydrogenolysis and dihaloelimination, to produce less-chlorinated products (such as dichloroethylene, dichloroethane, and vinyl chloride) (Vogel et al. 1987; Wiedemeier et al. 1996).

TABLE 6.1 Measured Half-Lives of Chlorinated Aliphatic Hydrocarbons Undergoing Abiotic and Anaerobic Biological Transformation

Constituent	Abiotic Hydrolysis or Dehydrohalogenation Half-Life (years)	Anaerobic Biodegradation Laboratory Half-Life (days)	Anaerobic Biodegradation Field-Observed Half-Life (days)
Carbon tetrachloride	16–41	7–28	ND[a]
Chloroform	742–3,000	21–42	ND
1,1-Dichloroethane	24–61	>60	ND
1,2-Dichloroethane	29–72	>60	ND
1,1-Dichloroethene	$4.7 \times 10^7 - 1.2 \times 10^8$	81–173	ND
cis-1,2-Dichloroethene	$8.5 \times 10^9 - 2.1 \times 10^{10}$	88–339	ND
trans-1,2-Dichloroethene	$8.5 \times 10^9 - 2.1 \times 10^{10}$	53–147	ND
Dichloromethane	686	11	3.1–400
1,1,2,2-Tetrachloroethane	0.17–0.41	7–28	ND
Tetrachloroethene	$3.8 \times 10^8 - 9.9 \times 10^8$	34–23	ND
1,1,1-Trichloroethane	0.42–1.1	16–230	ND
1,1,2-Trichloroethane	37	24	ND
Trichloroethene	$4.9 \times 10^5 - 1.3 \times 10^6$	33–230	ND
Vinyl chloride	>10	>60	76–125

[a] ND = not documented.

Sources: Adapted from Barbee (1994) and Lehmicke (1998).

During hydrogenolysis, microorganisms use the CAHs as electron acceptors while other compounds that can serve as electron donors or substrates (source of carbon for microbial growth) are present. The rate of reductive dechlorination typically decreases as the degree of chlorination in the CAHs decreases.

Under aerobic conditions, CAHs can be biotransformed through two processes: primary substrate utilization and cometabolism (McCarty and Semprini 1993). In primary substrate utilization, a few CAHs serve as primary substrates for the energy and growth of microorganisms. These CAHs are the less halogenated one- and two-carbon CAHs (e.g., dichloromethane and 12DCE) (McCarty and Semprini 1993). Cometabolism, however, is a process by which most CAHs can be biotransformed. In cometabolism, bacterial growth is supported by a primary substrate. The primary substrate supplies energy and carbon for growth and causes the release of enzymes and cofactors that facilitate the removal of halogen atoms (e.g., chlorine) from the CAHs.

Oxidizing conditions prevail near the water table. CAHs can be aerobically transformed through microbial cometabolism. The transformation is an oxidation reaction that is slower with the higher halogenated compounds than with the lower halogenated compounds (Table 6.2). TRCLE cometabolism by methanotrophic bacteria produces TRCLE epoxide, which is an unstable compound. Chemical decomposition of that compound yields a variety of products, including carbon monoxide, formic acid, glyoxylic acid, and chlorinated acids (McCarty and Semprini 1993). With an appropriate mixture of microorganisms, TRCLE can be further mineralized to carbon dioxide, water, and chloride (McCarty and Semprini 1993).

Preliminary results of a microbiological characterization of soil collected at the TBP AOC indicate that biphenyl degraders and methanotrophic microorganisms are present at the site (Huang 1994). The significance of these microorganisms to the natural transformation of CAHs in the surficial aquifer beneath the TBP AOC is not known. However, it is possible that cometabolism of TRCLE by methanotrophic bacteria (organisms that oxidize methane for energy and growth) may transform the compound to carbon dioxide, water, and chloride in the vadose zone. The potential for biodegradation of CAHs at the TBP AOC is being evaluated.

6.1.4 Aromatic Hydrocarbons

Common aromatic hydrocarbons found at J-Field include benzene, toluene, and chlorobenzene. Benzene and toluene are components of the fuel oil used for burning waste material. Chlorobenzene is commonly used as a solvent and degreasing agent.

Toluene, benzene, and chlorobenzene are fairly mobile in the soil and groundwater. If a small quantity of aromatic hydrocarbons is released, most of it is sorbed in the vadose zone; only a small fraction will be present in soil gas and soil moisture. However, if substantial amounts of these

TABLE 6.2 Potential for Biotransformation of Chlorinated Aliphatic Hydrocarbons as a Primary Substrate or through Cometabolism

	Primary Substrate		Cometabolism[a]		
Compound	Aerobic Potential	Anaerobic Potential	Aerobic Potential	Anaerobic Potential	Major Degradation Product
Chlorinated methanes					
Carbon tetrachloride (CCl_4)	NI[b]	NI	–	XXXX	$CHCl_3$
Chloroform ($CHCl_3$)	NI	NI	X	XX	CH_2Cl_2
Methylene chloride (CH_2Cl_2)	Yes	Yes	XXX	NI	CH_3Cl
Chlorinated ethanes					
Chloroethane (CH_3CH_2Cl)	Yes	NI	XX	–[c]	CH_3COOH
1,1-Dichloroethane (CH_3CHCl_2)	NI	NI	X	XX	CH_3CH_2Cl
1,2-Dichloroethane (CH_2ClCH_2Cl)	Yes	NI	X	X	CH_3CH_2Cl
1,1,1-Trichloroethane (CH_3CCl_3)	NI	NI	X	XXXX	CH_3CHCl_2
Chlorinated ethenes					
1,1-Dichloroethene ($CH_2{=}CCl_2$)	NI	NI	X	XX	$CH_2{=}CHCl$
cis-1,2-Dichloroethene ($CHCl{=}CHCl$)	NI	NI	XXX	XX	$CH_2{=}CHCl$
Tetrachloroethene ($CCl_2{=}CCl_2$)	NI	NI	–	Unknown	$CHCl{=}CCl_2$
Trichloroethene ($CHCl{=}CCl_2$)	NI	NI	XX	XX	$CHCl{=}CHCl$
Vinyl chloride ($CH_2{=}CHCl$)	Yes	NI	XXXX	X	$CH_2{=}CH_2$

[a] – = very small, if any, potential; X = some potential; XX = fair potential; XXX = good potential; XXXX = excellent potential.

[b] NI = no information.

[c] Readily hydrolyzed abiotically, with half-life on the order of 1 month.

Source: Modified from McCarty and Semprini (1993).

contaminants were released into sandy sediments, the contaminants would migrate downward until they reached the capillary fringe above the water table. Toluene and benzene, which are lighter than water, are likely to spread laterally in the capillary fringe. Chlorobenzene, however, is denser than water and may continue to migrate downward in the saturated zone until it encounters a low-permeability layer. Once the contaminants reach the groundwater, some of the aromatic hydrocarbons will dissolve and migrate with the flow of groundwater. Soils with low organic carbon content also have low potential for adsorption of the aromatic hydrocarbons.

Chemical transformation of aromatic hydrocarbons is generally not expected to be significant in natural soil (Borden 1993). Under normal environmental conditions, benzene is not expected to undergo hydrolysis, nor is it susceptible to oxidation or reduction reactions (Little 1985). However, under certain conditions, natural biodegradation of benzene, toluene, and other hydrocarbons has been reported (Borden 1993). When sufficient oxygen is available in groundwater, as is the case near the water table, aerobic biodegradation of low-molecular-weight aromatic compounds is possible. The biodegradation rate depends on the availability of specific microorganisms, oxygen, electron acceptors, and nutrients. Other factors affecting the biodegradation rate include temperature and pH.

6.1.5 Polychlorinated Biphenyls

PCBs are persistent in the environment. They are extremely resistant to oxidation and acidic and basic hydrolysis (EPA 1979), and they have very low solubility in water. Adsorption to sediments and soil is a major mechanism for the immobilization of PCBs. Under environmental conditions, biodegradation can transform the lighter PCB compounds, but such transformation is not likely in PCBs with five or more chlorines. PCBs are also strongly bioaccumulated (EPA 1979).

6.1.6 Chemical Agents and Degradation Products

6.1.6.1 Mustard (bis[2-Chloroethyl] Sulfide)

Mustard is a powerful vesicant (blister agent) with somewhat delayed effects. The mustard in most mustard-containing munitions is material that was distilled before loading (symbol HD) and, therefore, originally was fairly pure. Dry HD confined a long time in sealed containers can undergo thermal degradation to form, primarily, 1,4-dithiane and 1,2-dichloroethane (Bell et al. 1927). In particular, 1,4-dithiane is found in groundwater that has been in contact with leaking mustard containers; it is considered a compound of low toxicity.

HD dissolves very slowly in water, even when stirred vigorously. Once dissolved in a high proportion of water, HD goes through a series of hydrolysis intermediates to form mainly thiodiglycol (Rosenblatt et al. 1975) and hydrochloric acid. Under quiescent conditions, however, buried masses of HD tend to polymerize at the HD/water interface (MacNaughton and Brewer 1994). The rather toxic oligomeric or polymeric degradation products thus formed may effectively encapsulate the HD, retarding dissolution in the groundwater. Under appropriate conditions, such products have the potential for slowly reforming mustard (Committee on Alternative Demilitarization Technologies 1993). Eventually such degradation intermediates are hydrolyzed to thiodiglycol or to 1,4-oxathiane (also known as 1,4-thioxane), both of low toxicity. The latter is quite soluble in water and highly mobile; its detection in groundwater suggests that unreacted HD exists in the vicinity. Sodium hydroxide or lime give essentially the same hydrolysis products as water.

The extremely alkaline decontamination solution 2 (DS-2) used at J-Field is a polar nonaqueous, nonoxidizing liquid composed of 70% diethylenetriamine, 28% 2-methoxyethanol, and 2% sodium hydroxide by weight. With HD, it forms exclusively divinyl sulfide (a relatively harmless product) by elimination of hydrogen chloride (Yang et al. 1992).

Chlorinated decontaminating agents were commonly used in the disposal of unconfined HD at the TBP AOC. Among such agents were chlorinated lime [Ca(Cl)(OCl)], high-test hypochlorite [HTH; $Ca(OCl)_2$], and bleach solution (3–5% aqueous NaOCl). All of these are alkaline. HD reacts violently with solid chlorinated lime or HTH. While the reaction pathways under less drastic conditions vary with the proportion of reactants and the temperature, mineralization of HD (to sulfate, chloride, carbon dioxide, and water) is essentially complete in the presence of a sufficient excess of alkaline hypochlorite. The required molar ratio of hypochlorite to HD to cause mineralization is 14:1. One trial that demonstrated such decontamination to be complete used a hypochlorite to HD ratio of 19:1 (Durst et al. 1988). For low alkaline hypochlorite ratios, Yang et al. (1992) listed a variety of potential partially oxidized intermediates, including mustard sulfoxide, mustard sulfone, 2-chloroethyl vinyl sulfoxide, 2-chloroethyl vinyl sulfone, divinyl sulfoxide, and divinyl sulfone.

While alkaline chlorinating agents yield products of oxidation and dehydrochlorination (above), acidic or neutral chlorinating agents tend to attack by chlorination on carbon (MacNaughton and Brewer 1994).

DANC, an obsolete decontaminant for HD, consisted of a 7% solution of an organochlorinating agent in TCLEA. At least two organochlorinating agents — 1,3-dichloro-5,5-dimethylhydantoin and 1,1'-methylenebis (3-chloro-5, 5-dimethylhydantoin) — were used at various times in DANC preparations. Such chlorinating agents reportedly react with HD in aqueous solution to give sulfilimine derivatives (Durst et al. 1988). The solvent used in DANC (TCLEA) is quite toxic.

Mustard may persist in surface soil for weeks and has been found in subsurface soil 30 years after its disposal in O-Field at APG (Nemeth 1989). Mustard is denser than water, with a density of 1.27 g/mL at 25°C (Samuel et al. 1983); thus, it behaves like a dense nonaqueous-phase liquid (DNAPL). If a large quantity of mustard were released to the subsurface, it would either sink until it encountered a low-permeability barrier or pool in low areas (Nemeth 1989).

In O-Field at APG, where chemical decontamination and burning were used to dispose of mustard, mustard-related compounds found in groundwater include 1,4-dithiane and 1,4-oxathiane (Nemeth 1989). At the TBP AOC, groundwater collected in the Pushout Area and near several pits contained high levels of sodium, calcium, and chloride, which could have been the remains of mustard decontamination operations. 1,4-Dithiane was found in many TBP AOC wells; 1,4-oxathiane and thiodiglycol were also found, although less frequently.

6.1.6.2 Lewisite (2-Chlorovinyldichlorarsine)

Lewisite (L) is an organic arsenic compound that causes rapid, painful burns to the skin and especially the eyes. On contact with water, lewisite hydrolyzes rapidly to 2-chlorovinylarsonous acid, which gradually loses water to form lewisite oxide (LO, or 2-chlorovinylarsenoxide). The trans-isomer of LO slowly forms a polymer of low aqueous solubility. Treatment of lewisite or its hydrolysis products with strong base forms acetylene, along with the inorganic arsenite ion (Rosenblatt et al. 1975). In strongly oxidizing environments, lewisite hydrolysis products are oxidized to 2-chlorovinylarsonic acids (Nemeth 1989), and arsenite is oxidized to arsenate.

Degradation products of lewisite and related organic arsenical compounds normally cause soil contamination only near the point of release. In one U.S. Army installation where lewisite was manufactured, soil samples contained LO (or its polymer) 40 years after lewisite was released to the environment. Such longevity may not be the case at the TBP AOC, where lewisite underwent decontamination before disposal. However, high levels of arsenic, a component of lewisite degradation products, have been found in groundwater collected from wells P3 and JF83 at the TBP AOC (see Section A.1, Appendix A).

6.1.6.3 Sarin (Isopropylmethylphosphonofluoridate)

The nerve agent sarin (GB) is infinitely miscible with water and hydrolyzes fairly rapidly. For example, at 25°C, the half-life of GB in water at pH 5 is about 160 hours (Clark 1989); significant increases or decreases in pH (relative to pH 5) result in shorter half-lives. Under acidic conditions, the hydrolysis products are hydrofluoric acid and isopropyl methylphosphonic acid; under basic conditions, the anions of these acids, namely fluoride and isopropyl methylphosphonate, are formed (Nemeth 1989).

Sarin has commonly been decontaminated with aqueous sodium carbonate or sodium hydroxide, which accelerated base-catalyzed hydrolysis. The products were the same as with uncatalyzed hydrolysis (Nemeth 1989).

Aside from its ease of hydrolysis, GB is rather volatile; the vapor pressure at 25°C is 2.94 torr, and the heat of vaporization is 81 cal/g (Samuel et al. 1983). GB released to the soil and groundwater at the TBP AOC over a period of time would have almost completely dissipated by evaporation or been converted to hydrolysis products.

6.1.6.4 VX (O-Ethyl S-[2-Diisopropylaminoethyl] Methylphosphonothioate)

VX, a persistent, dermally effective nerve agent, is completely miscible with water below 9.4°C but is not extremely soluble above that temperature (Nemeth 1989). At 25°C, the solubility is 3% (Edgewood Arsenal 1974). Hydrolysis rates depend on both pH and temperature. For example, at 25°C, the half-life of VX in water at pH 5 is about 2,342 hours (Clark 1989). Significant increases in pH shorten the half-life; at pH 10, the half-life is about 41 hours (Epstein et al. 1974). Because VX has three different points of hydrolytic cleavage, there are three main sets of hydrolysis products: ethyl methylphosphonic acid (or its anion) and 2-diisopropylaminoethanethiol from P-S cleavage; S-(2-diisopropylaminoethyl) methylphosphonothioic acid (EA2192) and ethanol from P-O cleavage; and o-ethyl methylphosphonothioic acid and 2-diisopropylaminoethanol from C-S cleavage (Epstein et al. 1974). The 2-diisopropylaminoethanethiol is air-oxidized to bis (2-diisopropylaminoethyl) disulfide, which is relatively immobile in soil. EA 2192 is a very polar, rather toxic, and persistent nerve agent. Another toxic product, though less persistent, resulting from VX degradation is diethyl dimethylpyrophosphonate (Small 1983).

With the alkaline decontaminant DS-2 (see Section 6.1.6.1), VX initially forms ethyl 2-methoxyethyl methylphosphonate and 2-diisopropylaminoethanethiol. The 2-methoxyethyl methylphosphonate can further decompose in time to give ethyl methylphosphonate and 2-methoxyethyl methylphosphonate (Yang et al. 1992). As noted above, the 2-diisopropylaminoethanethiol is easily air-oxidized to bis (2-diisopropylaminoethyl) disulfide.

At a 9:1 molar ratio of hypochlorite to VX, alkaline hypochlorite decontaminating solutions completely (in theory) oxidize the sulfur of VX and the ethylene bridge between sulfur and nitrogen to form ethyl methylphosphonate, diisopropylamine, chloride, sulfate, and carbonate. Under acidic conditions, 2-diisopropylaminoethanesulfonic acid and ethyl methylphosphonic acid are produced at a chlorine-to-VX molar ratio of 3:1 (Yang et al. 1992). Neither the basic nor the acidic chlorination products are believed to be highly toxic.

Elevated concentrations of sulfate are found in groundwater wells P3 and P4 (see Section A.1.3, Appendix A). These levels of sulfate might have resulted from the decontamination of mustard or VX with oxidizing hypochlorite solutions.

6.1.7 Riot Control Agents

6.1.7.1 α-Chloroacetophenone

α-Chloroacetophenone (symbol CN, the active ingredient of mace) is a tear agent formerly used by the military. A crystalline solid, CN melts at 56.5°C (Weast 1980) and has an aqueous solubility of about 1 g/L (Franke 1967). The hydrolysis rate is very low (Nemeth 1989). These properties indicate a high degree of persistence in the environment. Related compounds identified in O-Field groundwater — acetophenone, α-methylbenzyl alcohol, and α-chloromethylbenzyl alcohol (Nemeth 1989) — could be the result of microbiological reductions of α-chloroacetophenone.

6.1.7.2 Chloropicrin (Nitrotrichloromethane)

Chloropicrin (symbol PS) was used as an irritant chemical agent during World War I. It is a colorless, slightly oily liquid with a specific gravity of 1.692 at 0°C (Nemeth 1989). It has an aqueous solubility of 1.621 g/L at 0°C and a boiling point of 112°C (Boit et al. 1972). PS has a low hydrolysis rate that accelerates with increasing temperature, and, on exposure to light, it decomposes to release chlorine and oxides of nitrogen. PS persists moderately long in soil and water (Nemeth 1989).

6.1.7.3 o-Chlorobenzylidene malononitrile

o-Chlorobenzylidene malononitrile (symbol CS) was used as a lachrymator (tear gas) during the Vietnam War. It is a white crystalline solid melting at 95.4°C (Headquarters, Departments of the Army, Navy, and Air Force 1990), with an aqueous solubility of about 0.2 g/L. Once dissolved, CS is rapidly hydrolyzed to o-chlorobenzaldehyde and malononitrile. It may be very persistent in the soil (Nemeth 1989).

6.2 POTENTIAL MIGRATION PATHWAYS AND RECEPTORS

The potential migration pathways and the routes of exposure for contaminants are discussed in this section. The contamination sources, release mechanisms, and potential exposure routes are outlined in Figure 6.1 and discussed in more detail in the following sections.

6.2.1 Primary Sources

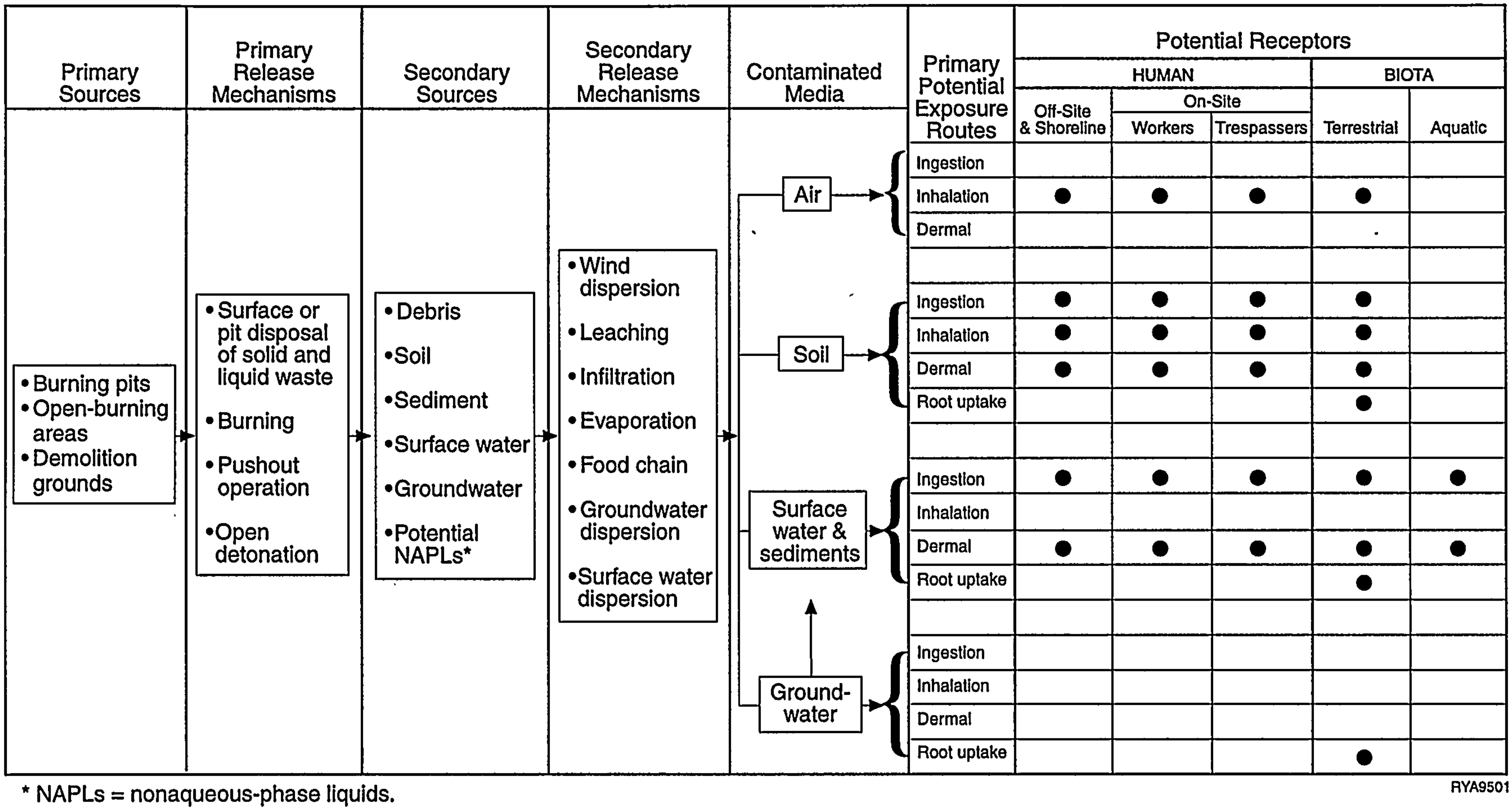
Six types of sites where contamination occurs at J-Field have been identified: (1) burning pits, (2) demolition grounds, (3) suspect open-burning areas, (4) ruins sites, (5) storage areas, and (6) craters. Field data have confirmed that past operations at the burning pits, demolition grounds, and suspect burning areas have created important primary sources of contamination. The contamination at the ruins sites, storage areas, and craters, however, is very limited and not significant (Sections A.13 and A.15, Appendix A); therefore, these sites are not considered primary sources of contamination.

All primary sources of contamination at J-Field occur on or near the ground surface. Burning pits present the most serious environmental problems. Some of the pits are open, and others are filled. Data from borings and geophysical surveys for filled trenches, as well as observations of currently exposed trenches, indicate that these pits are relatively shallow, ranging from 4 to 8 ft deep. Most of the pits have been used for disposal of both liquid and solid waste. Metals and solvents (e.g., TRCLE, 111TCE) are contaminants commonly found in areas associated with the pits.

Demolition grounds and suspect open-burning areas are also potential contamination sources. Activities were conducted on the ground surface, and the residues normally contained metal debris (lead, zinc, barium, and copper). These metals were often present as filler compounds in bombs (Conley 1994). Contamination by the actual explosives (e.g., 2,4,6-trinitrotoluene [TNT]) near these sites seems limited, as indicated by environmental data for the HE Demolition Ground and RPDG (Section A.7, Appendix A).

6.2.2 Primary Release Mechanisms and Secondary Contamination Sources

Liquid wastes, fuel oil, and solid wastes were burned in the disposal sites at the burning pits and most likely at the suspect open-burning areas. Potential contaminants derived from these materials may have been released to the surrounding media, including soil and groundwater, as residuals or through infiltration. This situation has been confirmed by field observation and by environmental data. High levels of chlorinated solvents and metals have been found in soil in the TBP AOC. Fuel oil has been detected near the bottom of the filled VX Pit and the RCP.



Contaminated Media	Primary Potential Exposure Routes	HUMAN			BIOTA	
		Off-Site & Shoreline	On-Site			
			Workers	Trespassers	Terrestrial	Aquatic
Air	Ingestion					
	Inhalation	●	●	●	●	
	Dermal					
Soil	Ingestion	●	●	●	●	
	Inhalation	●	●	●	●	
	Dermal	●	●	●	●	
	Root uptake				●	
Surface water & sediments	Ingestion	●	●	●	●	●
	Inhalation					
	Dermal	●	●	●	●	●
	Root uptake				●	
Ground-water	Ingestion					
	Inhalation					
	Dermal					
	Root uptake				●	

* NAPLs = nonaqueous-phase liquids.

FIGURE 6.1 Conceptual Exposure Model for J-Field

Groundwater data indicate that nonaqueous-phase liquids (NAPLs), such as chlorinated solvents, are also present in the subsurface.

Another way contaminants may have been introduced to the environment was through the waste pushout operations. After wastes were burned, scrap materials and ash were pushed out of the disposal sites; thus, the contaminated debris and soil was spread into the area surrounding the main burning or disposal pits. Because many of these pushout areas are next to surface water bodies or marshes, contact of the contaminated material with surface water produced secondary contamination sources in surface water and sediment.

At the demolition grounds, potential contaminants may also have been spread through air transport by explosions and through the pushout of debris after demolition. The pushout of debris may produce a secondary potential contamination source in soil near the demolition grounds.

6.2.3 Secondary Release Mechanisms and Contaminated Media

Natural processes can further spread contaminants from secondary contamination sources to the wider environment. The transport processes can occur in the air, on the ground surface, and in the ground subsurface. The media facilitating the transport processes include groundwater, surface water, air, and biota.

6.2.3.1 Leaching, Infiltration, and Vapor Diffusion

Infiltration of rain or melted water from snow can leach contaminants deposited on the ground surface into the subsurface. Also, liquid contaminants, especially in the burning pits, can infiltrate downward and reach the groundwater in the surficial aquifer. Dissolved contaminants in groundwater would then follow the flow path of the groundwater and spread out in the subsurface. Fuel oil, if a large quantity were used, might float on top of the groundwater table and disperse laterally from the fluctuation of the water table. Most chlorinated solvents, if present, would sink in the surficial aquifer until they encountered a hydraulic barrier. A small portion of the chlorinated solvents would dissolve in the groundwater and migrate with the groundwater flow. Groundwater that flows laterally may discharge contaminants by seeping into surface waters such as streams, ponds, or marshes. All of these transport processes occur at the TBP AOC.

Volatile contaminants in liquid or solid subsurface media can diffuse into the interstitial air pockets in the soil vadose zone. Such soil gas contamination has been detected in soil near some of the burning pits at J-Field.

6.2.3.2 Surface Water Dispersion

Contaminants present near demolition grounds, burning pits, and suspect burning areas are likely to be transported by water erosion. Surface runoff, resulting in transport of soluble constituents or contaminated soil, would be greatest around disturbed areas without vegetation cover. Generally, dissolved contaminants would be discharged into surface water bodies, while contaminated soil and particulate material would be deposited along drainage channels and be less likely to travel great distances.

6.2.3.3 Wind Dispersion

Atmospheric transport is limited to particulate contaminants located at or near the ground surface and to vapors released to the atmosphere from soil gas. Wind erosion is more likely to transport particulate contaminants from demolition sites and disposal areas that lack sufficient vegetation cover. The hazard typically decreases with distance downwind. The release of soil gas is controlled mainly by the volatility of the contaminant, wind speed, temperature, and depth of the water table.

6.2.3.4 Food Chain

Biological transport may include uptake of contaminants by plants and wildlife and transfer of contaminants through food chains by on- and off-site biota. The ultimate ecological fate and effect of the contaminant depend on the type (terrestrial or aquatic) and form (grassland, forest, stream, or pond) of the ecosystem in which the contaminant occurs, the nature and concentration of the contaminant in the media, the length of exposure of the biota to the contaminant, the order of the food chain through which the contaminant travels, and a particular species' biological tolerance of the contaminant.

6.2.3.5 Groundwater Dispersion

Dissolved contaminants present in groundwater are going to follow groundwater flow, creating plumes of contaminated groundwater downgradient from the source areas. Also, free-phase DNAPLs may be retained among the pores of sediment and released into groundwater through dissolution. If large quantities of DNAPLs are present in the subsurface, they may move by gravity, following the topography of an underlying barrier.

6.2.4 Potential Exposure Routes and Receptors

6.2.4.1 Human Exposure

Several potential human exposure pathways have been identified at J-Field (ICF Kaiser Engineers 1994; Benioff et al. 1995a). These pathways include contaminant exposure through dermal contact with soil, surface water, and sediment; ingestion of soil and water; and inhalation of vapors and particulate matter. The most likely human receptors are site workers; however, in order to comply with EPA guidelines (EPA 1991), the analysis also takes into consideration trespassers and persons fishing along the J-Field shoreline. Because J-Field is situated in a restricted area with a wide range of physical security (e.g., patrols by military police), the likelihood of trespassing at J-Field is low. Hunters are no longer considered likely human receptors because hunting has been banned at J-Field (Wrobel 1994).

6.2.4.2 Ecological Exposure

Approximately 35 species of aquatic and terrestrial biota were selected as preliminary ecological receptors for the J-Field site (Hlohowskyj et al. 1995). The potential exposure routes for these receptors, which are discussed in detail in Section 3 of the ecological risk assessment (Volume 3 of this report) (Hlohowskyj et al. 1999), include incidental inhalation of contaminated vapor and airborne particulates; ingestion of contaminated soil by terrestrial biota; dermal contact with soil, surface water, and sediment; root uptake of contaminated groundwater by vegetation; and food chain transfer of contaminants to higher trophic levels. This last pathway represents the major contaminant route to birds of prey that may use the site. For example, soil contaminants may be taken up by vegetation, which in turn is consumed by mice and voles, both of which constitute a large portion of the diet of the red-tailed hawk.

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APPENDIX A:

DETAILED DATA SUMMARY

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APPENDIX A:

DETAILED DATA SUMMARY

Appendix A summarizes characterization data gathered to date for J-Field. The data are organized according to areas of concern (AOCs), media, and findings related to individual potential source areas of contamination within each AOC. The nature and extent of contamination are evaluated in detail for each AOC. The summary presents the results of previous environmental studies as well as the results of studies conducted more recently for the RI. Table A.1-1 provides summary information on all the J-Field studies conducted to date.

A.1 TOXIC BURNING PITS AREA OF CONCERN

A.1.1 Screening Investigations

A.1.1.1 Soil Gas

Soil gas monitoring was conducted at several locations in the Toxic Burning Pits (TBP) AOC in 1993 and 1994. Active soil gas monitoring techniques were used for unsaturated soil conditions, and passive soil gas monitoring techniques were used for both saturated and unsaturated soil conditions.

In 1993, passive soil gas monitoring was conducted with EMFLUX soil gas collection devices at four locations: sampling points SG1 and SG2 in the marsh downgradient and east of the Main Burning Pits, SG3 in the Southern Main Pit, and SG4 south of the Main Burning Pits area (Figure A.1-1). The results of the survey are provided in Table A.1-2. Target compounds were those on the U.S. Environmental Protection Agency (EPA) Target Compound List (TCL). The highest emission flux rates were detected in samples SG1 and SG3. Compounds with the highest relative flux rates were trichloroethene (TRCLE, up to 1,139 ng/m^2/min in SG1), tetrachloroethane (TCLEA, up to 1,127 ng/m^2/min in SG1), and tetrachloroethene (TCLEE, up to 202 ng/m^2 /min in SG3) (Prasad 1993).

In February 1994, an EMFLUX passive soil gas survey was conducted at 63 locations in the marsh east and south of the TBP AOC and in other areas too saturated to allow active soil gas monitoring (Figure A.1-1). The results of this survey are provided in Table A.1-3. Target compounds were those on the EPA's TCL. The highest emission flux rates for total chlorinated hydrocarbons were detected in marsh samples (60, 87, and 95) downgradient of the Main Burning Pits and in one

TABLE A.1-1 Summary of Field Investigations at J-Field

Field Investigation	Investigator	Date	Objective
Environmental Contamination Survey	U.S. Army Toxic and Hazardous Materials Agency (USATHAMA)	1977–1978	Conducted to determine if contamination from past operations was migrating off-post. Eleven monitoring wells (TH1–11) were installed in the surficial aquifer — 10 near the Toxic Burning Pits and White Phosphorus Burning Pits and 1 near the Robins Point Tower. Groundwater samples were collected and analyzed. (Sonntag 1991)
Munitions Disposal Study	Princeton Aqua Science	1983	Installed nine monitoring wells (P1-9) in the surficial aquifer — five near the Toxic Burning Pits and four near the White Phosphorus Burning Pits. Composite soil samples were collected during drilling of wells. Soil samples were also collected from the pits in the Toxic Burning Pits and White Phosphorus Burning Pits areas. (Princeton Aqua Science 1984)
Resource Conservation and Recovery Act (RCRA) Facility Investigation	U.S. Army Environmental Hygiene Agency (USAEHA)	1986	Sampled groundwater from TH and P series wells. Soil samples were also collected in and around the pits in the Toxic Burning Pits, White Phosphorus Burning Pits, and Riot Control Pit areas and near the Prototype Building. A field radiation survey was also performed. (Nemeth 1989)
Hydrological Assessment, Phase I	U.S. Geological Survey (USGS)	1987–1992	Drilled exploratory boreholes, collected soil and soil gas samples, and ran geophysical logs. Installed 12 well clusters (JF1–12), each consisting of three wells screened in the upper portions of the confined aquifer, the confining unit, and surficial aquifer. Wells were sampled on a monthly (1987) and quarterly (1989–1992) basis; water-level measurements were also taken. Conducted slug tests. Used MODFLOW model to simulate contaminant pathways in groundwater. A total of 21 surface water samples were also collected from Gunpowder River and Chesapeake Bay. Soil/soil gas samples were collected in the Toxic Burning Pits and White Phosphorus Burning Pits areas. (USGS 1991; Hughes 1992)

TABLE A.1-1 (Cont.)

Field Investigation	Investigator	Date	Objective
Characterization and Interim Remediation	Roy F. Weston, Inc.	1992	Conducted topographic survey of J-Field area; surveyed unexploded ordance (UXO) in each burning pit and along shoreline of White Phosphorus Burning Pits and Riot Control Pit; constructed access roads; placed rip-rap and gabion structures along the White Phosphorus Burning Pits and Riot Control Pit shorelines; removed and staged surface material and debris from burning pit areas; sampled and staged drums from the Prototype Building; sampled and analyzed soil from the pits and pushout areas at the Toxic Burning Pits; installed flood control berms in the pit areas; and collected surface and subsurface soil samples. (Weston 1992)
Hydrological Assessment, Phase II	USGS	1992	Continued sampling groundwater, measuring water levels in all monitoring wells, and slug testing. Four new wells installed. Collected surface water samples from marsh areas and estuaries surrounding J-Field, based on thermal imagery studies conducted by the USGS. (Hughes 1993)
Sediment Sampling Study	U.S. Environmental Protection Agency (EPA)	1992	Conducted a study to characterize the estuarine sediments around the Gunpowder Neck Peninsula. (EPA 1993)
Piezometer Installation and Sampling	USGS	1994	Installed five clusters of two piezometers each (JFPM1–JFPM5) in the marsh adjacent to the Toxic Burning Pits area.
Toxic Pits Pilot Remediation Study	EPA Emergency Response Team	1994	Conducted soil and soil gas sampling to determine the optimal placement of a pilot-scale soil vapor extraction (SVE) unit, scheduled for 1994. The SVE unit was never installed. (Weston 1994)
Deep Drilling	USGS and U.S. Army Corps of Engineers (COE)	1995	Drilled a 961-ft-deep borehole at Robins Point. The borehole penetrated a portion of a Susquehanna River paleochannel and provides further confirmation of the hydrogeological understanding of J-Field.

TABLE A.1-1 (Cont.)

Field Investigation	Investigator	Date	Objective
Remedial Investigation	Argonne National Laboratory (ANL)	1991–1996	Conducted soil gas surveys, geophysical surveys, radioactivity surveys, and x-ray fluorescence field surveys in surface soils. Installed three new monitoring wells (JF173, JF183, and JF193). Sampled groundwater and analyzed for VOCs, metals, and Chemical Surety Material (CSM)/CMS degradation products. Researched historical aerial photos for evidence of other potential areas of concern (PAOCs). Sampled surface and subsurface soil samples and analyzed for metals, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), and other miscellaneous parameters. Developed a conceptual geological site model. Conducted several pump tests. Conducted a confined aquifer contaminant transport study. Data were used to identify contamination sources, characterize the nature and extent of contamination present, and support the human health risk assessment. Data were used as the basis for risk assessment and remedial action planning. (See main text of this report)
Ecological Risk Assessment	ANL	1994–1996	Conducted qualitative and quantitative surveys of wetland and terrestrial vegetation, soil, benthic invertebrates, fish, and terrestrial wildlife; toxicity testing of soil, sediment, surface water and groundwater; surveys of soil processes, such as nitrogen mineralization and microbial enzyme activity; and residue analyses of biological tissue. These data, along with those collected during the remedial investigation (RI), were used to characterize exposure and evaluate the risk to various ecological receptors at the site. (Hlohowskyj et al. 1999)
Aquatic Toxicity Evaluation	University of Maryland at College Park	1994–1997	Conducted a series of aquatic bioassays for chronic toxicity testing on surface water and surficial sediments near the Toxic Burning Pits area. Also performed comprehensive chemical and munitions analyses (including general chemistry, metals, VOCs, base neutrals, acid compounds, pesticides/PCBs, herbicides, nitroaromatics, and nitramines) for these media. (Burton and Turley 1997)
Well Installation and Sampling	Roy F. Weston, Inc.	1996	Installed five monitoring wells (JFP1–JFP5) and four lysimeter pairs (JFL1–JFL4) in the Toxic Burning Pits area. Wells were sampled in 1997 and analyzed for VOCs. (Weston 1997)

TABLE A.1-1 (Cont.)

Field Investigation	Investigator	Date	Objective
Natural Attenuation Study	ANL	1997–1998	Sampled existing wells in the Toxic Burning Pits area for natural attenuation parameters (including chloride, alkalinity, dissolved oxygen, carbon dioxide, iron, pH, conductivity, total organic carbon, ethane, ethene, methane, sulfate, sulfide, nitrate, nitrite, temperature, and oxidation-reduction potential). (Unpublished ANL data on natural attenuation of chlorinated solvents in groundwater at the Toxic Burning Pits Area; in progress in 1998)

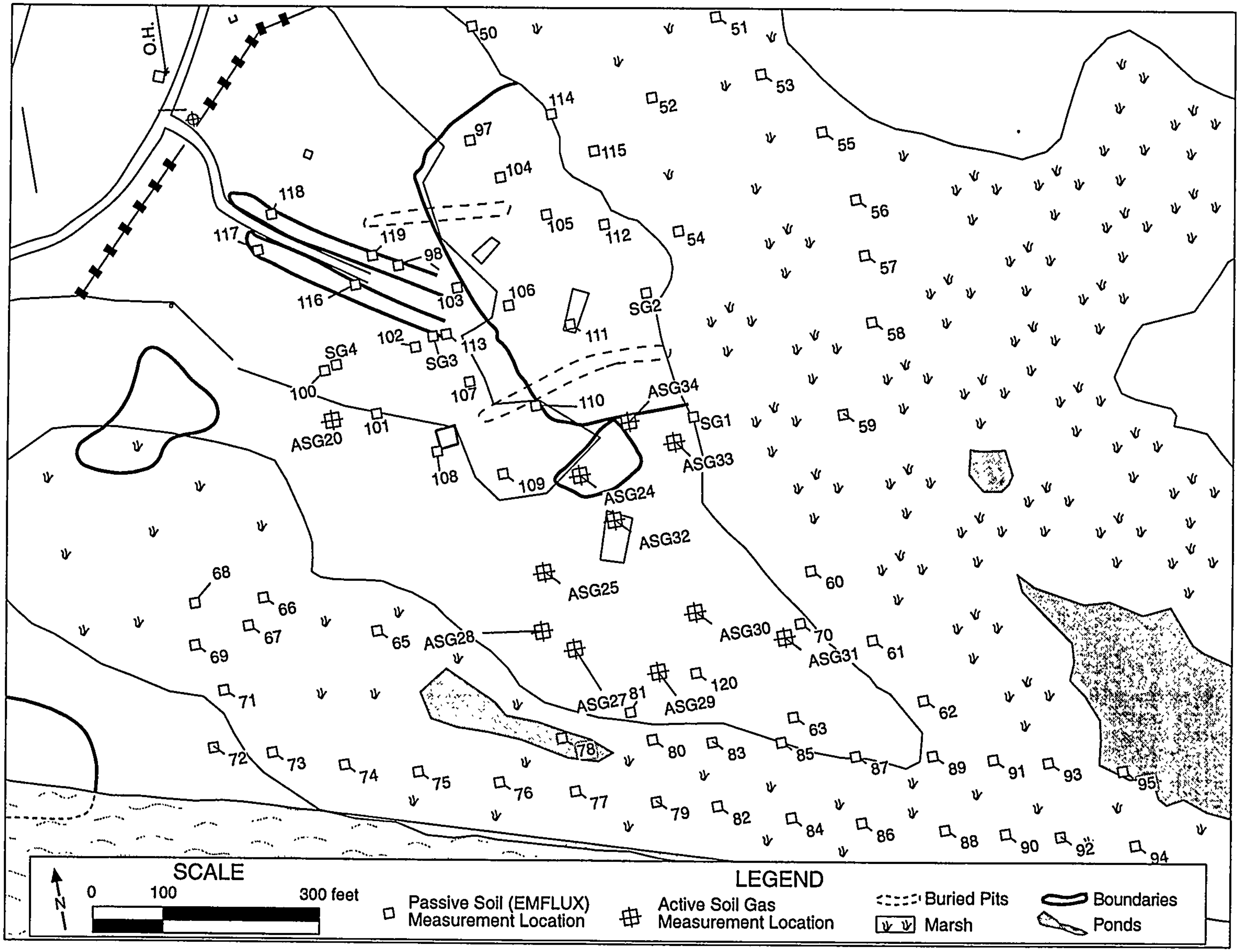

FIGURE A.1-1 Locations of Passive and Active Soil Gas Measurements in the TBP AOC: 1993–1994

TABLE A.1-2 EMFLUX Emission Flux Rates at the TBP AOC in 1993 Testing[a]

	Flux Rate (ng/m²/min) by Sample Location[b]			
Parameter	SG1	SG2	SG3	SG4
Acetone	4.2	-	-	-
Benzene	2.5	-	1.5	-
Carbon disulfide	0.9	-	-	-
Chlorobenzene	0.8	-	3.8	-
1,2-Dichlorobenzene	-	-	5.2	-
1,3-Dichlorobenzene	-	-	0.8	-
1,4-Dichlorobenzene	-	-	1.1	-
1,2-Dichloroethane	-	0.6	-	-
1,1-Dichloroethene	1.8	-	0.8	-
1,2-Dichloroethene	376.5	3.8	38.7	-
1,1,2,2-Tetrachloroethane	1,127.3	0.6	678.5	1.0
Tetrachloroethene	62.2	-	202.4	-
Toluene	3.0	29.8	-	-
1,1,2-Trichloroethane	202.9	-	33.0	-
Trichloroethene	1,138.5	9.4	-	2.9
Xylene	-	-	2.4	-

[a] Notation: A hyphen denotes value below the reported quantitation level. Quantitation levels were not available.

[b] Sampling locations are shown in Figure A.1-1.

Source: Prasad (1993).

TABLE A.1-3 EMFLUX Emission Flux Rates (ng/m^2/min) at the TBP AOC in 1994 Testing[a]

	Flux Rate (ng/m^2/min) by Sample Location[b]											
Parameter	QL[c]	50	51	52	53	54	55	56	57	57D	58	59
Chloromethane	2.7	-	-	-	44.9	14.8	-	17.7	-	-	-	-
1,2-Dichloroethane	2.1	-	-	4.2	-	-	-	-	-	-	-	-
1,1-Dichloroethene	9.3	-	-	-	-	-	-	-	-	-	-	-
1,2-Dichloroethene (total)	2.8	-	-	4.2	-	-	-	-	-	-	-	-
Tetrachloroethene	1.0	-	-	2.7	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	1.2	-	-	6.8	-	-	-	-	-	-	-	-
Trichloroethene	0.9	-	-	16.3	-	-	-	-	-	-	-	-
Total chlorinated hydrocarbons	0.9	-	-	34.2	44.9	14.8	-	17.7	-	-	-	-
Benzene (B)	1.7	-	-		1.7	-	-	-	-	-	-	-
Toluene (T)	0.9	1.2	1.2	1.8	1.2	-	1.4	1.1	-	1.4	-	1.8
Xylene (X)	0.9	-	-	-	-	-	-	-	-	-	-	-
Total B, T, X	0.9	1.2	1.2	1.8	2.9	-	1.4	1.1	-	1.4	-	1.8
Acetone	6.4	21.9	-	9.4	38.7	18.3	8.4	13.0	6.6	-	8.2	12.6
Bromomethane	31.1	-	-	-	-	-	-	-	-	-	-	-
2-Butanone	5.0	-	-	-	0.9	-	-	-	-	-	-	-
Carbon disulfide	15.5	-	41.6	-	44.1	-	75.8	120.6	261.11	111.3	-	16.2

TABLE A.1-3 (Cont.)

		Flux Rate (ng/m^2/min) by Sample Location[b]									
Parameter	QL[c]	60	61	62	63	65	66	67	68	68D	69
Chloromethane	2.7	93.0	-	11.1	59.5	-	-	56.8	-	-	2.8
1,2-Dichloroethane	2.1	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	9.3	-	-	-	-	-	-	-	-	-	-
1,2-Dichloroethene (total)	2.8	-	-	-	-	-	-	-	-	-	-
Tetrachloroethene	1.0	-	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	1.2	-	-	-	-	-	-	-	-	-	-
Trichloroethene	0.9	6.5	1.4	1.3	-	-	-	-	-	-	-
Total chlorinated hydrocarbons	0.9	99.5	1.4	12.4	59.5	-	-	56.8	-	-	2.8
Benzene (B)	1.7	1.9	-	-	-	-	2.1	-	-	-	-
Toluene (T)	0.9	2.8	36.9	-	-	-	1.0	-	-	1.0	1.2
Xylene (X)	0.9	1.4	-	-	-	-	-	-	-	-	-
Total B, T, X	0.9	6.1	36.9	-	-	-	3.1	-	-	1.0	1.2
Acetone	6.4	73.9	34.1	18.1	7.2	-	21.1	9.0	12.7	7.8	-
Bromomethane	31.1	-	-	-	-	-	-	-	-	-	-
2-Butanone	5.0	6.8	-	-	-	-	-	-	-	-	-
Carbon disulfide	15.5	48.5	82.7	43.5	-	-	37.3	70.9	151.7	113.7	156.0

TABLE A.1-3 (Cont.)

	Flux Rate (ng/m^2/min) by Sample Location[b]										
Parameter	QL[c]	70	71	72	73	74	75	76	77	78	79
Chloromethane	2.7	-	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	2.1	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	9.3	-	-	-	-	-	-	-	-	-	-
1,2-Dichloroethene (total)	2.8	-	-	-	-	-	-	-	-	-	-
Tetrachloroethene	1.0	-	6.3	1.2	-	-	-	1.0	-	-	-
1,1,2-Trichloroethane	1.2	-	-	-	-	-	-	-	-	-	-
Trichloroethene	0.9	-	-	-	-	-	-	-	-	-	-
Total chlorinated hydrocarbons	0.9	-	6.3	1.2	-	-	-	1.0	-	-	-
Benzene (B)	1.7	1.7	-	-	-	3.9	-	3.4	1.9	-	5.7
Toluene (T)	0.9	4.8	1.3	1.0	-	1.2	-	1.4	-	1.1	3.2
Xylene (X)	0.9	1.1	-	-	-	-	-	-	-	-	1.0
Total B, T, X	0.9	7.6	1.3	1.0	-	5.1	-	4.8	1.9	1.1	9.9
Acetone	6.4	9.6	-	11.3	10.7	36.5	6.6	7.8	11.4	-	21.5
Bromomethane	31.1	-	-	-	-	-	-	-	-	-	-
2-Butanone	5.0	-	-	-	-	-	-	-	-	-	-
Carbon disulfide	15.5	-	154.8	-	-	-	-	-	-	-	-

TABLE A.1-3 (Cont.)

		Flux Rate (ng/m^2/min) by Sample Location[b]										
Parameter	QL[c]	80	81	81D	82	83	84	85	86	87	88	89
Chloromethane	2.7	34.6	35.9	-	-	39.5	-	89.2	-	127.6	-	-
1,2-Dichloroethane	2.1	-	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	9.3	-	-	-	-	-	-	-	-	-	-	-
1,2-Dichloroethene (total)	2.8	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethene	1.0	-	-	-	-	-	-	-	-	-	1.4	-
1,1,2-Trichloroethane	1.2	-	-	-	-	-	-	-	-	-	-	-
Trichloroethene	0.9	-	-	1.5	-	-	-	-	-	-	-	5.7
Total chlorinated hydrocarbons	0.9	34.6	35.9	1.5	-	39.5	-	89.2	-	127.6	1.4	5.7
Benzene (B)	1.7	-	-	-	1.8	-	3.7	-	-	-	-	-
Toluene (T)	0.9	-	-	-	-	-	2.5	-	-	-	-	-
Xylene (X)	0.9	-	-	-	-	-	-	-	-	-	-	-
Total B, T, X	0.9	-	-	-	1.8	-	6.2	-	-	-	-	-
Acetone	6.4	-	22.5	-	11.3	13.9	14.7	11.2	9.8	34.5	10.2	8.6
Bromomethane	31.1	-	-	-	-	-	-	37.3	-	-	-	-
2-Butanone	5.0	-	-	-	-	-	-	-	-	1.6	-	-
Carbon disulfide	15.5	88.9	107.5	106.9	-	32.9	-	-	-	-	-	-

TABLE A.1-3 (Cont.)

Parameter	Flux Rate ($ng/m^2/min$) by Sample Location[b]							
	QL[c]	90	91	92	93	93D	94	95
Chloromethane	2.7	-	4.7	-	-	-	-	-
1,2-Dichloroethane	2.1	-	-	-	-	-	-	-
1,1-Dichloroethene	9.3	-	-	-	-	-	-	9.7
1,2-Dichloroethene (total)	2.8	-	-	-	-	-	-	29.3
Tetrachloroethene	1.0	-	-	-	-	-	-	1.1
1,1,2-Trichloroethane	1.2	-	-	-	-	-	-	5.7
Trichloroethene	0.9	-	2.8	-	2.3	1.6	-	84.7
Total chlorinated hydrocarbons	0.9	-	7.5	-	2.3	1.6	-	130.5
Benzene (B)	1.7	3.6	-	3.3	-	-	2.8	-
Toluene (T)	0.9	1.2	-	1.8	1.0	1.5	-	-
Xylene (X)	0.9	-	-	-	-	-	-	-
Total B, T, X	0.9	4.8	-	5.1	1.0	1.5	2.8	-
Acetone	6.4	10.7	8.2	11.1	12.9	33.6	15.7	-
Bromomethane	31.1	-	-	-	-	-	-	-
2-Butanone	5.0	-	-	-	-	-	-	-
Carbon disulfide	15.5	-	-	-	-	-	-	-

TABLE A.1-3 (Cont.)

Parameter	Flux Rate (ng/m^2/min) by Sample Location[b]										
	QL[c]	97	97D	98[c]	100	101	101D	102	103	104	105
Chlorobenzene	0.9	-	-	-	-	-	-	-	-	-	-
Chloroform	2.3	-	-	-	-	-	-	-	-	-	-
1,2-Dichloroethene (total)	2.8	-	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	1.2	-	-	-	-	-	-	-	-	-	-
Tetrachloroethene	1.0	2.1	3.3	3.0	-	-	-	-	-	-	-
1,1,1-Trichloroethane	2.4	-	-	-	-	-	-	7.5	-	-	-
1,1,2-Trichloroethane	1.2	-	-	-	-	-	-	-	-	-	-
Trichloroethene	0.9	1.3	2.8	-	-	-	-	-	2.2	-	-
Total chlorinated hydrocarbons	0.9	3.4	6.1	3.0	-	-	-	7.5	2.2	-	-
Benzene (B)	1.7	-	-	-	-	-	-	-	3.8	-	-
Toluene (T)	0.9	-	-	-	1.0	-	1.0	-	2.0	-	-
Xylene (X)	0.9	-	-	-	-	-	-	-	1.2	-	-
Total B, T, X	0.9	-	-	-	1.0	-	1.0	-	7.0	-	-
Acetone	6.4	-	-	2.3	2.8	-	2.2	0.6	-	-	-
Styrene	1.0	-	-	-	-	-	-	-	-	-	-

TABLE A.1-3 (Cont.)

Parameter	Flux Rate (ng/m^2/min) by Sample Location[b]										
	QL[c]	106	107	108	109	110	111	112	113	114	115
Chlorobenzene	0.9	-	-	-	-	-	-	-	-	-	-
Chloroform	2.3	-	-	-	-	-	-	-	-	-	-
1,2-Dichloroethene (total)	2.8	-	-	-	-	-	-	-	131.1	-	-
1,1,2,2-Tetrachloroethane	1.2	-	-	-	-	-	-	-	508.6	-	-
Tetrachloroethene	1.0	3.6	1.4	-	-	-	-	-	3.9	-	-
1,1,1-Trichloroethane	2.4	2.9	-	-	3.0	-	-	-	-	-	-
1,1,2-Trichloroethane	1.2	-	-	-	-	-	-	-	21.7	-	-
Trichloroethene	0.9	14.7	1.8	-	-	-	3.9	-	537.0	-	-
Total chlorinated hydrocarbons	0.9	21.2	3.2	-	3.0	-	3.9	-	1,202.3	-	-
Benzene (B)	1.7	-	-	-	4.1	-	-	-	-	-	-
Toluene (T)	0.9	-	-	-	2.4	-	-	-	-	-	-
Xylene (X)	0.9	-	-	-	1.1	-	-	-	-	-	-
Total B, T, X	0.9	-	-	-	7.6	-	-	-	-	-	-
Acetone	6.4	-	38.3	-	-	0.5	6.9	-	-	0.3	-
Styrene	1.0	-	-	-	-	-	-	-	-	-	-

TABLE A.1-3 (Cont.)

	Flux Rate (ng/m²/min) by Sample Location[b]					
Parameter	QL[c]	116	117	118	119	120
Chlorobenzene	0.9	-	-	-	1.1	-
Chloroform	2.3	-	-	-	22.0	-
1,2-Dichloroethene (total)	2.8	3.3	-	-	-	-
1,1,2,2-Tetrachloroethane	1.2	-	-	-	-	-
Tetrachloroethene	1.0	-	-	-	-	-
1,1,1-Trichloroethane	2.4	3.8	2.5	2.8	-	-
1,1,2-Trichloroethane	1.2	-	-	-	-	-
Trichloroethene	0.9	17.2	-	3.6	-	-
Total chlorinated hydrocarbons	0.9	24.3	2.5	6.4	23.1	-
Benzene (B)	1.7	3.5	-	3.9	1.9	-
Toluene (T)	0.9	1.3	-	1.2	1.2	1.3
Xylene (X)	0.9	-	-	-	1.2	-
Total B, T, X	0.9	4.8	-	5.1	4.3	1.3
Acetone	6.4	-	-	-	-	4.2
Styrene	1.0	-	-	-	-	5.5

[a] Notation: A hyphen denotes value below the reported quantitation level.

[b] Sampling locations are shown in Figure A.1-1.

[c] QL = quantitation limit.

Source: Prasad and Martino (1994a).

sample (113) in the Southern Main Pit. Chlorinated hydrocarbon compounds with the highest relative flux rates were primarily in the sample from the Southern Main Pit: 1,2-dichloroethene (12DCE, 131 ng/m^2/min), TCLEA (509 ng/m^2/min), and TRCLE (537 ng/m^2 /min) (Prasad and Martino 1994a). Emissions of TRCLE were found in 19 sampling locations clustered in two areas: (1) the Main Burning Pits and adjacent Pushout Area and (2) the southeastern tip of the TBP AOC.

In addition to the passive soil gas studies, the EPA emergency response team (ERT) conducted active soil gas sampling at 58 locations in the southeastern part of the TBP AOC (Weston 1994) (Figure A.1-2). Table A.1-4 lists the results of that survey for those locations where some contamination was detected. The samples were analyzed on-site with a Microsensor Technology model P200 gas chromatograph. The target compounds included 1,1-dichloroethene (11DCE), TRCLE, isooctane, 1,2-dichloroethene (12DCE), chloroform, m-xylene, o-xylene, toluene, and carbon tetrachloride. Fifty soil gas samples and two ambient-air field blanks contained no detectable levels of the target compounds. The compound TRCLE (up to 2.2 mg/m^3) was detected in eight samples (B12–B15, C10, C15, D8, and F5) along the southern boundary of the South Main Pit. However, TRCLE was also found in one of the three ambient-air field blanks. Low levels of TCLEE were also found in sample D8. No other compounds were detected (Weston 1994).

The main objective of the EPA ERT study was to determine the optimal placement of a pilot-scale soil vapor extraction (SVE) unit that was planned for installation in 1994. The sampling design was based on previous groundwater and passive soil gas data collected at the TBP AOC. However, concurrent studies conducted by Argonne National Laboratory (ANL) (Table A.1-3) revealed most of the soil gas contamination to be in an area just to the north of the ERT's sampling grid, but with the same general southeast trend. The SVE unit was never installed at the site.

TABLE A.1-4 P200 Gas Chromatographic Soil Gas Results for the TBP AOC[a]

		Soil Gas Reading (mg/m^3) by Sample Location[b]							
Parameter	Amb. Air	B12	B13	B14	B15	C10	C15	D8	F5
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	0.29	ND
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	0.16	0.06	0.80	2.2	1.49	0.93	0.12	1.57	0.29

[a] Notation: ND = not detected.

[b] Sampling locations are shown in Figure A.1-2.

Source: Weston (1994).

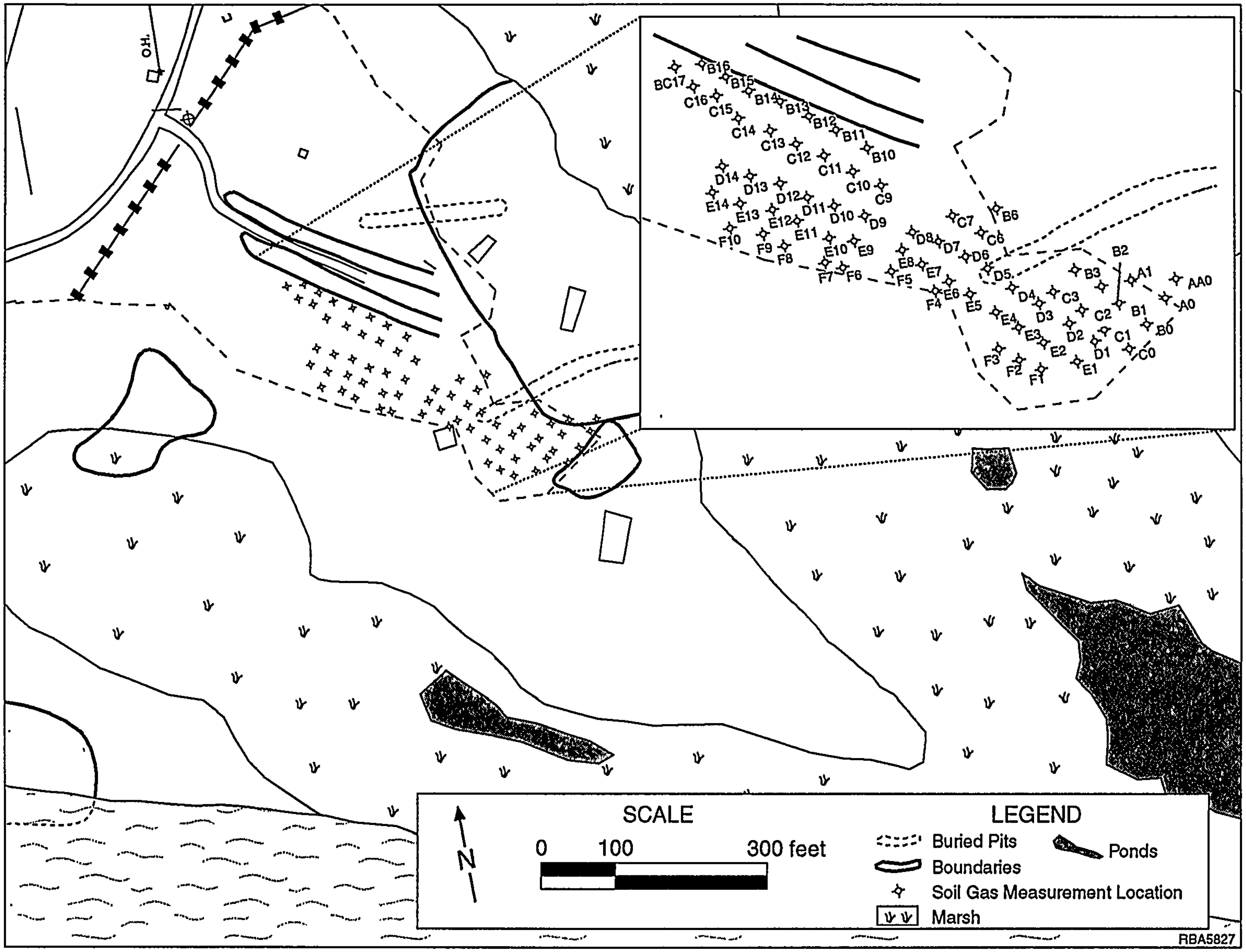

FIGURE A.1-2 Locations of Active Soil Gas Samples at the TBP AOC (Source: Weston 1994)

In 1994, a Sentex Scentograph Plus II portable gas chromatograph (GC) was used for active gas sampling at 11 locations (ASG20, ASG24, ASG25, and ASG27–34 in Figure A.1-1). TRCLE was found in the field blank. Low levels of TRCLE (0.03 parts per million [ppm]), 12DCE (0.04 ppm), m-xylene (0.04 ppm), and toluene (0.16 ppm) were detected at ASG33, but duplicate and triplicate measurements did not indicate their presence. No detectable levels of the target compounds were found at the other locations.

A.1.1.2 In Situ X-Ray Fluorescence

A qualitative field x-ray fluorescence (XRF) instrument (TN Technologies Spectrace 9000) was used by ANL investigators (Martino and Prasad 1995) to identify "hot spots" of metal contamination in the TBP AOC. For the procedure used, the XRF data were initially reported as measurement results with standard deviations. An element reading greater than 10 times the standard deviation was considered to be present at the concentration reported. An element reading less than 3 times the standard deviation was considered to be below the detection limit of the instrument. Readings between 3 and 10 standard deviations were interpreted less definitively; the element might be present, but the reported concentration is semiquantitative at best. Survey results are in Table A.1-5.

The field XRF survey was conducted at 68 locations in the TBP AOC: 2 in the Main Burning Pits area (XRTBP18 and XRTBP45); 37 in the Pushout Area (approximately) between the VX and Mustard Pits (XRTBP1–16, XRTBP19, XRTBP23–39; XRTBP42–44); 11 in the High Explosives (HE) Demolition Ground (XRHE1–11); 12 in the Square Pit and Southwestern Suspect Burning Area (XRSP1–9, SP-MOUND, SP-MOUNDA, and SP-MOUNDB); 5 on the western side of the TBP AOC (XRTBP20–22); 2 on the northern side (XRTBP40 and XRTBP46); and 1 (with a duplicate) northwest of the Mustard Pit (XRTBP17 and XRTBP17B) (Martino and Prasad 1995). The sampling locations are shown in Figure A.1-3.

Elevated concentrations of zinc and lead were found in samples from all suspected contamination sources except the HE Demolition Ground. The elevated level of titanium in sample XRSP1 was about 25 times higher than the average level detected at other locations in the general area.

A.1.1.3 Geophysical Surveys

In 1993, a geophysical survey (Daudt et al. 1994) was conducted at the TBP AOC to delineate the filled VX trench and the Liquid Smoke Disposal Pit and to investigate the stratigraphy under the AOC. The methods used included seismic refraction, seismic reflection, electrical resistivity soundings, electrical conductivity, magnetometer, and ground-penetrating radar (GPR).

TABLE A.1-5 Results of the Field-Portable X-Ray Fluorescence Analysis at the TBP AOC[a]

	Concentration (mg/kg)										
Sample Number[b]	Chromium +3	Chromium +5	Potassium	Calcium	Titanium	Manganese	Iron	Cobalt	Nickel	Copper	Zinc
Detection limit	90	263	161	70	55	203	111	101	63	44	35
Main Burning Pits Area											
XRTBP18	197	ND	*5,204*	*6,362*	*2,158*	282	*14,853*	ND	ND	*430*	*2,351*
XRTBP45	*7,206*	*10,432*	*9,849*	*7,807*	*2,986*	*1,225*	*63,134*	672	ND	*22,384*	*3,001*
Pushout Area											
XRTBP1	*378*	ND	*3,446*	*2,610*	*1,477*	ND	*7,391*	ND	ND	*173*	*513*
XRTBP2	*352*	349	*4,202*	*8,367*	*1,773*	ND	*13,736*	ND	ND	*560*	*741*
XRTBP3	261	ND	*3,809*	1,733	*2,037*	ND	*10,451*	ND	ND	*182*	*619*
XRTBP4	128	ND	*4,011*	*3,270*	*2,086*	ND	*10,215*	ND	ND	*354*	*760*
XRTBP5	238	ND	*3,563*	*4,518*	*1,604*	ND	*8127*	ND	ND	*205*	*646*
XRTBP6	364	ND	*5,425*	*7,610*	*2,331*	304	*15,536*	ND	ND	*360*	*1,306*
XRTBP7	168	ND	*5,616*	*5,957*	*2,461*	ND	*12,062*	ND	ND	*243*	*593*
XRTBP8	273	ND	*5,503*	*8,025*	*2,143*	ND	*12,917*	190	ND	*188*	*645*
XRTBP9	268	ND	*5,428*	*5,837*	*2,287*	308	*10,384*	ND	ND	*410*	*1,129*
XRTBP10	216	ND	*4,943*	*10,301*	*1,550*	ND	*7,241*	ND	ND	*450*	*1,459*
XRTBP11	176	ND	7,460	*10,540*	*1,915*	275	*9,338*	163	ND	*777*	*2,206*
XRTBP12	355	ND	*3,326*	*3,195*	*1,123*	ND	*7,337*	ND	ND	*490*	*1,070*
XRTBP13	312	ND	4,023	*17,146*	*1,547*	ND	*15,618*	ND	ND	*635*	*614*
XRTBP14	*390*	ND	*4,776*	*12,355*	*1,307*	ND	*10,684*	166	ND	*631*	*238*
XRTBP15	ND	ND	*8,356*	*30,285*	*2,600*	810	*10,496*	184	ND	*2,377*	*4,217*
XRTBP16	*436*	ND	*3,896*	*7,262*	*909*	ND	*8,636*	ND	ND	*552*	*1,034*
XRTBP19	188	638	*3,492*	*733*	*4,151*	452	*25,311*	363	ND	*534*	*734*
XRTBP24A	ND	ND	*5,007*	*1,083*	*19,272*	ND	*42,180*	331	ND	*290*	*900*
XRTBP24B	ND	643	*3,344*	*667*	*7,958*	688	*27,942*	426	ND	*528*	*1,017*
XRTBP25	132	524	*3,965*	*942*	*3,838*	383	*13,329*	285	ND	*155*	*402*
XRTBP26	ND	870	*4,771*	*1,233*	*4,805*	758	*48,056*	601	125	*370*	*5,889*
XRTBP26 DUP	ND	1,268	*4,624*	*1,254*	*4,077*	977	*47,429*	564	158	*420*	*5,783*
XRTBP27	228	632	*4,788*	*2,658*	*3,523*	756	*42,714*	699	105	*504*	*7,055*
XRTBP28	ND	494	*7,066*	*5,529*	*4,319*	728	*24,618*	418	66	*553*	*4,184*
XRTBP29	ND	597	*6,084*	*2,445*	*3,530*	795	*25,580*	421	ND	*772*	*3,993*
XRBPT30	152	651	*5,870*	*1,698*	*2,866*	580	*27,970*	369	ND	*486*	*1,225*
XRTBP31	ND	870	*6,275*	*1,810*	*6,445*	ND	*27,660*	404	ND	*488*	*931*
XRTBP32	ND	750	*5,102*	*1,962*	*10,478*	ND	*45,261*	396	ND	*3,355*	*5,068*
XRTBP33	249	847	*5,171*	*2,561*	*3,646*	ND	*23,631*	301	ND	*844*	*4,127*
XRTBP34	ND	*883*	*3,639*	*2,070*	*4,257*	ND	*11,994*	ND	ND	*222*	*1,546*
XRTBP36	ND	756	*5,204*	*5,667*	*3,018*	ND	*20,126*	ND	ND	*375*	*3,609*
XRTBP37	ND	*1,224*	*3,203*	*4,440*	*923*	ND	*7,330*	ND	ND	ND	*1,125*
XRTBP38	ND	802	*6,548*	*10,890*	*2,622*	306	*18,024*	ND	ND	*306*	*3,640*

TABLE A.1-5 (Cont.)

	Concentration (mg/kg)										
Sample Number[b]	Chromium +3	Chromium +5	Potassium	Calcium	Titanium	Manganese	Iron	Cobalt	Nickel	Copper	Zinc
Detection limit	90	263	161	70	55	203	111	101	63	44	35
XRTBP39	164	ND	*3,567*	*673*	*1,069*	ND	*6,696*	ND	ND	49	*200*
XRTBP41	143	ND	*3,791*	*19,640*	*516*	*2,180*	*6,676*	ND	82	*254*	*8,799*
XRTBP42	ND	ND	*7,346*	*6,474*	*3,057*	421	*16,498*	ND	ND	*316*	*2,694*
XRTBP43	ND	ND	*7,556*	*6,816*	*3,781*	285	*13,865*	200	ND	*245*	*4,209*
XRTBP44	ND	365	*8,058*	*4,563*	*4,639*	384	*15,107*	ND	ND	*1,067*	*1,054*
West of TBP AOC											
XRTBP20	204	ND	*8,226*	*1,247*	*2,514*	ND	*12,854*	ND	ND	90	108
XRTBP21	254	ND	*7,812*	*1,270*	*2,867*	376	*9,332*	ND	ND	152	*245*
XRTBP22	251	ND	*7,065*	*1,192*	*2,032*	ND	*8,859*	ND	ND	83	*131*
XRTBP40	ND	ND	*7,029*	*1,666*	*2,031*	ND	*9,729*	ND	ND	ND	*109*
XRTBP40 DUP	ND	ND	*10,286*	*1,402*	*4,052*	ND	*14,771*	128	ND	72	*96*
Northwest of Mustard Pit											
XRTBP17	245	ND	*6,567*	*1,691*	*2,090*	ND	*8,079*	ND	ND	ND	77
XRTBP17 DUP	203	ND	*6,558*	*1,587*	*2,229*	ND	*8,016*	ND	ND	ND	75

TABLE A.1-5 (Cont.)

	Concentration (mg/kg)										
Sample Number[b]	Arsenic	Selenium	Strontium	Zirconium	Molybdeum	Mercury	Lead	Rubidium	Cadmium	Tin	Antimony
Detection limit	25	17	14	3	4	29	14	5	86	47	32
Main Burning Pits Area											
XRTBP18	16	ND	*39*	*421*	ND	ND	*180*	16	ND	ND	ND
XRTBP45	ND	ND	*96*	*463*	9	ND	*303*	ND	ND	ND	65
Pushout Area											
XRTBP1	ND	ND	*23*	*473*	6	ND	*354*	ND	ND	ND	ND
XRTBP2	ND	ND	*53*	*539*	8	ND	*536*	15	ND	ND	48
XRTBP3	ND	ND	*33*	*810*	7	ND	*659*	ND	ND	ND	70
XRTBP4	ND	ND	*41*	*521*	5	ND	*520*	ND	ND	84	49
XRTBP5	ND	ND	*31*	*384*	ND	ND	*530*	ND	ND	ND	42
XRTBP6	ND	ND	*59*	*404*	ND	ND	*1,185*	ND	ND	ND	112
XRTBP7	ND	ND	*51*	*761*	ND	ND	*1,084*	19	ND	ND	52
XRTBP8	ND	ND	*60*	*505*	7	ND	*1,070*	18	ND	ND	76
XRTBP9	ND	ND	*52*	*488*	10	ND	*519*	14	ND	ND	64
XRTBP10	ND	ND	*58*	*395*	5	ND	*613*	15	ND	ND	33
XRTBP11	ND	ND	*86*	*424*	ND	ND	*796*	18	ND	ND	37
XRTBP12	ND	ND	*32*	*123*	ND	ND	*398*	ND	ND	ND	33
XRTBP13	ND	ND	*47*	*457*	ND	ND	*572*	15	ND	ND	51
XRTBP14	ND	ND	*35*	*459*	9	ND	*1,028*	ND	ND	ND	66
XRTBP15	ND	ND	*112*	*342*	ND	ND	*822*	23	ND	ND	ND
XRTBP16	ND	ND	*42*	*234*	6	ND	*427*	ND	ND	ND	47
XRTBP19	ND	ND	*29*	*252*	9	ND	*11,664*	25	ND	54	*379*
XRTBP24 A	ND	ND	*57*	318	ND	ND	*19,862*	ND	ND	173	*1,249*
XRTBP24 B	ND	ND	*36*	*232*	*9*	ND	*8,298*	19	ND	75	*407*
XRTBP25	ND	ND	*42*	*352*	ND	ND	*7,696*	14	ND	ND	*296*
XRTBP26	ND	ND	*52*	*266*	ND	ND	*21,536*	ND	ND	131	*727*
XRTBP26 DUP	ND	ND	*48*	*247*	ND	ND	*21,102*	ND	ND	144	*798*
XRTBP27	ND	ND	*50*	*387*	ND	ND	*10,061*	ND	ND	ND	*350*
XRTBP28	ND	ND	*59*	*427*	ND	ND	*9,435*	ND	ND	65	*370*
XRTBP29	ND	ND	*58*	*424*	7	ND	*7,292*	27	ND	64	*292*
XRBPT30	ND	ND	*49*	401	5	ND	*6,602*	ND	ND	ND	*220*
XRTBP31	ND	ND	*63*	*495*	ND	ND	*10,601*	ND	ND	107	*589*
XRTBP32	ND	ND	*59*	*422*	ND	ND	*5,144*	ND	ND	98	*228*
XRTBP33	ND	ND	*60*	*352*	ND	ND	*5,947*	ND	ND	ND	*273*
XRTBP34	ND	ND	*27*	*167*	ND	ND	*1,385*	ND	ND	ND	81
XRTBP36	ND	ND	*69*	*240*	ND	ND	*4,915*	ND	ND	ND	125
XRTBP37	ND	ND	*43*	*299*	ND	ND	*25,256*	ND	ND	ND	91
XRTBP38	ND	ND	*57*	*312*	ND	ND	*4,406*	ND	ND	ND	165

TABLE A.1-5 (Cont.)

	Concentration (mg/kg)										
Sample Number[b]	Arsenic	Selenium	Strontium	Zirconium	Molybdeum	Mercury	Lead	Rubidium	Cadmium	Tin	Antimony
Detection limit	25	17	14	3	4	29	14	5	86	47	32
XRTBP39	38	ND	***21***	***221***	6	ND	20	14	ND	ND	ND
XRTBP41	ND	ND	***73***	***86***	ND	ND	***1,107***	ND	ND	ND	52
XRTBP42	ND	ND	***63***	381	5	ND	***799***	ND	ND	ND	40
XRTBP43	ND	ND	***68***	***501***	ND	ND	***1,410***	36	ND	ND	***95***
XRTBP44	ND	ND	***60***	***537***	6	ND	***818***	35	ND	ND	66
West of TBP AOC											
XRTBP20	42	ND	***39***	***616***	8	ND	***77***	30	ND	ND	ND
XRTBP21	41	ND	***33***	***575***	ND	ND	***86***	24	ND	ND	ND
XRTBP22	30	ND	***38***	***562***	***13***	ND	23	24	ND	ND	ND
XRTBP40	ND	ND	***40***	***544***	6	ND	38	28	ND	ND	ND
XRTBP40 DUP	ND	ND	***49***	***728***	ND	ND	33	ND	ND	ND	28
Northwest of Mustard Pit											
XRTBP17	48	ND	***37***	***612***	7	ND	ND	23	ND	ND	ND
XRTBP17 DUP	57	ND	***41***	***591***	7	ND	ND	16	ND	ND	ND

[a] Standard script indicates that metal is present at less than 10 times but greater than 3 times the standard deviation of counting statistics. Bold italic script indicates that the metal is present at greater than 10 times the standard deviation of counting statistics. Notation: ND = not detected.

[b] Samples XRFTBP23 and 35 were not measured; sample locations are not shown in Figure A.1-3.

Source: Martino and Prasad (1995).

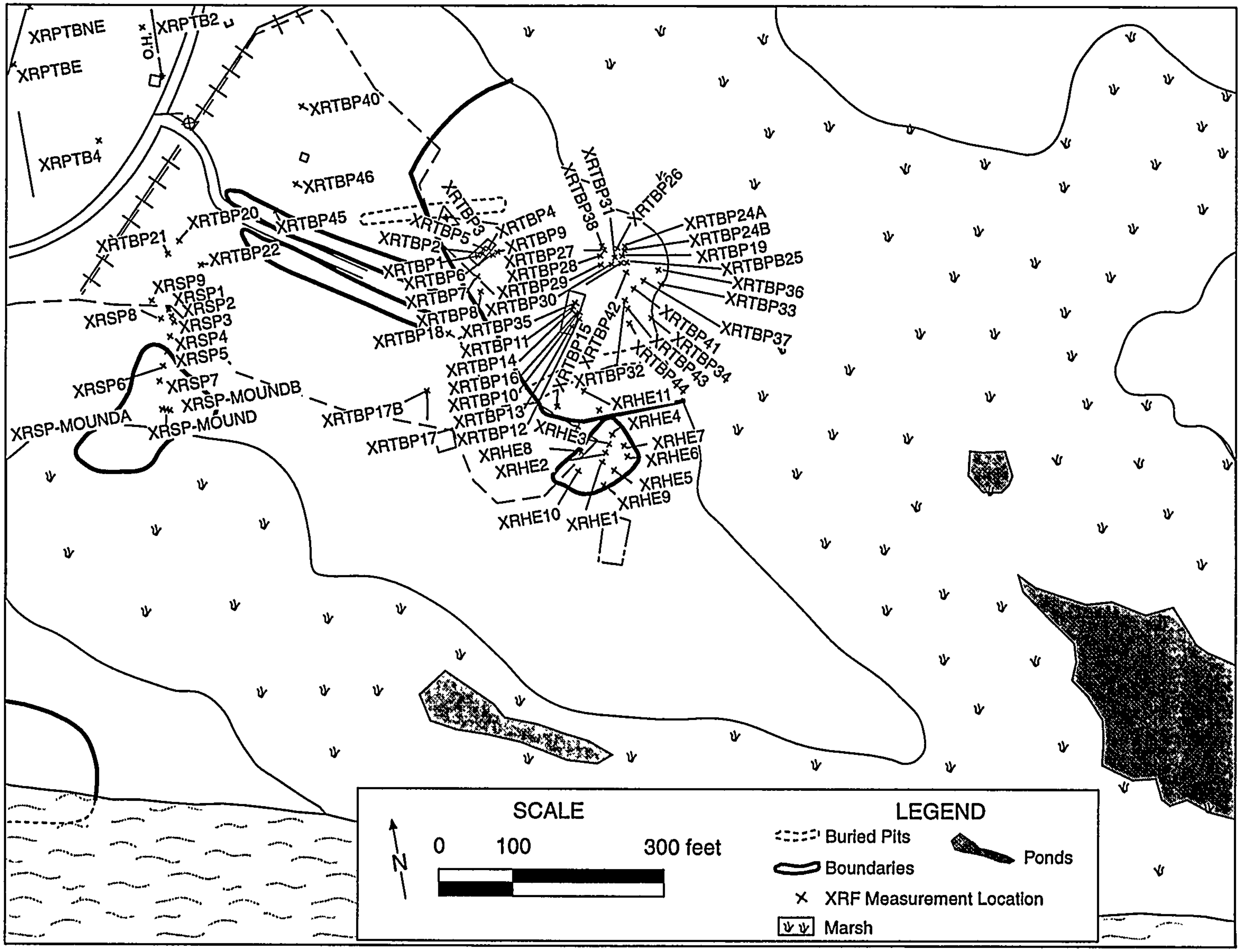

FIGURE A.1-3 Locations of In Situ X-Ray Fluorescence Measurements in the TBP AOC

Total field magnetic and GPR geophysical anomalies were found near the southwestern end of the filled VX Pit. The location of the Liquid Smoke Disposal Pit was not determined. The depth and thickness of the Unit B (the confining unit) of the Talbot Formation was estimated from the seismic data. Elevations for the top of the confining unit range from 15 to 45 ft below mean sea level (MSL). Elevations for the bottom of Unit B range from 40 to 95 ft. However, near-surface velocity variations may have slightly exaggerated these depths. The unit thickens significantly to the east, ranging from only 25 to 35 ft in the western portion of the site to up to 80 ft in the eastern portion (Daudt et al. 1994).

In 1995, a more focused geophysical survey was conducted to delineate the areal extent of the filled VX Pit and the filled Mustard Pit by using electrical conductivity, magnetometer, and GPR methods (Davies et al. 1995). The survey confirmed the location of the VX trench found in the earlier survey (Daudt et al. 1994). The exact locations of the filled VX trench and the filled Mustard Pit were delineated (Figure 4.1). Both pits showed clear electrical conductivity and magnetic and ground-penetrating anomalous signals (Davies et al. 1995).

A.1.2 Soil Analyses

Soil data collected at the TBP AOC are discussed below; the discussion is organized according to the individual contamination source (Main Burning Pits, Pushout Area, etc.). The surface soil data are presented first, followed by soil boring data, if available.

A.1.2.1 Main Burning Pits

A.1.2.1.1 Surface Soil. As part of the Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) (Nemeth 1989), surface soil radiation was surveyed with portable gamma and beta detectors. The survey, conducted in February 1988, included the Main Burning Pits, the Pushout Area, the VX and Mustard Pits, the HE Demolition Area, and the Liquid Smoke Disposal Pit. No radioactivity above normal background levels was detected. Gamma levels in the TBP area ranged from 8 to 12 microrad per hour (μR/h), and the level in a background area not suspected of contamination was 10 μR/h. The beta activity in the TBP AOC ranged from 5 to 9 counts per minute (cpm) (Nemeth 1989). The RFA report (Nemeth 1989) does not specify the location of sampling points surveyed, although it is likely that they correspond to the sample locations shown in Figure A.1-4.

The RFA also reported systematic sampling at the Main Burning Pits. Eight surface soil samples (depths unknown) were collected — four in the Northern Main Pit (J7–J10) and four in the Southern Main Pit (J1 and J3–J5) (Figure A.1-4). Other samples were collected north and south of

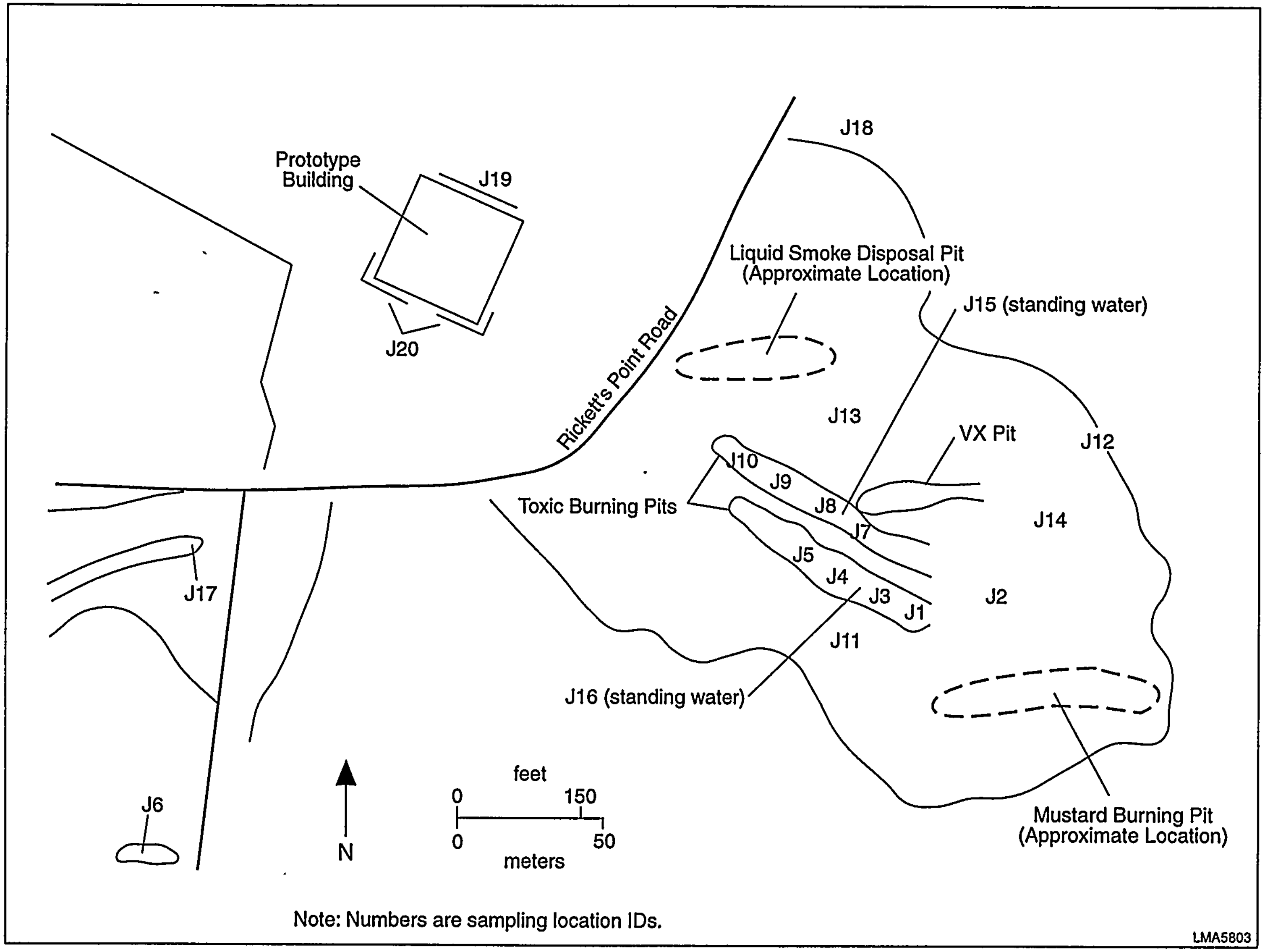

FIGURE A.1-4 Locations of Surface Soil and Surface Water Samples Collected during the 1986 RCRA Facility Assessment (Source: Adapted from Nemeth 1989)

the Main Burning Pits and in the Pushout Area; these samples are discussed in a later section. The burning pit samples were analyzed for metals, extractable metals, and explosives-related compounds (Table A.1-6). High levels of arsenic (up to 55 mg/kg in J1) and lead (up to 2,998 mg/kg in J7) were detected in samples collected from both Main Burning Pits. Several additional metals, including arsenic, barium, cadmium, chromium, mercury, and silver, were detected at concentrations exceeding the calculated background. No explosives-related compounds were detected.

A composite sample from the Southern Main Pit (J1) and the Pushout Area (J2) (Figure A.1-4) contained 13,000 µg/kg of heptachlor epoxide (a pesticide), 230,000 µg/kg of the polychlorinated biphenyl (PCB) Aroclor 1248, and low concentrations of other pesticides (Nemeth 1989). The presence of PCB was confirmed in another composite sample (J3-J5) collected from the Southern Main Pit, in which 3,700 µg/kg of Aroclor 1248 was found. The PCB was reportedly used as heat-transfer fluid at the Edgewood Area and disposed of at J-Field (Nemeth 1989). Another composite soil sample from the two Main Burning Pits (J3–J5 plus J7–J10) also contained pesticides — 1,000 µg/kg of dichlorodiphenyldichloroethane (DDD) and 1,000 µg/kg of dichlorodiphenyldichloroethylene (DDE).

In 1993, Weston collected four surface soil samples at depths of 3 in. and 1 ft at two locations (JBPPB and JBPPC) near the edge of the Northern Main Pit (Mazelon 1993). The JBPPB samples were collected near the northwestern end of the pit, and the JBPPC samples were from the northern edge of the pit (Figure A.1-5). The samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, pesticides, and PCBs. Table A.1-7 summarizes the results. The highest levels of contamination were found in JBPPB at the northwestern end of the pit. Low levels of VOCs were found in the samples from 1 ft — TCLEE at 99 µg/kg and TRCLE at 31 µg/kg. Low levels of SVOCs (2-methylnaphthalene, di-n-butylphthalate, naphthalene, and phenanthrene) were also found. Of particular note were the high levels of Aroclor 1248 found in the 3-in. JBPPB sample and elevated levels of lead and zinc in the 1-ft JBPPB sample.

In December 1993, Argonne collected 12 additional surface soil samples to delineate the extent of contamination near the Main Burning Pits. These samples came from six locations at the edges of the pits — OT1–OT4 along the southern edge of the Southern Main Pit, and OT17 and OT18 along the northern edge of the Northern Main Pit (Figure A.1-5). These samples were collected from depths of 0–6 in. (A samples) and 6–12 in. (B samples). They were analyzed for metals, VOCs, and SVOCs; the results are summarized in Tables A.1-8 (metals) and A.1-9 (VOCs).

The highest levels of metals were found in sample OT1A (0–6 in.) at the southeastern end of the Southern Main Pit — copper at 774 mg/kg, lead at 497 mg/kg, and zinc at 1,022 mg/kg (Table A.1-8). The levels of these metals exceeded calculated background concentrations in most samples. Arsenic and cadmium were not detected; however, the detection limits for these metals were greater than the calculated background. Therefore, it is not possible to determine whether the concentrations in the TBP samples exceeded the calculated background levels.

TABLE A.1-6 Analytical Results for Metals and Extractable Metals in Surface Soil Samples Collected from the TBP AOC during the 1986 RCRA Facility Assessment[a]

	Concentration by Sample Location									
	Northern Main Pit				Southern Main Pit				SE of Main Burning Pits	
Parameter[b]	J7	J8	J9	J10	J1	J3	J4	J5	J2[c]	Background[d]
Total Metals (mg/kg)										
Arsenic	***47***	***26***	***44***	***32***	***55***	***22***	***41***	***19***	***25***	5
Barium	***488***	***172***	***296***	***208***	***592***	***313***	91	***134***	***277***	94
Cadmium	***17***	***8.6***	***6.1***	***4.8***	***8.1***	***2.5***	***4.9***	***1.6***	***4.6***	0.70
Chromium	***73***	***76***	***53***	***58***	***76***	***46***	***96***	***71***	***54***	41
Lead	***2,998***	***720***	***1,369***	***4,101***	***472***	***378***	***85***	60	***548***	61
Mercury	***2.2***	***11***	***7.3***	***6.1***	***0.78***	***0.46***	***0.15***	***0.22***	***0.87***	0.080
Silver	***15***	***7.0***	<5.0	<5.0	***14.0***	<5.0	***12.1***	<5.0	<5.0	0.39
Extractable Metals (mg/L)										
Cadmium	0.23	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	NA
Lead	5.2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	NA
Silver	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	NA

[a] Notation: NA = not available. Sampling locations are shown in Figure A.1-4. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Includes parameters that were detected in at least one soil sample.

[c] VOCs were measured in sample J2 only; 1,000 µg/kg of trichloroethene and traces of other VOCs were found.

[d] Background values were derived from soil data in ICF Kaiser Engineers (1995).

Source: Nemeth (1989).

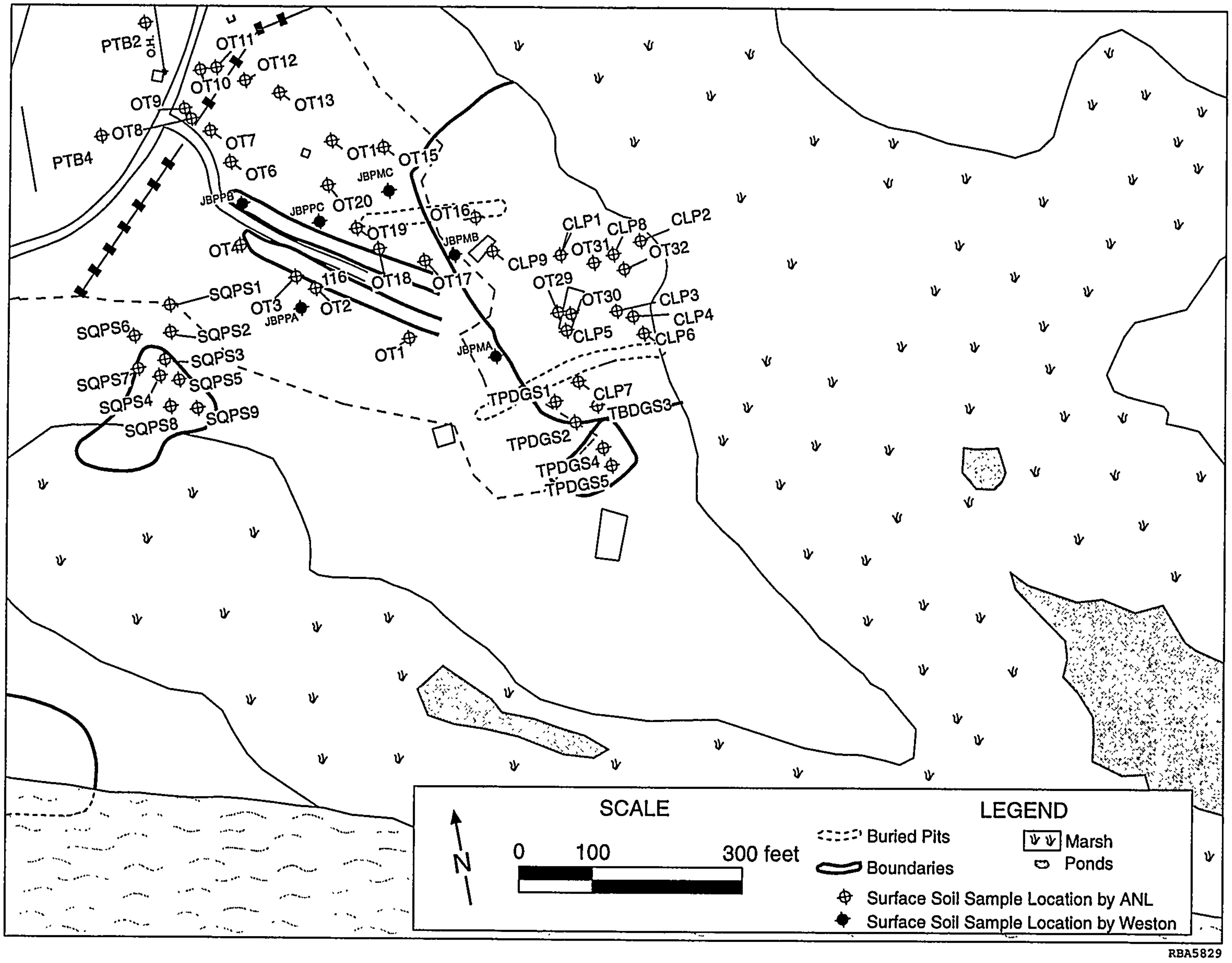

FIGURE A.1-5 Locations of Surface Soil Samples Collected in the TBP AOC since 1993 (JBP sample locations from Mazelon 1993)

TABLE A.1-7 Analytical Results for Various Parameters in Surface Soil Samples Collected from the Main Burning Pits in the TBP AOC: 1993[a]

Parameter	Concentration (µg/kg, except as noted) by Sample Location[b]			
	JBPPB (3 in.)	JBPPB (1 ft)	JBPPC (3 in.)	JBPPC (1 ft)
VOCs				
Acetone	<14	20	<12	20
Carbon disulfide	<7	<6	<6	<6
Chlorobenzene	<7	<6	<6	<6
Chloroform	<7	10	<6	<6
1,2-Dichloroethane	<7	<6	<6	<6
1,1-Dichloroethene	<7	<6	<6	<6
1,2-Dichoroethene	NT	NT	NT	NT
trans-1,2-Dichloroethene	<7	<6	<6	<6
Ethylbenzene	<7	<6	<6	<6
Methylene chloride	8 B	8	5 J	6
1,1,2,2-Tetrachloroethane	4 J	2 J	<6	9
Tetrachloroethene	24	99	<6	<6
Toluene	<7	3 J	<6	<6
1,1,2-Trichloroethane	<7	<6	<6	<6
Trichloroethene	9	31	<6	<6
Vinyl chloride	<14	<12	<12	<12
Xylenes (total)	<7	<6	<6	<6
SVOCs				
Benzoic acid	<2,280	<1,950	<1,960	<1,960
Bis(2-ethylhexyl)phthalate	<455	<389	<392	<392
Di-n-butylphthalate	56 J	<389	<392	<392
Fluorene	<455	<389	<392	<392
Hexachlorobenzene	<455	<389	<392	<392
2-Methylnaphthalene	161 J	<389	<392	<392
Naphthalene	309 J	<389	<392	<392
Nitrobenzene	<455	<389	<392	<392
n-Nitrosodiphenylamine	<455	<389	<392	<392
Phenanthrene	73 J	<389	<392	<392
Pyrene	<455	<389	<392	<392
2,4,6-Trichlorophenol	<455	<389	<392	<392

TABLE A.1-7 (Cont.)

Parameter	JBPPB (3 in.)	JBPPB (1 ft)	JBPPC (3 in.)	JBPPC (1 ft)
	Concentration (μg/kg, except as noted) by Sample Location[b]			
Pesticides				
delta-Benzenehexachloride	<42	<3.6	3.7	<3.6
4,4′-Dichlorodiphenyldichloroethene	<51	42	<1.6	<1.6
4,4′-Dichlorodiphenyltrichloroethane	<56	<4.7	<4.8	<4.8
Endrin	<28	2.7	<2.4	<2.4
Heptachlor	<14	20	4.0	<1.2
PCBs				
Aroclor 1248	3,820	<40	<40	<40
Aroclor 1254	<462	<40	<40	<40
Metals[c] (mg/kg)				
Antimony	67	44	<4.6	<4.6
Arsenic	17	109	2.6	1.9
Beryllium	<0.22	<0.19	0.21	0.26
Cadmium	11	9.6	0.99	<0.57
Copper	908	662	33	8.4
Lead	1,180	1,110	28	9.0
Zinc	1,640	5,820	83	21

[a] Only detected analytes are reported; for samples with duplicate analyses, the higher value is reported. Notation: B = analyte also found in the associated blank; J = estimated value; NT = not tested..

[b] Sampling locations are shown in Figure A.1-5.

[c] Calculated background concentrations (mg/kg): antimony, 3.8; arsenic, 5.0; beryllium, 1.0; copper, 21; cadmium, 0.70; lead, 61; zinc, 118.

Source: Mazelon (1993).

TABLE A.1-8 Analytical Results for Selected Metals in Surface Soil Samples Collected near the Main Burning Pits: 1993[a,b]

	Concentration (mg/kg) in Northern Main Pit by Sample Location[b]			
Parameter	OT17A (0–6 in.)	OT17B (6–12 in.)	OT18A (0–6 in.)	OT18B (6–12 in.)
Arsenic	10	<10	<10	<10
Cadmium	<10	<10	<10	<10
Copper	***212***	16	***136***	***153***
Lead	***157***	15	***194***	***249***
Zinc	***603***	54	***676***	***546***

	Concentration (mg/kg) in Southern Main Pit by Sample Location[b]			
Parameter	OT1A (0–6 in.)	OT1B (6–12 in.)	OT2A (0–6 in.)	OT2B (6–12 in.)
Arsenic	<10	<10	<10	<10
Cadmium	13	<10	<10	<10
Copper	***774***	***57***	***69***	***212***
Lead	***497***	40	31	57
Zinc	***1,022***	***167***	***801***	***147***

	Concentration (mg/kg) in Southern Main Pit by Sample Location (Cont.)[b]				
Parameter	OT3A (0–6 in.)	OT3B (6–12 in.)	OT4A (0–6 in.)	OT4B (6–12 in.)	Background (mg/kg)[c]
Arsenic	<10	<10	<10	<10	5.0
Cadmium	<10	<10	<10	<10	0.70
Copper	***43***	***104***	***211***	***28***	20
Lead	25	21	***143***	28	61
Zinc	116	108	***372***	76	118

[a] Inorganics from the OT sample series were analyzed with laboratory XRF. Sample concentrations equal to or exceeding calculated background are presented in bold italics.

[b] Sampling locations are shown in Figure A.1-5.

[c] Background values were derived from soil data in ICF Kaiser Engineers (1995).

TABLE A.1-9 Analytical Results for Selected VOCs in Surface Soil Samples Collected near the Main Burning Pits

	Concentration (µg/kg) in Northern Main Pit by Sample Location[a]			
Parameter	OT17A (0–6 in.)	OT17B (6–12 in.)	OT18A (0–6 in.)	OT18B (6–12 in.)
Benzene	50	<20	<20	<20
Chloroform	<20	<20	<20	<20
1,1-Dichloroethene	50	<20	<20	<20
1,2-Dichloroethene	<20	<20	<20	<20
Hexachloroethane	<20	<20	<20	<20
Methylene chloride	50	50	<20	50
Tetrachloroethene	<20	<20	<20	<20
Toluene	<20	<20	<20	<20
1,1,2,2-Trichloroethane	<20	<20	<20	<20
Trichloroethene	50	<20	50	<20

	Concentration (µg/kg) in Southern Main Pit by Sample Location[a]			
Parameter	OT1A (0–6 in.)	OT1B (6–12 in.)	OT2A (0–6 in.)	OT2B (6–12 in.)
Benzene	100	<20	<20	<20
Chloroform	50	<20	<20	<20
1,1-Dichloroethene	50	<20	<20	50
1,2-Dichloroethene	<20	<20	<20	<20
Hexachloroethane	50	<20	<20	<20
Methylene chloride	100	100	50	50
Tetrachloroethene	100	<20	50	100
Toluene	50	<20	<20	<20
1,1,2,2-Trichloroethane	<20	<20	<20	<20
Trichloroethene	60	50	100	100

	Concentration (µg/kg) in Southern Main Pit by Sample Location[a] (Cont.)			
Parameter	OT3A (0–6 in.)	OT3B (6–12 in.)	OT4A (0–6 in.)	OT4B (6–12 in.)
Benzene	<20	<20	<20	<20
Chloroform	<20	<20	<20	<20
1,1-Dichloroethene	<20	<20	<20	<20
1,2-Dichloroethene	<20	<20	<20	<20
Hexachloroethane	<20	<20	<20	<20
Methylene chloride	100	50	50	100
Tetrachloroethene	<20	<20	<20	<20
Toluene	<20	<20	<20	<20
1,1,2,2-Trichloroethane	<20	<20	<20	<20
Trichloroethene	100	100	50	<20

[a] Sampling locations are shown in Figure A.1-5.

Analyses for VOCs detected low levels of TRCLE (up to 100 µg/kg at OT2 and OT3) at each location sampled from the Main Burning Pits (Table A.1-9). Sample OT1A (0–6 in.) had detectable concentrations of several VOCs — 11DCE, benzene, chloroform, hexachloroethane, methylene chloride, TCLEE, toluene, and TRCLE. No VOCs except methylene chloride were detected in most of the other samples. SVOCs were detected in only four samples: OT1A (2,4,6-trichloroanaline at 4,100 µg/kg), OT4A (phenol at 100 µg/kg and 2,4,6-trichloroanaline at 4,700 µg/kg), OT18A (2,4,6-trichloroanaline at 900 µg/kg), and OT18B (2,4,6-trichloroanaline at 1,600 µg/kg). According to Nemeth (1989), 2,4,6-trichloroanaline was used to treat clothing at APG.

A.1.2.1.2 Subsurface Soil. In 1983, Princeton Aqua Science (1984) collected subsurface soil samples during the drilling of monitoring wells around the Main Burning Pits. These samples were collected at 5-ft intervals and composited for analysis. The samples were analyzed for VOCs, metals, cyanide, phenols, total phosphorus, PCBs, pesticides, and herbicides. The results are given in Table A.1-10. Samples were also collected from the bottom of each of the Main Burning Pits and analyzed for similar parameters (Table A.1-11). The data showed elevated concentrations of lead, zinc, nitrate, and petroleum hydrocarbons in each of the samples. It should be noted that the background samples also contained somewhat elevated concentrations of petroleum hydrocarbons.

Eleven additional soil borings were drilled and sampled at or near the pits from 1993 to 1995. The depth of the borings ranged from 4 to 12 ft. Figure A.1-6 shows the locations of the borings, and the results are discussed below.

Northern Main Pit. Six borings of different depths (from 4 to 12 ft) were drilled in the Northern Main Pit: JBP2W, TBPNPBOR3, JBP2C, TBPNPBOR2, TBPNPBOR1, and JBP2E from west to east (Figure A.1-6). Table A.1-12 presents the analytical matrix; sample depths are also given. Soil samples from the borings were analyzed for VOCs, SVOCs, and metals. A subset of the samples was also analyzed for PCBs, pesticides, dioxins/furans, Chemical Surety Material (CSM)/CSM degradation products, explosives-related compounds, cyanide, total petroleum hydrocarbons (TPH), and gross alpha and gross beta radioactivity. Tables A.1-13 through A.1-17 summarize the results.

The contamination in the Northern Main Pit varied spatially; generally, contamination decreased from west to east in the pit. Metal and VOC contamination extended to more than 10 ft below the bottom of the pit. SVOC contaminants were found primarily in the upper 4 ft of soil.

Near the middle section of the Northern Main Pit, where borings TBPNPBOR1, TBPNPBOR2, and JBP2-C were drilled, low to moderate levels of VOCs were present in the underlying soil (Table A.13). The highest levels were between the depths of 2 to 6 ft. For example, the highest levels of TCLEA (160 µg/kg) and 1,2-dichloroethene (12DCE; 490 µg/kg) were found

TABLE A.1-10 Analytical Results for Various Parameters in Subsurface Soil Samples Collected from Wells P1 through P4 near the Main Burning Pits: 1983

Parameter	Concentration (ppm, except as noted) by Sample Location[a]			
	P1	P2	P3	P4
Arsenic	0.4	<0.15	1.5	10.0
Barium	28.0	23.1	145	208
Cadmium	<0.164	<0.203	0.665	1.33
Chromium	14.9	8.1	16.3	28.6
Iron	9,374	5,803	8,820	18,350
Lead	5.21	3.83	23.3	1,360
Manganese	52.0	58.0	65.5	82.3
Mercury	0.031	0.058	0.056	0.197
Potassium	954	684	657	1,015
Zinc	56.2	71.2	125	548
Cyanide	<0.02	<0.02	<0.02	<0.02
pH (standard units)	5.2	5.2	5.4	5.3
Phenols	0.035	<0.079	<0.1099	<0.0814
Phosphorus (total) (mg/kg)	36.5	56.2	81.2	64.5
Cation exchange capacity (meq/100 g)[b]	3.9	2.1	3.3	5.1
Percent solids	84.2	84.9	83.6	85.3
Gas chromatography purgeables	<0.005	<0.005	<0.005	<0.005
Gas chromatography pesticides/PCBs	<0.005	<0.005	<0.005	<0.005
Gas chromatography herbicides	<0.005	<0.005	<0.005	<0.005

[a] On the basis of available information, it is inferred that JBP-1 corresponds to Well P-1, etc. (see Figure 2.7).

[b] meq = milliequivalent.

Source: Princeton Aqua Science (1984).

TABLE A.1-11 Analytical Results for Various Parameters in Subsurface Soil Samples Collected from the Main Burning Pits: 1983

	Concentration (mg/kg, except as noted) by Sample Location		
Parameter[a]	Pit 1[b]	Pit 2[b]	Background[c]
Arsenic	***3.6***	<0.53	<0.48
Barium	***247***	***257***	110
Cadmium	***4.5***	***2.2***	0.84
Chromium	***413***	***192***	75
Iron	***18,900***	***17,000***	6,000
Lead	***717***	***281***	77
Manganese	***169***	***206***	153
Mercury	***0.080***	***0.008***	0.034
Potassium	***1,450***	***1,650***	857
Zinc	***1,510***	***810***	250
pH (standard units)	***8.5***	***8.8***	6.3
Nitrate	***316***	249	295
Phosphorus (total)	<0.50	<0.25	9.0
Cyanide	<0.50	<0.50	<0.50
Total petroleum hydrocarbons	***800***	***850***	113
Phenols	<0.13	0.31	0.37
Toluene (µg/kg)	***32***	***28***	<20
Ethylbenzene (µg/kg)	<20	<20	20

[a] All analytes listed were detected at least once. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] On the basis of available information, it is inferred that Pit 1 is the Northern Main Pit and Pit 2 is the Southern Main Pit.

[c] Locations of background samples not given.

Source: Princeton Aqua Science (1984).

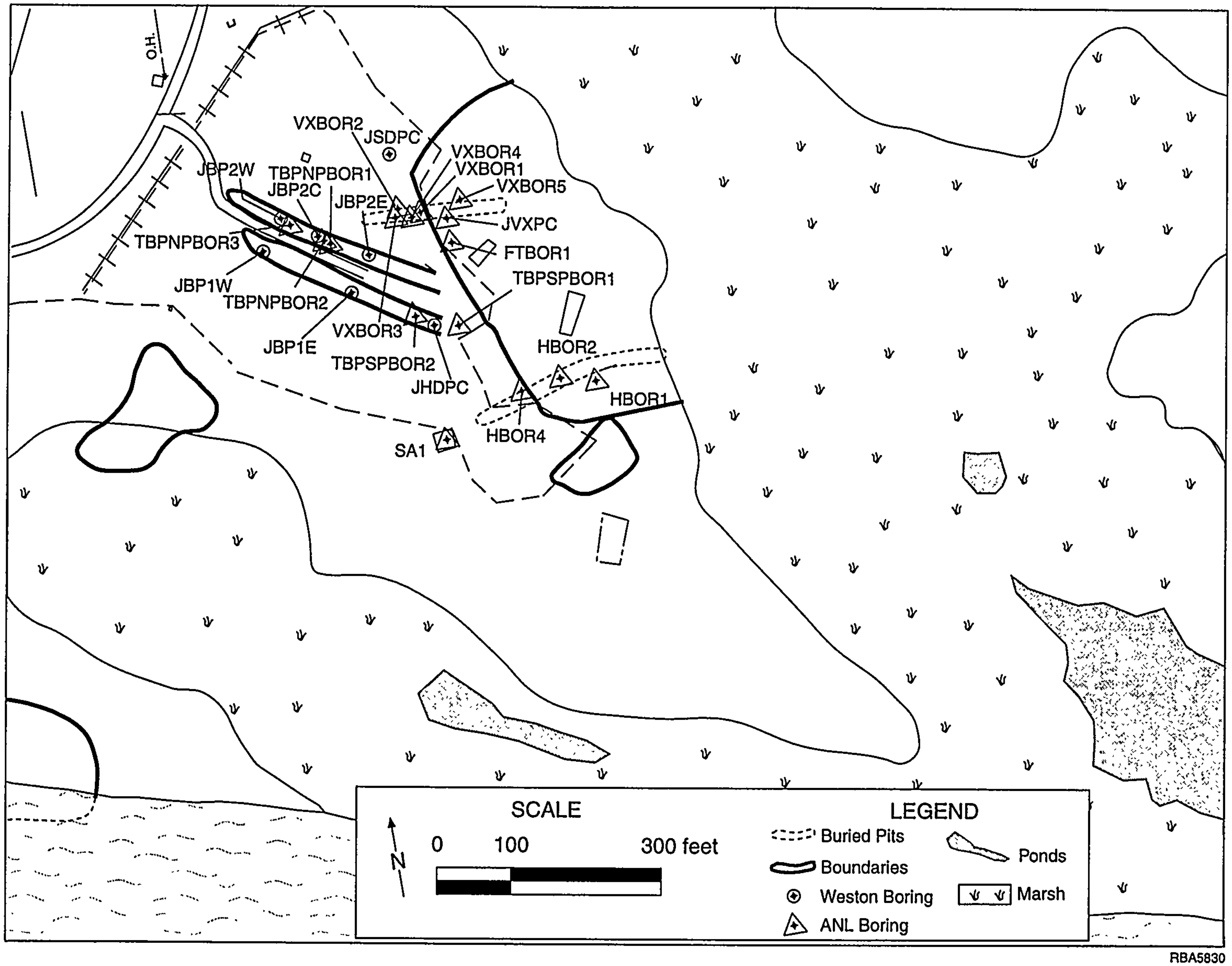

FIGURE A.1-6 Locations of Soil Borings in the TBP AOC

TABLE A.1-12 Analytical Matrix of Subsurface Soil Samples Collected from the Northern Main Pit: 1993–1995[a]

		Chemical Categories Analyzed						
Sample Location[b]	Depth (ft)	VOCs	SVOCs	Metals	Pesticides	PCBs	Dioxins/ Furans	Others
Middle Section of the Pit								
TBPNPBOR1	0–2	X	X	X		X		PAHs, TPH, cyanide, gross alpha, gross beta
	2–4	X	X	X		X		PAHs, TPH, cyanide, gross alpha, gross beta
	4–6	X	X	X		X		PAHs, TPH, cyanide
	6–8	X	X	X				PAHs, TPH, cyanide
	8–10	X	X	X				Cyanide
TBPNPBOR2	0–2	X		X	X	X		Explosives, CSM, cyanide
	2–6	X		X	X	X		CSM, cyanide, gross alpha, gross beta
	6–8			X				CSM, cyanide, gross alpha, gross beta
	10–12	X		X				CSM, cyanide
JPB2C	2	X	X	X	X	X		
	4	X	X	X	X	X		
Western Section of the Pit								
TBPNPBOR3	0–2	X	X	X	X	X		Cyanide
	2–4	X	X	X	X	X		Cyanide
	4–6	X	X	X	X	X	X	Explosives, cyanide
	6–8	X	X	X				Cyanide
	8–10	X	X	X				Cyanide
	10–12	X	X	X				Cyanide
JPB2W	2	X	X	X	X	X		
	4	X	X	X	X	X		
Eastern Section of the Pit								
JBP2E	2	X	X	X	X	X		
	4	X	X	X	X	X		

[a] Notation: CSM = chemical surety material/CSM degradation products, PAH = polynuclear aromatic hydrocarbon, TPH = total petroleum hydrocarbons; explosives = explosives-related compounds. X = analyzed; blank space = not analyzed.

[b] Sampling locations are shown in Figure A.1-6.

TABLE A.1-13 Analytical Results for VOCs in Subsurface Soil Samples Collected from the Northern Main Pit: 1993[a]

	Concentration (µg/kg) by Sample Location[b]				
Parameter	TBPNPBOR1 (0–2 ft)	TBPNPBOR1 (2–4 ft)	TBPNPBOR1 (4–6 ft)	TBPNPBOR1 (6–8 ft)	TBPNPBOR1 (8–10 ft)
Acetone	12 B	13 B	22 B	<12	12 B
Benzene	<12	<12	<12	<12	<12
Carbon disulfide	<12	<12	<12	<12	<12
Chlorobenzene	<12	<12	<12	<12	<12
Chloroform	<12	10 J	9 J	<12	<12
1,2-Dichloroethane	<12	<12	<12	<12	<12
1,1-Dichloroethene	<12	<12	<12	<12	<12
trans-1,2-Dichloroethene	<12	<12	<12	<12	<12
1,2-Dichloroethene (total)	9 J	100	490	190	23
Ethyl benzene	<12	<12	<12	<12	<12
Methylene chloride	<12	<12	<12	<12	<12
1,1,2,2-Tetrachloroethane	53	93	160	17	4 J
Tetrachloroethene	9 J	19	2 J	<12	<12
Toluene	<12	<12	<12	<12	<12
1,1,2-Trichloroethane	<12	<12	<12	<12	<12
Trichloroethene	83	230	140	58	12
Vinyl chloride	<12	<12	<12	<12	<12
Xylenes (total)	<12	<12	<12	<12	<12

	Concentration (µg/kg) by Sample Location[b]		
Parameter	TBPNPBOR2 (0–2 ft)	TBPNPBOR2 (2–4 ft)	TBPNPBOR2[c] (10–12 ft)
Acetone	10 J	6 J	1,020 B
Benzene	<12	<12	<62
Carbon disulfide	2 J	<12	<62
Chlorobenzene	<12	<12	<62
Chloroform	<12	<12	<62
1,2-Dichloroethane	<12	<12	<62
1,1-Dichloroethene (total)	<12	<12	<62
trans-1,2-Dichloroethene	NT	NT	NT
1,2-Dichloroethene	4 J	<12	<62
Ethyl benzene	<12	<12	<62
Methylene chloride	10 BJ	8 BJ	31 BJ
1,1,2,2-Tetrachloroethane	<12	<12	<62
Tetrachloroethene	6 J	<12	<62
Toluene	<12	<12	<62
1,1,2-Trichloroethane	<12	<12	<62
Trichloroethene	8 J	<12	<62
Vinyl chloride	<12	<12	<62
Xylenes (total)	<12	<12	<62

TABLE A.1-13 (Cont.)

	Concentration (µg/kg) by Sample Location[b]					
Parameter	TBPNPBOR3 (0–2 ft)	TBPNPBOR3[c] (2–4 ft)	TBPNPBOR3[c] (4–6 ft)	TBPNPBOR3[c] (6–8 ft)	TBPNPBOR3[c] (8–10 ft)	TBPNPBOR3 (10–12 ft)
Acetone	67 B	210	<71	1,500	6,000 D	140 B
Benzene	<12	<68	51 J	67	<63	<62
Carbon disulfide	4 J	8 J	<71	<60	<63	<62
Chlorobenzene	<12	980	23,000	9,600 D	140	1,000 J
Chloroform	<12	20 J	19 J	<60	<63	<62
1,2-Dichloroethane	<12	<68	<71	<60	<63	<62
1,1-Dichloroethene	<12	<68	<71	<60	<63	<62
trans-1,2-Dichloroethene	NT	NT	NT	NT	NT	NT
1,2-Dichloroethene (total)	22	280	980	2,000	230	350
Ethyl benzene	<12	<68	250	6,600 D	90	1,100
Methylene chloride	12 BJ	41 BJ	23 BJ	<60	27 BJ	35 BJ
1,1,2,2-Tetrachloroethane	<12	<68	<71	<60	<63	<62
Tetrachloroethene	2 J	43 J	<71	750	10 J	160
Toluene	<12	7 J	320	4,200 D	55 J	660
1,1,2-Trichloroethane	<12	<68	<71	<60	<63	<62
Trichloroethene	13	105	58 J	<60	<63	<62
Vinyl chloride	<12	37 J	750	<60	<63	<62
Xylenes (total)	<12	<68	680	46,000 D	540	2,400 J

	Concentration (µg/kg) by Sample Location[b]					
Parameter	JBP2C (2 ft)	JBP2C (4 ft)	JBP2E (2 ft)	JPB2E (4 ft)	JPB2W (2 ft)	JPB2W (4 ft)
Acetone	19 B	30 B	45 B	116 B	18 B	17 B
Benzene	<7	<6	<6	<6	<6	<6
Carbon disulfide	<7	<6	<6	<6	<6	<6
Chlorobenzene	<7	<6	<6	<6	<6	<6
Chloroform	17	<6	<6	<6	<6	1 J
1,2-Dichloroethane	2 J	<6	<6	<6	<6	<6
1,1-Dichloroethene	14	<6	<6	<6	<6	<6
trans-1,2-Dichloroethene	92	5 J	<6	<6	16	62
1,2-Dichloroethene (total)	<7	<6	<6	<6	<6	<6
Ethyl benzene	<7	<6	<6	<6	<6	<6
Methylene chloride	7 B	5 BJ	6 BJ	6 B	6 B	6 BJ
1,1,2,2-Tetrachloroethane	<7	<6	3 J	6 J	26	16
Tetrachloroethene	582 D	40	<6	<6	26	9
Toluene	<7	<6	<6	<6	<6	<6
1,1,2-Trichloroethane	<7	<6	<6	<6	<6	<6
Trichloroethene	499 D	39	<6	<6	176 D	168 D
Vinyl chloride	<7	<6	<12	<6	<6	<6
Xylenes (total)	<7	<6	<6	<6	<6	<6

[a] Notation: B = analyte also found in associated blank; D = sample was diluted for analysis; J = estimated value; NT = not tested.

[b] Sampling locations are shown in Figure A.1-6.

[c] Dilution factor is 5.

TABLE A.1-14 Analytical Results for SVOCs in Subsurface Soil Samples Collected from the Northern Main Pit: 1993[a]

Parameter	Concentration (μg/kg) by Sample Location[b] TBPNPBOR1 (0–2 ft)	TBPNPBOR1 (2–4 ft)	TBPNPBOR1 (4–6 ft)	TBPNPBOR1 (6–8 ft)	TBPNPBOR1 (8–10 ft)
Benzo[k]fluoranthene	<410	<410	<410	<410	<400
Benzoic acid	NT	NT	<410	<410	<400
Bis(2-ethylhexyl)phthalate	210 J	100 J	93 J	45 J	160 J
Di-n-butylphthalate	310 JB	290 JB	190 JB	200 JB	210 JB
Fluorene	<410	<410	<410	<410	<400
Hexachlorobenzene	<410	920	180 J	97 J	<400
2-Methylnaphthalene	230 J	42 J	<410	<410	<400
Naphthalene	89 J	42 J	<410	<410	<400
Nitrobenzene	55 J	<410	<410	<410	<400
n-Nitrosodiphenylamine	<410	160 J	<410	<410	<400
Phenanthrene	250 J	<410	<410	<410	<400
Pyrene	79 J	<410	<410	<410	<400
2,4,6-Trichlorophenol	43 J	<410	<410	<410	<400

Parameter	Concentration (μg/kg) by Sample Location[b] TBPNPBOR3 (0–2 ft)	TBPNPBOR3 (2-4 ft)	TBPNPBOR3 (4–6 ft)	TBPNPBOR3 (6–8 ft)	TBPNPBOR3 (8–10 ft)	TBPNPBOR3 (10–12 ft)
Benzo[k]fluoranthene	51 J	<446	<465	<393	<412	<406
Benzoic acid	NT	NT	NT	NT	NT	NT
Bis(2-ethylhexyl)phthalate	65 J	<446	1,300	1,900	210 J	1,800
Di-n-butylphthalate	<393	<446	<465	<393	63 J	<406
Fluorene	<393	<446	<465	<393	<412	<406
Hexachlorobenzene	170 J	<446	<465	<393	<412	<406
2-Methylnaphthalene	120 J	<446	580	2,100	<412	1,700
Naphthalene	<393	<446	710	1,800	<412	1,600
Nitrobenzene	<393	<446	<465	<393	<412	<406
n-Nitrosodiphenylamine	<393	<446	<465	<393	<412	<406
Phenanthrene	93 J	<446	<465	880	<412	<406
Pyrene	62 J	<446	<465	<393	<412	<406
2,4,6-Trichlorophenol	<393	<446	<465	<393	<412	<406

TABLE A.1-14 (Cont.)

	Concentration (µg/kg) by Soil Sample Location[b]					
Parameter	JBP2C (2 ft)	JBP2C (4 ft)	JBP2E (2 ft)	JBP2E (4 ft)	JBP2W (2 ft)	JBP2W (4 ft)
Benzo[k]fluoranthene	<455	<392	<396	<396	<396	<396
Benzoic acid	<2,280	<1,960	<1,980	<1,980	118 J	<1,960
Bis(2-ethylhexyl)phthalate	<455	<392	<396	<396	<396	<396
Di-n-butylphthalate	<455	<392	77 J	<396	<396	<396
Fluorene	531	<392	<396	<396	<396	<396
Hexachlorobenzene	<455	380 J	<396	<396	845	<396
2-Methylnaphthalene	<455	<392	<396	<396	<396	<396
Naphthalene	50 J	<392	<396	<396	<396	<396
Nitrobenzene	<455	57 J	<396	57 J	<396	<396
n-Nitrosodiphenylamine	<455	<392	<396	<396	<396	<396
Phenanthrene	52 J	43 J	<396	<396	<396	<396
Pyrene	<455	<392	<396	<396	<396	<396
2,4,6-Trichlorophenol	<455	<392	<396	<396	<396	<396

[a] Sample TBPNPBOR2 was not analyzed for SVOCs. Notation: NT = not tested; B = analyte also found in the associated blank; J = estimated value.

[b] Sampling locations are shown in Figure A.1-6.

TABLE A.1-15 Analytical Results for Selected Metals in Subsurface Soil Samples Collected from the Northern Main Pit: 1993–1995[a]

	Concentration (mg/kg) by Sample Location[b]				
Parameter	TBPNPBOR1 (0–2 ft)	TBPNPBOR1 (2–4 ft)	TBPNPBOR1 (4–6 ft)	TBPNPBOR1 (6–8 ft)	TBPNPBOR1 (8–10 ft)
Antimony	*19*	*15*	<5.4	<4.9	<5.6
Arsenic	*1,440*	*2,290*	*247*	*199*	*17*
Beryllium	0.76	0.78	0.59	0.39	0.44
Cadmium	*36*	*13*	*44*	*77*	*2.8*
Chromium	*240*	*82*	18	18	9.7
Copper	*2,240*	*7,120*	*1,120*	*544*	*91*
Lead	*1,910*	*1,630*	*117*	*90*	48
Mercury	*2.2*	*5.2*	*0.85*	*0.34*	0.085
Nickel	*76*	*52*	19	18	7.7
Silver	*25*	*15*	*4.4*	*2.9*	<0.5
Zinc	*9,840*	*6,530*	*4,360*	*3,650*	*1,150*

	Concentration (mg/kg) by Sample Location[b]			
Parameter	TBPNPBOR2 (0–2 ft)	TBPNPBOR2 (2–6 ft)	TBPNPBOR2 (6–8 ft)	TBPNPBOR2 (10–12 ft)
Antimony	*73*	0.28	<0.21	<0.21
Arsenic	*14*	2.7	2.1	1.5
Beryllium	0.27	0.24	0.18	<0.14
Cadmium	*16*	<0.35	0.51	0.39
Chromium	*106*	8.0	9.1	2.4
Copper	*1,030*	7.6	7.4	<2.8
Lead	*4,790*	8.1	8.3	3.7
Mercury	*1.5*	<0.043	<0.061	0.03
Nickel	*49*	5.2	8.4	4.5
Silver	*4.5*	<0.082	<0.086	<0.086
Zinc	*2,690*	46	*149*	*198*

	Concentration (mg/kg) by Sample Location[b]			
Parameter	JBP2C (2 ft)	JBP2C (4 ft)	JBP2E (2 ft)	JBP2E (4 ft)
Antimony	<5.3	<4.7	<4.6	<4.6
Arsenic	*7.9*	*6.9*	3.5	2.3
Beryllium	0.24	<0.19	0.23	0.38
Cadmium	*7.0*	<0.57	<0.58	<0.57
Chromium	7.4	8.4	14	13
Copper	*413*	*43*	6.9	10
Lead	*403*	38	16	*96*
Mercury	<0.14	<0.12	<0.12	<0.12
Nickel	9.9	<6.9	8.2	<6.9
Silver	<0.19	<0.17	<0.17	<0.17
Zinc	*17,800*	*834*	94	77

TABLE A.1-15 (Cont.)

	Concentration (mg/kg) by Soil Sample Location[b]					
Parameter	TBPNPBOR3 (0–2 ft)	TBPNPBOR3 (2–4 ft)	TBPNPBOR3 (4–6 ft)	TBPNPBOR3 (6–8 ft)	TBPNPBOR3 (8–10 ft)	TBPNPBOR3 (10–12 ft)
Antimony	***20***	***24***	3.4	<0.20	<0.21	<0.21
Arsenic	***278***	***64***	***316***	***7.6***	***6.4***	***11***
Beryllium	<0.13	<0.15	0.20	0.17	0.25	0.14
Cadmium	***5.1***	***3.6***	***5.7***	0.58	***0.70***	***0.71***
Chromium	72	37	24	9.2	8.8	5.2
Copper	***814***	***916***	***191***	15	8.0	12
Lead	***3,230***	***459***	***93***	19	6.7	23
Mercury	***0.93***	0.074	<0.069	0.044	<0.062	<0.053
Nickel	***85***	***52***	***69***	8.0	7.1	6.1
Silver	4.5	0.15	<0.099	<0.083	<0.087	<0.086
Zinc	13,900	13,800	3,880	283	113	205

	Concentration (mg/kg) by Sample Location[b]			TCLP Results[d] Concentration (μg/L) by Sample Location[b]		
Parameter	JBP2W (2 ft)	JBP2W (4 ft)	Calculated Background[c] (mg/kg)	TBPNPBOR2 (0–2 ft)	TBPNPBOR3 (0–2 ft)	TBPNPBOR3 (2–4 ft)
Antimony	<4.6	<4.6	3.8	NT	NT	NT
Arsenic	***27***	4.0	5.0	ND	155	216
Beryllium	0.19	<0.19	1.0	NT	NT	NT
Cadmium	<0.58	<0.57	0.70	187	42.9	16.4
Chromium	11	13	41	ND	ND	ND
Copper	18	18	20	NT	NT	NT
Lead	38	8.5	61	26,500	45,700	1,620
Mercury	<0.12	<0.12	0.10	ND	ND	ND
Nickel	8.0	10	20	NT	NT	NT
Silver	<0.17	<0.17	0.40	ND	ND	ND
Zinc	***516***	***167***	118	NT	NT	NT

[a] For samples with duplicate analyses, the higher value is reported. Notation: NT = not tested; ND = not detected. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Sampling locations are shown in Figure A.1-6.

[c] Background values were derived from soil data in ICF Kaiser Engineers (1995).

[d] Toxicity Characteristics Leaching Procedure (TCLP) standards: arsenic 5,000 μg/L, cadmium 1,000 μg/L, lead 5,000 μg/L.

Source: Data for samples JBP2C, JBP2W, and JBP2E taken from Mazelon (1993).

TABLE A.1-16 On-Site Analytical Results for PAHs, TPH, and PCBs in Subsurface Soil Samples Collected from the Northern Main Pit: 1995[a]

	Concentration (mg/kg) by Sample Location			
Parameter	TBPNPBOR1 (0–2 ft)	TBPNPBOR1 (2–4 ft)	TBPNPBOR1 (4–6 ft)	TBPNPBOR1 (6–8 ft)
Polynuclear aromatic hydrocarbons	1 U	1 U	1 U	1 U
Total petroleum hydrocarbons	100 U 10	100 G	100 U 10	10 U
Polychlorinated biphenyls	10 U 1	10 U 1	10 U 1	NT

[a] Sampled and analyzed on-site by Argonne. Notation: 10 U 1 = <10 mg/kg but >1 mg/kg; 100 U 10 = <100 mg/kg but >10 mg/kg; G = > value given; NT = not tested; U = < value given.

TABLE A.1-17 Analytical Results for Dioxins and Furans in Subsurface Soil Samples Collected from the Northern Main Pit: 1995

Parameter	Concentration (μg/kg) in TBPNPBOR3 (4–6 ft)
Heptachlorodibenzo-p-dioxin	2.9
Heptachlorodibenzo-p-furan	2.9
Hexachlorodibenzo-p-dioxin	1.6
Hexachlorodibenzo-p-furan	3.1
Octachlorodibenzo-p-dioxin	4.3
Octachlorodibenzo-p-furan	1.7
Pentachlorodibenzo-p-dioxin	0.26
Pentachlorodibenzo-p-furan	3.4
Tetrachlorodibenzo-p-dioxin	0.070
Tetrachlorodibenzo-p-furan	1.5

in the depth interval of 4–6 ft in boring TBPNPBOR1, while the highest levels of TRCLE (499 μg/kg) and TCLEE (582 μg/kg) were detected in the 2-ft-depth samples collected from boring JBP2-C.

Borings JBP2W and TBPNPBOR3 were drilled near the western end of the pit. Moderate to high levels of petroleum-related VOCs were found in boring TBPNPBOR3 — benzene (up to 67 μg/kg), chlorobenzene (up to 23,000 μg/kg), ethylbenzene (up to 6,600 μg/kg) toluene (up to 4,200 μg/kg), and xylenes (up to 46,000 μg/kg). The highest concentrations of VOCs (except acetone) were found between 4 and 8 ft in boring TBPNPBOR3.

Sample JBP2E was drilled near the eastern end of the pit. The sample showed only trace amounts of TCLEA, acetone, and methylene chloride.

Low levels of SVOCs were detected in samples from the middle section and western end of the Northern Main Pit (Table A.1-14). The sample from the eastern end contained relatively little contamination. The highest levels of SVOCs were found between depths of 4 and 8 ft in sample TBPNPBOR3 from the western end — 2-methylnaphthalene (up to 2,100 μg/kg), bis(2-ethylhexyl)phthalate (up to 1,900 μg/kg), naphthalene (up to 1,800 μg/kg), and phenanthrene (up to 880 μg/kg).

Significant metal contamination was detected in the soil underlying the Northern Main Pit (Table A.1-15). Generally, the western and middle sections of the pit (sample locations TBPNPBOR1, TBPNPBOR2, JBP2-C, and TBPNPBOR3) were more contaminated than the eastern section. The highest levels of metals were present in the upper 4 ft of soil — arsenic (up to 2,290 mg/kg), lead (up to 4,790 mg/kg), and zinc (up to 17,800 mg/kg). However, elevated concentrations of metals, including arsenic, cadmium, copper, lead, and zinc, were found in soil more than 10 ft below the bottom of the pit. Metal contaminants infiltrating into deep soil may be due to past decontamination operations.

Surface soil samples from borings TBPNPBOR2 (0–2 ft) and TBPNPBOR3 (0–2 and 2–4 ft) were also tested by the EPA Toxicity Characteristic Leaching Procedure (TCLP) for metals (Table A.1-15). Only the lead levels exceeded the TCLP standard, with a concentration of 45,700 μg/L in sample TBPNPBOR3 (0–2 ft).

Soil samples from boring TBPNPBOR1 were analyzed on-site for polynuclear aromatic hydrocarbons (PAHs), TPH, and PCBs (Table A.1-16). An elevated level of TPH (>100 mg/kg) was detected in boring TBPNPBOR1 (2–4 ft). The three samples from boring TBPNPBOR1 had a PCB content of less than 10 mg/kg. Soil samples from boring TBPNPBOR1 had PAH concentrations of less than 1 mg/kg.

Samples from the Northern Main Pit were also analyzed for PCBs, pesticides, dioxins/furans, explosives-related compounds, CSM/CSM degradation products, and cyanide. PCBs were found only in samples TBPNPBOR2 (0–2 ft) and JBP2E (2 ft) — 570 µg/kg of Aroclor 1248 and 224 µg/kg of Aroclor 1254, respectively. Only very low levels of dioxins/furans were found in sample TBPNPBOR3 (4–5 ft) (Table A.1-17). TPH (19,000 mg/kg) and cyanide (11 mg/kg) were also detected in this sample. Cyanide was not detected in any of the other samples. The moderate level of TPH and the low levels of dioxins/furans are consistent with the detection of several petroleum-related SVOCs in the sample, confirming that burning activities took place in this location. No CSM/CSM degradation products or explosives-related compounds were detected in any of the samples.

Gross alpha activity ranged from less than 10 pCi/g to 11 pCi/g in TBNPBOR1; both samples in TBNPBOR2 (2–4 and 6–8 ft) measured 11 pCi/g. Gross beta activity was less than 8 pCi/g in all samples from the Northern Main Pit.

Southern Main Pit. Soil samples were collected from five borings drilled in the Southern Main Pit — JBP1W, JBP1E, TBPSPBOR2, JHDPC, and TBPSPBOR1 (from west to east) (Figure A.1-6). These samples were analyzed for VOCs, SVOCs, metals, TPH, PAHs, PCBs, trinitrotoluene (TNT), and gross alpha and gross beta activity. Table A.1-18 presents the analytical matrix; samples depths are also given. Tables A.1-19 through A.1-22 summarize the results.

The level of contamination in the Southern Main Pit was variable. In general, VOC concentrations were higher in the eastern end of the pit than in the middle or western sections. VOC concentrations also increased with depth in the eastern end of the pit, with maximum concentrations occurring at depths greater than 4 ft. Metals and SVOCs were found at relatively low levels; maximum concentrations were found primarily in the upper 2 ft of soil.

Concentrations of VOCs were highest in the eastern section of the Southern Main Pit, where borings TBPSPBOR2, JHDPC, and TBPSPBOR1 were drilled (Table A.1-19). The highest levels were between the depths of 4 and 10 ft. For example, the highest levels of most VOCs were found in sample JHDPC (6 ft) — TCLEA (3,270,000 µg/kg), 112TCE (8,540 µg/kg), TCLEE (25,700 µg/kg), and TRCLE (263,000 µg/kg). High levels of these compounds were also found in sample TBPSPBOR2.

Borings JBP1E and JBP1W were drilled in the middle and western sections, respectively. Because of safety concerns, both borings were drilled only to depths of 4 ft. Low levels of TCLEA, acetone, methylene chloride, TRCLE, and xylenes were detected; however, because these two borings did not extend beyond a depth of 4 ft, it is not known if higher levels of contamination are present at depth in these locations, as was the case in the borings drilled in the eastern section.

TABLE A.1-18 Analytical Matrix of Subsurface Soil Samples Collected from the Southern Main Pit[a]

		Chemical Constituents Analyzed					
Sample Location[b]	Depth (ft)	VOCs	SVOCs	Metals	Pesticides	PCBs	Others
Middle Section of the Pit							
JBP1E	2	X	X	X	X	X	
	4	X	X	X	X	X	
Western Section of the Pit							
JBP1W	2	X	X	X			
Eastern Section of the Pit							
JHDPC	4	X	X	X	X	X	
	6	X	X	X	X	X	
TBPSPBOR2	0–2	X	X	X		X	Explosives, PAHs, TPH, gross alpha, gross beta
	2–4	X	X	X		X	Explosives, PAHs, TPH, gross alpha, gross beta
	4–6	X	X	X		X	Explosives, PAHs, TPH
	6–8	X	X	X		X	Explosives, PAHs, TPH
	8–10	X	X	X		X	Explosives, PAHs, TPH
TBPSPBOR1	0–2	X	X	X		X	Explosives, PAHs, TPH, gross alpha, gross beta
	2–4	X	X	X		X	Explosives, PAHs, TPH
	4–6	X	X	X		X	Explosives, PAHs, TPH
	6–8	X	X	X		X	Explosives, PAHs, TPH
	8–10	X	X	X		X	Explosives, PAHs, TPH
	10–12	X	X	X		X	Explosives, PAHs, TPH, gross alpha, gross beta

[a] Notation: PAH = polynuclear aromatic hydrocarbon; TPH = total petroleum hydrocarbons; explosives = explosives-related compounds. X = analyzed; blank space = not analyzed. Dioxins/furans were not analyzed.

[b] Sampling locations are shown in Figure A.1-6.

TABLE A.1-19 Analytical Results for VOCs in Subsurface Soil Samples Collected from the Southern Main Pit: 1993[a]

Parameter	Concentration (μg/kg) by Sample Location in Eastern Section of the Pit[b]					
	TBPSPBOR1 (0–2 ft)	TBPSPBOR1 (2–4 ft)	TBPSPBOR1 (4–6 ft)	TBPSPBOR1 (6–8 ft)	TBPSPBOR1 (8–10 ft)	TBPSPBOR1 (10–12 ft)
Acetone	350 B	73 B	280 BD	42	42	30
Benzene	<12	2 J	<12	5 J	<12	<12
Bromodichloromethane	<12	<12	<12	<12	<12	<12
2-Butanone	37	<12	<12	<12	<12	<12
Carbon disulfide	<12	<12	6 J	4 J	<12	<12
Carbon tetrachloride	<12	<12	<12	<12	<12	<12
Chloroform	<12	<12	<12	<12	<12	<12
1,1-Dichloroethane	<12	<12	<12	15	<12	<12
1,2-Dichloroethane	<12	<12	<12	4 J	<12	<12
1,1-Dichlorothene	<12	<12	<12	<12	<12	<12
trans-1,2-Dichlorothene	<12	<12	<12	<12	<12	<12
1,2-Dichloroethene (total)	170	7 J	68 D	4,400 D	1,500 D	11 J
Ethylbenzene	<12	<12	<12	19	<12	<12
Methylene chloride	83	<12	<12	<12	<12	<12
1,1,2,2-Tetrachloroethane	100	8 J	9 J	7 J	600 D	280 D
Tetrachloroethene	<12	<12	<12	<12	41	<12
Toluene	<12	<12	<12	8 J	<12	<12
1,1,2-Trichloroethane	<12	<12	<12	3 J	140	15
Trichlorothene	50	<12	4 J	370 D	550 D	12
Vinyl chloride	<12	<12	19	180 D	16	<12
Xylenes	<12	<12	16	12 J	<12	<12

TABLE A.1-19 (Cont.)

Parameter	Concentration (µg/kg) by Sample Location in Eastern Section of Pit[b]						
	TBPSPBOR2 (0–2 ft)	TBPSPBOR2 (2–4 ft)	TBPSPBOR2 (4–6 ft)	TBPSPBOR2 (6–8 ft)	TBPSPBOR2 (8–10 ft)	JHDPC (4 ft)	JHDPC (6 ft)
Acetone	<12	<12	97 JB	<120	130 B	177	113
Benzene	<12	<12	<120	<120	<120	19	83
Bromodichloromethane	<12	<12	<120	<120	<120	2 J	6 J
2-Butanone	<12	<12	<120	<120	<120	<12	<11
Carbon disulfide	<12	<12	<120	<120	<120	<6	1 J
Carbon tetrachloride	<12	<12	<120	<120	<120	17	172
Chloroform	<12	<12	<120	<120	<120	142	445
1,1-Dichloroethane	<12	<12	<120	<120	<120	<6	9
1,2-Dichloroethane	<12	<12	<120	<120	<120	40	62
1,1-Dichlorothene	<12	<12	<120	<120	<120	31	78
trans-1,2-Dichlorothene	<12	<12	<120	<120	<120	3,860 D	3,220 D
1,2-Dichloroethene (total)	<12	<12	120 J	460	8,400 JD	NT	NT
Ethylbenzene	<12	<12	<120	<120	<120	<6	<6
Methylene chloride	<12	<12	<120	<120	<120	45 B	41 B
1,1,2-Trichloroethane	<12	<12	140	330	1,600	2,100 D	8,540 D
Tetrachloroethene	<12	<12	25 J	140	2,500	682	25,700 D
Toluene	<12	<12	<120	<120	<120	2 J	<6
1,1,2,2-Tetrachloroethane	12	130	4,600 D	24,000 D	220,000	289,000 D	3,270,000 D
Trichlorothene	<12	<12	350	1,200	21,000 JD	6,780 D	263,000 D
Vinyl chloride	<12	<12	<120	<120	<120	315	302
Xylenes	<12	<12	<120	<120	<120	<6	<6

TABLE A.1-19 (Cont.)

Parameter	Concentration (μg/kg) by Sample Location in WesternSection of Pit[b] JBP1W (2 ft)	JBP1W (4 ft)	Concentration (μg/kg) by Sample Location in Middle Section of Pit[b] JBP1E (2 ft)	JBP1E (4 ft)
Acetone	22 B	11 BJ	16	33 B
Benzene	<6	<6	<6	<6
Bromodichloromethane	<6	<6	<6	<6
2-Butanone	<12	<12	<12	<12
Carbon disulfide	<6	<6	<6	<6
Carbon tetrachloride	<6	<6	<6	<6
Chloroform	<6	<6	<6	<6
1,1-Dichloroethane	<6	<6	<6	<6
1,2-Dichloroethane	<6	<6	<6	<6
1,1-Dichlorothene	<6	<6	<6	<6
trans-1,2-Dichlorothene	<6	<6	2 J	<6
1,2-Dichloroethene (total)	NT	NT	NT	NT
Ethylbenzene	<6	<6	<6	<6
Methylene chloride	7 B	5 BJ	6 BJ	6 B
1,1,2,2-Tetrachloroethane	3 BJ	<6	7	4 J
Tetrachloroethene	<6	<6	<6	<6
Toluene	<6	<6	2 J	<6
1,1,2-Trichloroethane	<6	<6	<6	<6
Trichlorothene	<6	<6	28	<6
Vinyl chloride	<12	<12	<12	<12
Xylenes	<6	<6	<6	<6

[a] Notation: B = analyte also found in associated blank; D = sample was diluted for analysis; J = estimated value; NT = not tested.

[b] Sampling locations are shown in Figure A.1-6.

TABLE A.1-20 Analytical Results for SVOCs in Subsurface Soil Samples Collected from the Southern Main Pit: 1993[a]

	Concentration (µg/kg) by Sample Location in Eastern Section of Pit[b]					
Parameter	TBPSPBOR1 (0–2 ft)	TBPSPBOR1 (2–4 ft)	TBPSPBOR1 (4–6 ft)	TBPSPBOR1 (6–8 ft)	TBPSPBOR1 (8–10 ft)	TBPSPBOR1 (10–12 ft)
Anthracene	<380	<410	61 J	<410	<410	<390
Benzo[a]anthracene	42 J	<410	<400	<410	<410	<390
Benzo[b]fluoranthene	<380	<410	<400	<410	<410	<390
Benzo[k]fluoranthene	<380	<410	<400	<410	<410	<390
Benzoic acid	NT	NT	NT	NT	NT	NT
Benzo[a]pyrene	<380	<410	<400	<410	<410	<390
Bis(2-chloroethyl)ether	<380	<410	<400	<410	<410	<390
Bis(2-ethylhexyl)phthalate	240 J	<410	<400	54 J	<410	<390
Carbazole	<380	47 J	88 J	<410	<410	<390
Chrysene	43 J	<410	<400	<410	<410	<390
Dibenzofuran	38 J	<410	<400	<410	<410	<390
Di-n-butylphthalate	390 B	310 JB	290 JB	320 JB	110 JB	150 JB
1,2-Dichlorobenzene	<380	<410	<400	<410	<410	<390
Diethylphthalate	190 J	<410	79 J	<410	<410	<390
Fluoranthene	73 J	<410	<400	<410	<410	<390
Fluorene	<380	<410	88 J	<410	<410	<390
Hexachlorobenzene	210 J	<410	<400	<410	<410	<390
Hexachloroethane	580	<410	<400	<410	<410	<390
2-Methylnaphthalene	230 J	<410	<400	<410	<410	<390
Naphthalene	61 J	<410	<400	<410	<410	<390
n-Nitrosodiphenylamine	950	64 J	120 J	44 J	<410	<390
Phenanthrene	130 J	53 J	62 J	<410	<410	<390
Pyrene	74 J	42 J	<400	<410	<410	<390
1,2,4-Trichlorobenzene	340 J	<410	<400	<410	<410	<390

TABLE A.1-20 (Cont.)

Parameter	Concentration (µg/kg) by Sample Location in Eastern Section of Pit[b]						
	TBPSPBOR2 (0–2 ft)	TBPSPBOR2 (2–4 ft)	TBPSPBOR2 (4–6 ft)	TBPSPBOR2 (6–8 ft)	TBPSPBOR2 (8–10 ft)	JHDPC (4 ft)	JHDPC (6 ft)
Anthracene	<390	<390	<390	<400	<400	<396	<402
Benzo[a]anthracene	<390	<390	<390	<400	<400	<396	<402
Benzo[b]fluoranthene	<390	<390	<390	<400	<400	<396	<402
Benzo[k]fluoranthene	<390	<390	<390	<400	<400	<396	<402
Benzoic acid	<390	<390	<390	<400	<400	175 J	74 J
Benzo[a]pyrene	<390	<390	<390	<400	<400	<396	<402
Bis(2-chloroethyl)ether	390 J	<390	<390	<400	<400	<396	<402
Bis(2-ethylhexyl)phthalate	<390	<390	<390	<400	<400	<396	<402
Carbazole	<390	<390	<390	<400	<400	<396	<402
Chrysene	<390	<390	<390	<400	<400	<396	<402
Dibenzofuran	<390	<390	<390	<400	<400	<396	<402
Di-n-butylphthalate	230 JB	230 JB	260 JB	240 JB	190 JB	<396	<402
1,2-Dichlorobenzene	170 J	<390	<390	<400	<400	<396	<402
Diethylphthalate	<390	<390	<390	<400	<400	<396	<402
Fluoranthene	<390	<390	<390	<400	<400	<396	<402
Fluorene	<390	<390	<390	<400	<400	<396	<402
Hexachlorobenzene	<390	<390	<390	<400	<400	<396	<402
Hexachloroethane	<390	<390	<390	<400	58 J	<396	628
2-Methylnaphthalene	71 J	<390	<390	<400	<400	<396	<402
Naphthalene	<390	<390	<390	<400	<400	<396	<402
n-Nitrosodiphenylamine	<390	<390	<390	<400	<400	<396	<402
Phenanthrene	<390	<390	<390	<400	<400	<396	<402
Pyrene	<390	<390	<390	<400	<400	<396	<402
1,2,4-Trichlorobenzene	<390	<390	<390	<400	<400	<396	<402

TABLE A.1-20 (Cont.)

	Concentration (μg/kg) by Sample Location in Western Section of Pit[b]		Concentration (μg/kg) by Sample Location in Middle Section of Pit[b]	
Parameter	JBP1W (2 ft)	JBP1W (4 ft)	JBP1E (2 ft)	JBP1E (4 ft)
Anthracene	<402	<409	<392	<402
Benzo[a]anthracene	<402	<409	234 J	<402
Benzo[b]fluoranthene	<402	<409	221 J	<402
Benzo[k]fluoranthene	<402	<409	92 J	<402
Benzoic acid	<2,010	<2,050	<2,010	<2,010
Benzo[a]pyrene	<402	<409	137 J	<402
Bis(2-chloroethyl)ether	<402	<409	<392	<402
Bis(2-ethylhexyl)phthalate	<402	<409	<392	<402
Carbazole	NT	NT	NT	NT
Chrysene	<402	<409	335 J	<402
Dibenzofuran	<402	<409	<392	<402
Di-n-butylphthalate	<402	<409	<392	<402
1,2-Dichlorobenzene	<402	<409	<392	<402
Diethylphthalate	<402	<409	<392	<402
Fluoranthene	<402	<409	306 J	<402
Fluorene	<402	<409	<392	<402
Hexachlorobenzene	<402	<409	<392	<402
Hexachloroethane	<402	<409	<392	<402
2-Methylnaphthalene	<402	<409	471	<402
Naphthalene	<402	<409	107 J	<402
n-Nitrosodiphenylamine	<402	<409	<392	<402
Phenanthrene	<402	<409	376 J	<402
Pyrene	<402	<409	580	<402
1,2,4-Trichlorobenzene	<402	<409	<392	<402

[a] Notation: B = analyte also found in the associated blank; J = estimated value; NT = not tested.

[b] Sampling locations are shown in Figure A.1-6.

TABLE A.1-21 Analytical Results for Selected Metals in Subsurface Soil Samples Collected from the Southern Main Pit[a]

	Concentration (mg/kg) by Sample Location[b]					
Parameter	TBPSPBOR1 (0–2 ft)	TBPSPBOR1 (2–4 ft)	TBPSPBOR1 (4–6 ft)	TBPSPBOR1 (6–8 ft)	TBPSPBOR1 (8–10 ft)	TBPSPBOR1 (10–12 ft)
Antimony	6.2	<2.9	4.6	2.8	<2.9	<2.8
Arsenic	28	9.7	8.9	6.5	6.8	3.0
Beryllium	0.43	0.54	0.50	0.52	0.40	0.32
Cadmium	3.0	3.2	1.0	1.5	0.79	0.57
Copper	366	151	71	36	25	10
Lead	831	204	116	39	59	10
Zinc	1,240	450	192	80	61	38

	Concentration (mg/kg) by Sample Location[b]				
Parameter	TBPSPBOR2 (0–2 ft)	TBPSPBOR2 (2–4 ft)	TBPSPBOR2 (4–6 ft)	TBPSPBOR2 (6–8 ft)	TBPSPBOR2 (8–10 ft)
Antimony	<2.7	<2.9	<2.8	<2.8	<2.8
Arsenic	5.4	4.9	1.4	1.9	1.5
Beryllium	0.28	0.49	0.23	3.0	0.37
Cadmium	0.95	<0.51	<0.49	<0.50	<0.50
Copper	72	19	6.8	7.2	11
Lead	28	9.6	11	12	16
Zinc	97	49	18	23	45

	Concentration (mg/kg) by Sample Location[b]						
Parameter	JHDPC (4 ft)	JHDPC (6 ft)	JBP1E (2 ft)	JBP1E (4 ft)	JBP1W (2 ft)	JBP1W (4 ft)	Background (mg/kg)
Antimony	<4.6	<4.7	5.0	<4.7	<4.7	5.6	3.8
Arsenic	3.9	6.3	5.0	4.2	3.6	2.0	5.0
Beryllium	0.46	0.41	0.31	0.45	0.33	0.28	1.0
Cadmium	<0.58	7.3	3.2	<0.59	<0.59	0.75	0.70
Copper	<4.1	123	248	10	20	11	20
Lead	11	121	340	11	13	9.3	61
Zinc	25	296	1,220	123	303	52	118

[a] For samples with duplicate analyses, the higher value is reported.

[b] Sampling locations are shown in Figure A.1-6.

Source: Mazelon (1993).

TABLE A.1-22 On-Site Analytical Results for PAHs, TPH, PCBs, and TNT in Subsurface Soil Samples Collected from the Southern Main Pit: 1995[a]

Parameter	Concentration (mg/kg) by Sample Location[b] TBPSPBOR1 (0–2 ft)	TBPSPBOR1 (2–4 ft)	TBPSPBOR1 (4–6 ft)	TBPSPBOR1 (6–8 ft)	TBPSPBOR1 (8–10 ft)	TBPSPBOR1 (10–12 ft)
Polynuclear aromatic hydrocarbons	10 U 1	1 U	10 U 1	1 U	1 U	1 U
Total petroleum hydrocarbons	100 U 10	100 U 10	100 U 10	10 U	100 U 10	100 U 10
Polychlorinated biphenyls	10 U 1	1 U	1 U	1 U	1 U	1 U
Trinitrotoluene	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U

Parameter	Concentration (mg/kg) by Sample Location[b] TBPSPBOR2 (0–2 ft)	TBPSPBOR2 (2–4 ft)	TBPSPBOR2 (4–6 ft)	TBPSPBOR2 (6–8 ft)	TBPSPBOR2 (8–10 ft)
Polynuclear aromatic hydrocarbons	1 U	1 U	1 U	1 U	1 U
Total petroleum hydrocarbons	100 U 10	100 U 10	10 U	100 G	100 G
Polychlorinated biphenyls	10 G	10 U 1	1 U	1 U	1 U
Trinitrotoluene	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U

[a] Sampled and analyzed on-site by Argonne. Notation: 10 U 1 = <10 mg/kg but >1 mg/kg; 100 U 10 = <100 mg/kg but >10 mg/kg; G = > value given; U = < value given.

[b] Sampling locations are shown in Figure A.1-6.

Table A.1-20 summarizes the SVOC results. Samples from the eastern section of the pit (TBPSPBOR1, TBPSPBOR2, and JHDPC) contained low levels of several SVOCs. The highest levels of SVOCs were present in the upper 2 ft of sample TBPSPBOR1 — 1,2,4-trichlorobenzene (340 μg/kg), di-n-butylphthalate (390 μg/kg), hexachlorobenzene (210 μg/kg), and n-nitrosodiphenylamine (950 μg/kg). Di-n-butylphthalate was also present in laboratory blank samples. Only trace amounts of other SVOCs were found at depths greater than 4 ft.

Soil in the middle section of the pit also had low levels of several SVOCs in the upper 2 ft — 2-methylnaphthalene (471 μg/kg), chrysene (335 μg/kg), fluoranthene (306 μg/kg), phenanthrene (376 μg/kg), and pyrene (580 μg/kg). Soil from JBP1W, in the western section of the pit, had no detectable levels of SVOCs.

The soil underlying the Southern Main Pit generally contained fewer metal contaminants and lower levels of metals (Table A.1-21) than the soil from the Northern Main Pit (Table A.1-15). Most metal contamination in the Southern Main Pit occurs near the surface and decreases with depth.

The highest concentrations were found in TBPSPBOR1, in the eastern section of the pit. Six metals were found to exceed calculated background levels in the 0–2 ft depth interval — antimony, arsenic, cadmium, copper, lead, and zinc.

Samples from the Southern Main Pit were also analyzed for PAHs, TPH, pesticides, PCBs, and explosives-related compounds. The results of these analyses are summarized in Tables A.1-22 (field measurements) and A.1-23 (laboratory measurements). The concentrations of TPH were between 10 and 100 mg/kg in 7 of 11 samples. Deeper samples (6 to 10 ft) from TBPSPBOR2 had TPH levels greater than 100 mg/kg. PCBs were highest in samples from the middle section of the pits (up to 143,000 µg/kg in JBP1E at 2 ft). Low levels of pesticides were detected only in sample JHDP-C from the eastern section of the pit. No TNT was detected.

Gross alpha activity ranged from less than 6 pCi/g to 11 pCi/g in samples from the Southern Main Pit. Gross beta activity ranged from less than 6 pCi/g to 9 pCi/g.

A.1.2.2 VX Pit

A.1.2.2.1 Surface Soil. In December 1993, four surface soil samples (OT16A, OT16B, OT19A, and OT19B) were collected from two locations near the VX Pit. The OT19 samples were taken near the western end of the filled trench, and the OT16 samples were taken within the Pushout Area and near the eastern end of the filled trench (Figure A.1-5). These samples were collected from depths of 0–6 in. (A samples) and 6–12 in. (B samples). The samples were analyzed for VOCs, SVOCs and metals. Table A.1-24 summarizes the results of VOC and metal analyses.

TABLE A.1-23 Analytical Results for PCBs and Pesticides in Subsurface Soil Samples Collected from the Southern Main Pit

	Concentration (µg/kg) by Sample Location[a]					
Parameter	JBP1W (2 ft)	JBP1W (4 ft)	JBP1E (2 ft)	JBP1E (4 ft)	JHDPC (4 ft)	JHDPC (6 ft)
Polychlorinated biphenyls						
Aroclor 1248	<41	<42	143,000	1,180	<40	178
Aroclor 1254	<41	<42	<1,990	<204	<40	<38
Aroclor 1260	<41	<42	<1,990	<204	<40	<38
Pesticides						
4,4′-Dichlorodiphenyldichloroethane	<4.5	4.6	<219	<23	<4.4	6.6
4,4′-Dichlorodiphenyldichloroethene	<1.6	<1.7	<80	<8.2	<1.6	3.1
4,4′-Dichlorodiphenyltrichloroethane	<4.9	<5.0	<239	<25	8.27	179

[a] Sampling locations are shown in Figure A.1-6.

TABLE A.1-24 Analytical Results for Surface Soil Samples Collected near the VX Pit in the TBP AOC[a]

Parameter	Concentration by Sample Location[b] OT16A (0–6 in.)	OT16B (6–12 in.)	OT19A (0–6 in.)	OT19B (6–12 in.)	Background[d]
VOCs (µg/kg)					
Benzene	50	<20	<20	<20	-
Chlorobenzene	50	50	<20	<20	-
1,1-Dichloroethene	<20	<20	<20	<20	-
Methylene chloride	50	50	<20	50	-
Tetrachloroethene	100	200	<20	<20	-
Toluene	50	<20	<20	<20	-
Trichloroethene	50	50	<20	<20	-
Metals[c] (mg/kg)					
Antimony	NT	NT	NT	NT	3.8
Arsenic	<10	<10	<10	<10	5.0
Beryllium	NT	NT	NT	NT	1.0
Cadmium	<10	<10	<10	<10	0.70
Copper	***343***	***240***	***24***	<10	20
Lead	***264***	***220***	57	11	61
Zinc	***1,029***	***1,629***	96	35	118

[a] Notation: A hyphen denotes that this compound is not a natural constituent of soil and was not detected in the background sample; NT = not tested. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Sampling locations are shown in Figure A.1-5.

[c] Inorganics from the OT sample series were analyzed with laboratory XRF.

[d] Background values were derived from soil data in ICF Kaiser Engineers (1995).

Low levels of VOCs were detected in samples from location OT16 near the eastern end of the trench — benzene (up to 50 µg/kg), TCLEE (up to 200 µg/mg), toluene (up to 50 µg/mg), and TRCLE (up to 50 µg/kg). Metal concentrations (especially lead and zinc) were also highest at this location. Samples from the western end of the trench were relatively clean.

The only SVOC found in surface soil from the VX pit was 2,4,6-trichloroaniline. It was found at both sampling locations and was at the highest level (1,500 µg/kg) in the 0–6 in. interval of sample OT16A.

A.1.2.2.2 Subsurface Soil. The location of the VX Pit was delineated on the basis of early aerial photographs and two geophysical surveys. Results of the first geophysical survey (Daudt et al. 1994), were used to select the locations for two borings in the VX Pit (VXBOR1 and VXBOR2). A second, more focused geophysical survey (Davies et al. 1995) later confirmed that boring VXBOR1 was in the pit but that boring VXBOR2 fell just outside the pit. As a result, three additional borings (VXBOR3–VXBOR5) were drilled in the spring of 1995 (Figure A.1-6) to characterize the nature of the contamination of the VX Pit. Boring VXBOR3 was determined to be near the area where major disposal activities occurred, and boring VXBOR4 was immediately downgradient of the disposal area. Boring VXBOR5 was within the pushout area of the pit. Borings VXBOR3 and VXBOR4 could not be drilled more than 4 and 6 ft deep, respectively, because of the potential hazard associated with unexploded ordnance (UXO). This situation prevented a full characterization of the filled trench. On the other hand, boring VXBOR5 was drilled to a depth of 16 ft.

Table A.1-25 presents the analytical matrix for soil samples collected from the VX pit; sample depths are also given. Soil samples from the borings were analyzed for VOCs, SVOCs, and metals. A subset of the samples was also analyzed for pesticides, PCBs, dioxins/furans, CSM/CSM degradation products, PAHs, TPH, and explosives-related compounds.

The contamination in the pit varied spatially; in general, more contamination was associated with the area downgradient of the disposal area within the pit and in the pit's pushout area. Most VOC contamination occurred at depths greater than 2 ft and increased with increasing depth.

The results of VOCs analyses are given in Table A.1-26. Except for low levels of acetone and methylene chloride (common laboratory contaminants), no VOC contamination was found in samples VXBOR1 and VXBOR2. The highest VOC concentrations were found at the 4–6 ft depth interval of sample VXBOR4, associated with the disposal area within the VX Pit — acetone (up to 260 µg/kg), ethylbenzene (up to 2,900 µg/kg), and xylenes (up to 2,300 µg/kg). Ethylbenzene and xylenes are common components (and indicators) of gasoline. Lower concentrations of other VOCs (e.g., acetone, TCLEE, TRCLE, and vinyl chloride) were found in VXBOR5.

TABLE A.1-25 Analytical Matrix of Soil Samples Collected from the VX Pit[a]

Sample Location[b]	Depth (ft)	Chemical Constituents Analyzed: VOCs	SVOCs	Metals	Pesticides	PCBs	Dioxins/ Furans	Others
VXBOR1	0-2	X	X	X		X		Explosives, PAHs, TPH
	4–6	X	X	X		X		Explosives, PAHs, TPH
	6–8	X	X	X		X		Explosives, PAHs, TPH
	8–10	X	X			X		Explosives, PAHs, TPH
VXBOR2	0–2	X	X	X		X		Explosives, PAHs, TPH
	2–4	X	X	X		X		Explosives, PAHs, TPH
	4–6	X	X	X		X		Explosives, PAHs, TPH
	6–8		X	X		X		Explosives, PAHs, TPH
	8–10		X	X		X		Explosives, PAHs, TPH
	10–12		X	X		X		
VXBOR3	2–4	X	X		X	X		
VXBOR4	2–4	X	X	X	X	X	X	CSM, explosives
	4–6	X	X	X	X	X	X	CSM, explosives
VXBOR5	0–2	X		X				CSM, explosives
	4–6	X	X	X	X	X	X	CSM, explosives
	6–8	X		X				
	8–10	X	X	X	X	X	X	CSM, explosives
	10–12	X						CSM
	12–14	X						CSM
	14-16	X						CSM

[a] Notation: PAH = polynuclear aromatic hydrocarbon; TPH = total petroleum hydrocarbons; CSM = chemical surety material/CSM degradation products; explosives = explosives-related compounds. X = analyzed; blank space = not analyzed.

[b] Sampling locations are shown in Figure A.1-6.

Table A.1-27 summarizes the results of the SVOC analyses. Low levels of bis(2-ethylhexyl)phthalate and di-n-butylphthalate (common laboratory contaminants) and butylbenzlphthalate were detected in samples from borings VXBOR1 and VXBOR2. Substantially higher levels of di-n-butylphthalate (up to 47,000 µg/kg at 4–6 ft) were detected in soil samples from VXBOR4. The presence of this compound is likely related to past waste disposal activities in the pit.

In addition to the phthalates, other SVOCs were detected in soils at depths of 2–4 ft in boring VXBOR3 and at 2–6 ft in boring VXBOR4 (Table A.1-27). The detection of SVOCs is consistent with the aerial photograph that shows both borings to be near the major disposal area within the VX Pit. Boring VXBOR5, located in the pushout area of the pit, had fewer SVOCs, and their concentrations were lower by a factor of 10.

TABLE A.1-26 Analytical Results for VOCs in Subsurface Soil Samples Collected from the VX Pit: 1995[a]

	Concentration (μg/kg) by Sample Location[b]				
Parameter	VXBOR1 (0–2 ft)	VXBOR1 (4–6 ft)	VXBOR1 (6–8 ft)	VXBOR1 (8–10 ft)	VXBOR1 (9.5–10 ft)
Acetone	<12	26	<14	<12	<12
Benzene	<12	<12	<14	<12	<12
Carbon disulfide	<12	<12	<14	<12	<12
1,2-Dichloroethane	<12	<12	<14	<12	<12
1,2-Dichloroethene	<12	<12	<14	<12	<12
Ethylbenzene	<12	<12	>14	<12	<12
Methylene chloride	17	<12	10 J	<12	<12
Tetrachloroethene	<12	<12	<14	<12	<12
Trichloroethene	<12	<12	<14	<12	<12
Vinyl chloride	<12	<12	<14	<12	<12
Xylenes	<12	<12	<14	<12	<12

	Concentration (μg/kg) by Sample Location[b]					
Parameter	VXBOR2 (0–2 ft)	VXBOR2 (2–4 ft)	VXBOR2 (4–6 ft)	VXBOR3 (2–4 ft)	VXBOR4 (2–4 ft)	VXBOR4 (4–6 ft)
Acetone	<12	<12	<12	18	130	260
Benzene	<12	<12	<12	42	<64	<61
Carbon disulfide	<12	<12	<12	11 J	<64	<61
1,2-Dichloroethane	<12	<12	<12	<12	<64	<61
1,2-Dichloroethene	<12	<12	<12	5 J	<64	<61
Ethylbenzene	<12	<12	<12	58	1,300 JD	2,900 D
Methylene chloride	<12	<12	<12	<12	53 J	52 J
Tetrachloroethene	<12	<12	<12	<12	<64	<61
Trichloroethene	<12	<12	<12	15	<64	<61
Vinyl chloride	<12	<12	<12	<12	<64	<61
Xylenes	<12	<12	<12	27	1,200	2,300

	Concentration (μg/kg) by Sample Location[b]						
Parameter	VXBOR5 (0–2 ft)	VXBOR5 (4–6 ft)	VXBOR5 (6–8 ft)	VXBOR5 (8–10 ft)	VXBOR5 (10–12 ft)	VXBOR5 (12–14 ft)	VXBOR5 (14–16 ft)
Acetone	<12	160 D	20	210	14	550 D	1,100 D
Benzene	<12	<65	<12	<12	<13	<13	<62
Carbon disulfide	2 J	<65	<12	<12	<13	11 J	<62
1,2-Dichloroethane	<12	<65	<12	<12	<13	2 J	<62
1,2-Dichloroethene	<12	<65	2 J	<12	3 J	3 J	<62
Ethylbenzene	<12	<65	<12	<12	<13	<13	<62
Methylene chloride	7 J	39 J	6 BJ	7 BJ	11 BJ	8 BJ	28 J
Tetrachloroethene	<12	17 J	5 J	3 J	4 J	<13	<62
Trichloroethene	<12	8 J	<12	<12	<13	<13	<62
Vinyl chloride	<12	<65	<12	<12	<13	3 J	<62
Xylenes	<12	<65	<12	<12	<13	<13	<62

[a] Notation: B = analyte also found in the associated blank; D = sample was diluted for analysis; J = estimated value.

[b] Sampling locations are shown in Figure A.1-6.

TABLE A.1-27 Analytical Results for SVOCs in Subsurface Soil Samples Collected from the VX Pit: 1995[a]

	Concentration (µg/kg) by Sample Location[b]									
Parameter	VXBOR1 (0–2 ft)	VXBOR1 (2–4 ft)	VXBOR1 (6–8 ft)	VXBOR1 (8–10 ft)	VXBOR2 (0–2 ft)	VXBOR2 (2–4 ft)	VXBOR2 (4–6 ft)	VXBOR2 (6–8 ft)	VXBOR2 (8–10 ft)	VXBOR2 (10–12 ft)
Anthracene	<380	<410	<460	1,400	<410	<380	<390	<410	<420	<390
Benzo[a]anthracene	<380	<410	<460	<390	<410	<380	<390	<410	<420	<390
Benzo[b]fluoranthene	<380	<410	<460	<390	<410	<380	<390	<410	<420	<390
Benzo[k]fluoranthene	<380	<410	<460	<390	<410	<380	<390	<410	<420	<390
Benzo[g,h,i]perylene	<380	<410	<460	<390	<410	<380	<390	<410	<420	<390
Benzo[a]pyrene	<380	<410	<460	<390	<410	<380	<390	<410	<420	<390
Bis(2-ethylhexyl)phthalate	1,600 B	1,400 B	2,500 B	1,100 B	1,300 B	960 B	1,500 B	2,000 B	4,300 B	4,100 B
Butylbenzylphthalate	750 B	260 JB	<460	<390	<410	<380	<390	<410	<420	<390
Chrysene	<380	<410	<460	<390	<410	<380	<390	<410	<420	<390
Dibenz[a,h]anthracene	<380	<410	<460	<390	<410	<380	<390	<410	<420	<390
Di-n-butylphthalate	200 JB	1,200 B	350 JB	460 B	160 JB	<380	140 JB	<410	100 J	210 J
Di-n-octylphthalate	<380	<410	<460	<390	<410	<380	<390	<410	<420	<390
Fluoranthene	<380	<410	<460	<390	<410	<380	<390	<410	<420	<390
Fluorene	<380	<410	980	<390	<410	<380	<390	<410	<420	<390
Hexachlorobutadiene	<380	<410	<460	<390	<410	<380	<390	<410	<420	<390
Indeno[1,2,3-c,d]pyrene	<380	<410	<460	<390	<410	<380	<390	<410	<420	<390
2-Methylnaphthalene	<380	<410	<460	<390	<410	<380	<390	<410	<420	<390
Naphthalene	<380	<410	<460	<390	<410	<380	<390	<410	<420	<390
Phenanthrene	<380	3,500	2,000	1,200	<410	<380	<390	<410	<420	<390
Pyrene	<380	280 J	<460	160 J	<410	<380	<390	<410	<420	<390

TABLE A.1-27 (Cont.)

Parameter	Concentration (μg/kg) by Sample Location[b]				
	VXBOR3 (2-4 ft)	VXBOR4 (2-4 ft)	VXBOR4 (4-6 ft)	VXBOR5 (4-6 ft)	VXBOR5 (8-10 ft)
Anthracene	810 J	<8,350	<8,050	<428	<407
Benzo[a]anthracene	<7,920	1,200 J	<8,050	<428	<407
Benzo[b]fluoranthene	<7,920	1,200 J	1,020 J	<428	<407
Benzo[k]fluoranthene	<7,920	1,200	3,100 J	<428	<407
Benzo[g,h,i]perylene	890 J	2,400 J	1,600 J	<428	<407
Benzo[a]pyrene	<7,920	1,300 J	<8,050	<428	<407
Bis(2-ethylhexyl)phthalate	<7,920	<8,350	<8,050	<428	<407
Butylbenzylphthalate	<7,920	<8,350	<8,050	<428	<407
Chrysene	1,500 J	2,100 J	1,100 J	<428	<407
Dibenz[a,h]anthracene	<7,920	1,700 J	<8,050	<428	<407
Di-n-butylphthalate	<7,920	47,000 B	27,000 B	<428	73 J
Di-n-octylphthalate	<7,920	<8,350	<8,050	<428	<407
Fluoranthene	<7,920	2,600 J	1,900 J	150 J	<407
Fluorene	<7,920	<8,350	<8,050	<428	<407
Hexachlorobutadiene	<7,920	<8,350	<8,050	<428	<407
Indeno[1,2,3-c,d]pyrene	<7,920	2,000 J	<8,050	<428	<407
2-Methylnaphthalene	980 J	53,000	12,000	8,100 D	<407
Naphthalene	<7,920	<8,350	<8,050	420 J	<407
Phenanthrene	1,500	32,000	27,000	3,100	<407
Pyrene	3,300 J	<8,350	<8,050	170 J	<407

[a] Notation: B = analyte also found in associated blank; J = estimated value; ND = not detected.

[b] Sampling locations are shown in Figure A.1-6.

Table A.1-28 summarizes the results of the metal analyses for the VX Pit soil samples. A soil sample from VXVBOR4 at a depth of 2-4 ft had the highest concentrations of metal, including antimony (112 mg/kg), arsenic (19 mg/kg), lead (1,690 mg/kg), and zinc (2,320 mg/kg). However, these elevated levels did not extend deeper than 4 ft. For soil samples from VXBOR1 and VXBOR2, elevated levels of copper, lead, and zinc were generally limited to the upper 2 ft. Toward the marsh, in boring VXBOR5, the elevated concentrations extend to a depth of 6 ft. The surface soils (0–2 ft) of three borings (VXBOR1, VXBOR2, and VXBOR5) contained elevated levels of arsenic, cadmium, copper, lead, mercury, and zinc.

Soil samples from borings VXBOR1 and VXBOR2 were also analyzed for TPH, PAHs, PCBs, and TNT (Table A.1-29). The single soil sample (2–4 ft) from boring VXBOR3 was analyzed for PCBs and pesticides, and soil samples from borings VXBOR4 and VXBOR5 were analyzed for explosives-related compounds, pesticides, PCBs, dioxins/furans, and CSM/CSM degradation products (Table A.1-30). All but one sample had TPH levels higher than 100 mg/kg. Three soil samples from VXBOR1, collected from depths of 4–6, 6–8, and 8–12 ft, contained more than 10 mg/kg of PAHs. Soil samples from VXBOR2 did not show any PAH contamination. No PCBs were detected in any of the borings. Only one sample (VXBOR4, 2–4 ft) contained an explosives-related compound (1,670 µg/kg of pentaerythritol tetranitrate). A CSM degradation product, 1,4-dithiane, was detected in two samples — VXBOR5 (0–2 ft) and VXBOR5 (12–14 ft). Very low levels of furans and dioxins were detected in VXBOR4 (2–4 ft) and VXBOR5 (4–6 ft). Several pesticides, including 4,4'-DDD, 4,4'-DDE, alpha-benzene hexachloride (BHC), and endrin ketone, were detected at very low levels in two soil samples from VXBOR5. However, the highest levels of 4,4'-DDD (78.8 µg/kg) and 4,4'-DDE (18.2 µg/kg) were detected in surface soil from VXBOR3.

A.1.2.3 Pushout Area

A.1.2.3.1 Surface Soil. In the 1986 RFA (Nemeth 1989), surface soil samples (depths unknown) were collected from three locations (J2, J12, and J14) in the estimated Pushout Area (Figure A.1-4). The samples were analyzed for metals, extractable metals, and explosives-related compounds (Table A.1-31). VOCs were measured in sample J2 only. High levels of lead (up to 26,040 mg/kg) were detected in all three samples. The extractable level for lead in sample J12 (31.2 mg/L) exceeded the TCLP extraction procedure limit for lead (EPA limit of 5.0 mg/L) (*Code of Federal Regulations*, Title 40, Section 261 [40 CFR 261]). Several additional metals, including arsenic, barium, cadmium, chromium, and mercury, were detected at concentrations exceeding the calculated background. The VOC TRCLE was found at a concentration of 1,000 µg/kg in sample J2. Traces of other VOCs were also present according to Nemeth (1989). No explosives-related compounds were detected.

TABLE A.1-28 Analytical Results for Selected Metals in Subsurface Soil Samples Collected from the VX Pit: 1995[a]

	Concentration (mg/kg) by Sample Location[b]										
Parameter	VXBOR1 (0-2 ft)	VXBOR1 (4-6 ft)	VXBOR1 (6-8 ft)	VXBOR1 (8-10 ft)	VXBOR2 (0-2 ft)	VXBOR2 (2-4 ft)	VXBOR2 (4-6 ft)	VXBOR2 (6-8 ft)	VXBOR2 (8-10 ft)	VXBOR2 (10-12 ft)	VXBOR2 (8-10ft dup)
Antimony	NT[b]	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Arsenic	<13	<10	<10	<10	***15***	<10	<10	<10	<10	<10	<10
Cadmium	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Copper	***170***	***192***	<10	***78***	***124***	<10	***40***	<10	<10	<10	<10
Lead	***210***	49	<10	19	***161***	11	<10	<10	<10	<10	<10
Mercury	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Nickel	11	11	<10	<10	***23***	13	<10	<10	<10	<10	<10
Silver	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Zinc	***432***	71	19	57	***361***	17	31	32	42	63	55

	Concentration (mg/kg) by Sample Location[b]						
Parameter	VXBOR4 (2-4 ft)	VXBOR4 (4-6 ft)	VXBOR5 (0-2 ft)	VXBOR5 (4-6 ft)	VXBOR5 (6-8 ft)	VXBOR5 (8-10 ft)	Background (mg/kg)[c]
Antimony	***112***	0.69	<0.21	0.49	<0.21	<0.22	3.8
Arsenic	***19***	0.91	***6.1***	4.5	0.57	1.9	5.0
Cadmium	***2.7***	<0.49	***1.7***	***3.3***	<0.37	<0.37	0.70
Copper	***1,110***	***34***	***51***	***218***	<2.8	3.8	20
Lead	***1,690***	14	28	26	2.2	2.8	61
Mercury	***0.43***	<0.020	***0.34***	***0.26***	<0.050	<0.050	0.10
Nickel	***55***	3.9	6.1	16	3.2	4.3	20
Silver	***2.5***	***1.0***	<0.090	0.11	<0.090	<0.090	0.40
Zinc	***2,320***	38	***223***	***342***	12	17	118

[a] Notation: NT = not tested. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Sampling locations are shown in Figure A.1-6.

[c] Background values were derived from soil data in ICF Kaiser Engineers (1995).

TABLE A.1-29 On-Site Analytical Results for PAHs, TPH, PCBs, and TNT in Subsurface Soil Samples Collected from the VX Pit: 1995[a]

	Concentration (mg/kg) by Sample Location[b]			
Parameter	VXBOR1 (0–2 ft)	VXBOR1 (4–6 ft)	VXBOR1 (6–8 ft)	VXBOR1 (8–10 ft)
Polynuclear aromatic hydrocarbons	1 U	10 G	10 G	10 G
Total petroleum hydrocarbons	100 G	100 G	100 G	100 G
Polychlorinated biphenyls	1 U	1 U	1 U	1 U
Trinitrotoluene	0.7 U	0.7 U	0.7 U	0.7 U

	Concentration (mg/kg) by Sample Location[b]					
Parameter	VXBOR2 (0–2 ft)	VXBOR2 (2–4 ft)	VXBOR2 (4–6 ft)	VXBOR2 (6–8 ft)	VXBOR2 (8–10 ft)	VXBOR2 (10–12 ft)
Polynuclear aromatic hydrocarbons	1 U	1 U	1 U	1 U	1 U	1 U
Total petroleum hydrocarbons	100 G	100 G	100 G	100 G	100 U 10	100 G
Polychlorinated biphenyls	1 U	1 U	1 U	1 U	1 U	1 U
Trinitrotoluene	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U

[a] Sampled and analyzed on-site by Argonne. Notation: 100 U 10 = <100 mg/kg but >10 mg/kg; G = > value given; U = < value given.

[b] Sampling locations are shown in Figure A.1-6.

In 1991, the USGS collected surface soil samples to a depth of 1 ft at 10 locations: sites 26–34 and site 36 in Figure A.1-7. Five samples (28-32) are probably within the Pushout Area. These 10 samples were analyzed for indicator parameters, VOCs, SVOCs, metals, and explosives-related compounds (Hughes 1992). Table A.1-32 presents the results of these analyses, except those for explosives. Three samples (28–30) showed high levels of metal contamination. The soil sample from location 29 had the highest levels of arsenic (49 mg/kg), copper (786 mg/kg), lead (87,100 mg/kg), antimony (1,120 mg/kg), and zinc (7,960 mg/kg) — levels that were significantly higher than the corresponding background levels. Sampling location 29 was near 1986 RFA sample J12 (Figure A.1-4), in which the highest level of lead was detected. Samples from locations 28 and 30 also had elevated levels of arsenic (7.8 and 21 mg/kg), copper (233 and 48 mg/kg), and lead

TABLE A.1-30 Analytical Results for CSM/CSM Degradation Products, Dioxins/Furans, Explosives-Related Compounds, Pesticides, and PCBs in Subsurface Soil Samples Collected from the VX Pit: 1995[a]

	Concentration by Sample Location[b]									
Parameter	VXBOR3 (2–4 ft)	VXBOR4 (2–4 ft)	VXBOR4 (4–6 ft)	VXBOR5 (0–2 ft)	VXBOR5 (4–6 ft)	VXBOR5 (6–8 ft)	VXBOR5 (8–10 ft)	VXBOR5 (10–12 ft)	VXBOR5 (12–14 ft)	VXBOR5 (14–16 ft)
CSM/CSM degradation products (mg/kg)										
1,4-Dithiane	NT	<94	<36	0.46	<1.9	NT	<1.8	<1.8	0.23 J	<1.8
Dioxins/furans (μg/kg)										
Heptachlorodibenzo-p-furans	NT	0.070	<0.020	NT	<0.020	NT	<0.010	NT	NT	NT
Hexachlorodibenzo-p-furans	NT	0.030	<0.030	NT	<0.010	NT	<0.010	NT	NT	NT
Octachlorodibenzo-p-dioxins	NT	0.32	0.28	NT	0.010	NT	<0.020	NT	NT	NT
Tetrachlorodibenzo-p-furans	NT	0.040	0.040	NT	<0.020	NT	<0.010	NT	NT	NT
Explosives-related compounds (μg/kg)										
Pentaerythritol tetranitrate	NT	1,670	<1,250	<250	<250	NT	<250	NT	NT	NT
Pesticides (μg/kg)										
alpha-BHC	<41	<43	<21	NT	1.3 J	NT	<2.1	NT	NT	NT
4,4′-Dichlorodiphenyldichloroethane	79 JB	<84	<40	NT	4.6	NT	1.5 JB	NT	NT	NT
4,4′-Dichlorodiphenyldichloroethene	18 JB	<84	<40	NT	<4.3	NT	0.97 JB	NT	NT	NT
Endrin ketone	<79	<84	<40	NT	2.9 J	NT	<4.1	NT	NT	NT
PCBs (μg/kg)										
Aroclor 1248	<789	<838	<404	NT	<43	NT	<41	NT	NT	NT
Aroclor 1254	<789	<838	<404	NT	<43	NT	<41	NT	NT	NT

[a] Notation: B = analyte also found in the associated blank; J= estimated values; NT = not tested.

[b] Sample locations are shown in Figure A.1-6.

TABLE A.1-31 Analytical Results for Metals in Surface Soil Samples Collected from the Pushout Area in the TBP AOC during the 1986 RFA[a]

	Concentration by Sample Location			
Parameter[b]	J2[c]	J12	J14	Background
Total metals (mg/kg)				
Arsenic	25.2	24.1	28.7	5.0
Barium	277	855	256	94
Cadmium	4.57	3.57	1.47	0.70
Chromium	54.4	80.1	30.4	41
Lead	548	26,040	1,522	61
Mercury	0.87	0.77	0.59	0.080
Silver	<5.0	<5.0	<5.0	0.39
Extractable metals (mg/L)				
Cadmium	<0.10	<0.10	<0.10	NA[c]
Lead	<0.50	31.2	<0.50	NA
Silver	<0.50	<0.50	0.154	NA

[a] Notation: NA = not available.

[b] Includes parameters that were detected in at least one soil sample.

[c] VOCs were measured in sample J2 only; 1,000 µg/kg of trichloroethene and traces of other VOCs were found.

Source: Nemeth (1989).

(662 and 952 mg/kg). Low levels of the SVOCs butylbenzyl phthalate and benzoic acid were detected in samples from locations 27, 30, and 32.

In 1992, Weston collected six soil samples at depths of 3 in. and 1 ft at three locations (JBPMA, JBPMB, and JBPMC in Figure A.1-5) near the western margin of the Pushout Area (Mazelon 1993). Location JBPMA is near the boundary between the Southern Main Pit and Pushout Area. Location JBPMB is near the boundary between the previous location of the northern main trench (the eastern boundary of the Northern Main Pit has moved over time, as observed from aerial photographs) and the Pushout Area. Location JBPMC is located north of the VX Pit. The soil samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. The results are presented in Table A.1-33.

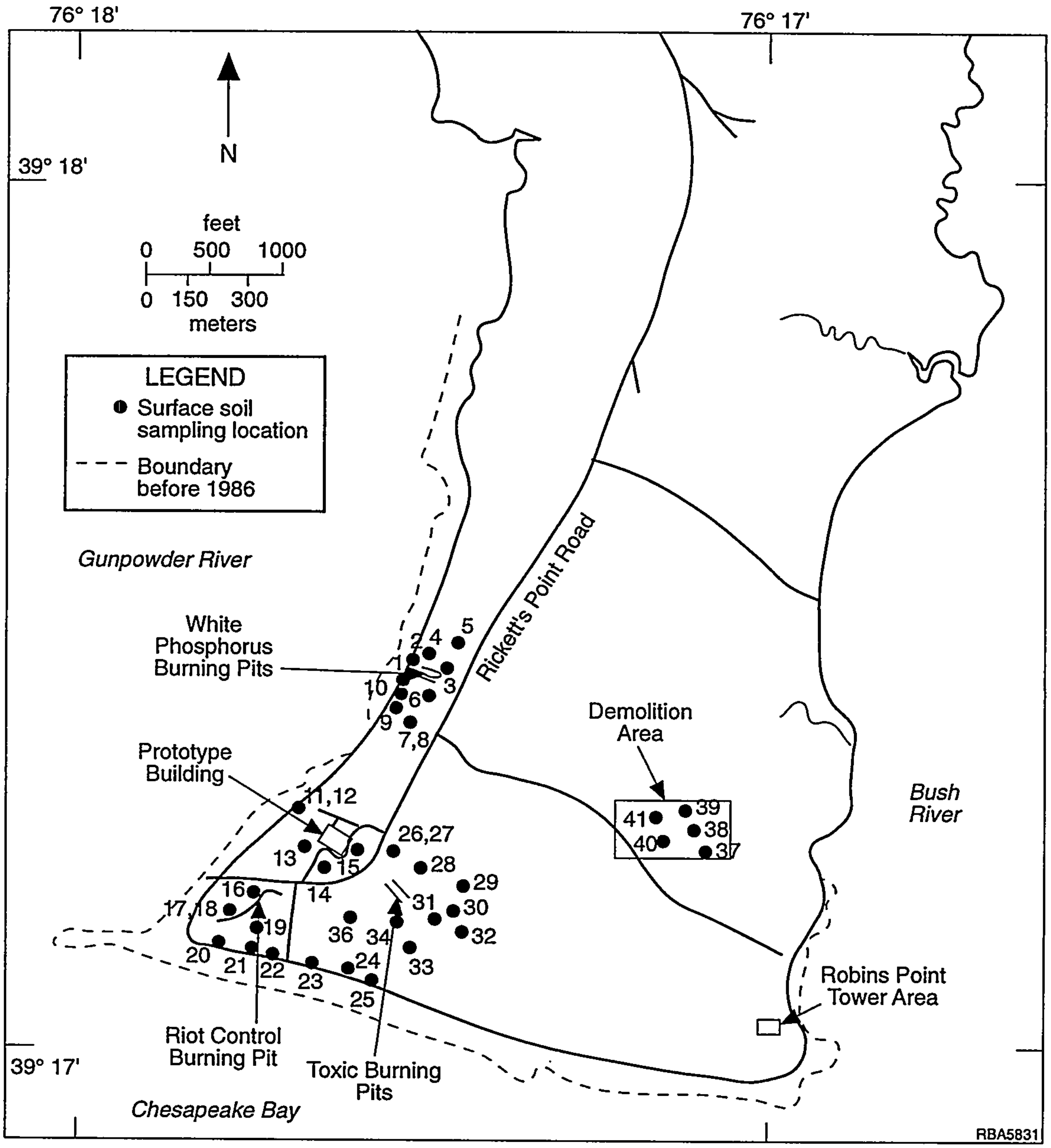

FIGURE A.1-7 Locations of Surface Soil Samples Collected by the U.S. Geological Survey in 1991 (Source: Adapted from Hughes 1992)

TABLE A.1-32 Analytical Results for Surface Soil Samples (1 ft) Collected by the U.S. Geological Survey from the Pushout Area in the TBP AOC: 1991[a]

	Concentration by Sample Location									
Parameter	26	27	28	29	30	31	32	33	34	36
Metals (mg/kg)										
Arsenic	4.5	4.2	7.8	49	21	2.6	3.3	3.5	6.6	3.2
Cadmium	ND[a]	ND	2.4	16	ND	ND	ND	ND	ND	ND
Chromium	16	15	37	121	46	12	13	13	17	17
Copper	22	19	233	786	48	4.2	11	15	40	17
Lead	41	38	662	87,100	952	15	17	29	42	19
Antimony	ND	ND	ND	1,120	ND	ND	ND	ND	ND	ND
Zinc	96	157	ND	7,960	ND	25	ND	ND	ND	ND
VOCs (mg/kg)										
Acetone	16	6.8	9.8	16	4.9	2.2	ND	21	ND	ND
cis-1,2-Dichloroethylene	NT[b]	NT	2.4	NT	2.4	NT	ND	NT	NT	NT
Trichloroethene	ND	ND	1.1	ND	ND	ND	ND	ND	ND	ND
SVOCs (mg/kg)										
Benzoic acid	ND	ND	ND	ND	420	ND	ND	2,100	ND	ND
Butylbenzl phthalate	ND	720	ND	ND	580	ND	ND	ND	ND	ND
Other (mg/kg)	ND	ND	ND	NT	ND	NT	ND	NT	NT	NT
Total Kjeldahl nitrogen	249	247	637	605	488	627	1,030	1,730	639	552
Total organic carbon	1,190	1,720	1,590	1,630	1,190	1,390	871	1,810	752	1,010
Total organic halide	20	48	37	34	ND	ND	ND	ND	ND	ND

[a] Notation: ND = not detected, detection limits unavailable; NT = not tested.

Source: Hughes (1992).

TABLE A.1-33 Analytical Results for Various Parameters in Surface Soil Samples Collected from the Pushout Area in the TBP AOC: 1992[a]

	Concentration by Sample Location					
Parameter	JBPMA (3 in.)	JBPMA (1 ft)	JBPMB (3 in.)	JBPMB (1 ft)	JBPMC (3 in.)	JBPMC (1 ft)
VOCs (μg/kg)						
Acetone	275	1,460 BJ	324	1,060 BJ	<13	57
Carbon disulfide	<27	<743	<29	<731	1 J	<6
Chloroform	<27	<743	<29	<731	<6	<6
trans-1,2-Dichloroethene	<27	<743	50	<731	<6	<6
Methylene chloride	36 B	467 BJ	36 B	451 BJ	9 B	6 B
Tetrachloroethene	13 J	530 J	17 J	<731	<6	<6
1,1,2,2-Tetrachloroethane	123	1,460 D	13,200 D	15,200	71	41
Toluene	11 J	<743	<29	<731	7	<6
1,1,2-Trichloroethane	61	367 J	80	<6	<6	<6
Trichloroethene	843	26,000 D	517	251 J	10	3 J
Xylenes	<27	<743	<29	<731	9	<6
SVOCs (μg/kg)						
Bis(2-ethylhexyl)phthalate	208 J	<392	190 J	<386	<419	<379
Di-n-butylphthalate	<392	77 J	<376	<386	<419	<379
Diethylphthalate	<392	49 J	<376	<386	<419	<379
Fluoranthene	77 J	<392	<376	<386	<419	<379
Hexachloroethane	<392	498	<376	<386	<419	<379
2-Methylnaphthalene	139 J	<392	<376	<386	<419	<379
Naphthalene	48 J	<392	<376	<386	<419	<379
Phenanthrene	311 J	<392	<376	<386	<419	<379
Pyrene	215 J	<392	<376	<386	<419	<379
Pesticides (μg/kg)						
delta-BHC	<3.6	<3.6	4.5	<3.5	28	<3.5
4,4′-Dichlorodiphenyltrichloroethane	<4.8	144	6.9	<4.7	<5.1	<4.6
4,4′-Dichloroethene	<4.4	56	6.5	<1.6	12	<1.5
Endrin	<2.4	<2.4	<2.3	<2.4	<2.6	<2.3
Heptachlor	<1.2	<1.2	<1.2	<1.2	<1.3	<1.2
PCBs (μg/kg)						
Aroclor 1248	<40	<40	<38	<39	<43	<39
Aroclor 1254	1,700	3,160	<38	<39	<43	<39

TABLE A.1-33 (Cont.)

	Concentration by Sample Location						
Parameter	JBPMA (3 in.)	JBPMA (1 ft)	JBPMB (3 in.)	JBPMB (1 ft)	JBPMC (3 in.)	JBPMC (1 ft)	Background (mg/kg)
Metals (mg/kg)							
Antimony	<4.6	<4.6	14	<4.5	<4.9	<4.4	3.8
Arsenic	4.8	23	7.5	3.6	12	2.3	5.0
Beryllium	0.43	0.26	0.34	0.40	<0.20	0.30	1.0
Cadmium	2.95	6.1	5.9	<0.56	2.4	<0.55	0.7
Copper	305	392	521	4.8	365	21	20
Lead	145	542	79,800	11	290	6.1	61
Zinc	690	678	1,000	47	252	27	118

[a] For samples with duplicate analyses, the higher value is reported. Notation: B = analyte also found in the associated blank; D = sample was diluted for analysis; J = estimated value.

Source: Mazelon (1993).

The highest levels of contamination were found in samples JBPMA and JBPMB, located downgradient of the Main Burning Pits. Of particular importance were the high levels of VOCs in these samples: TCLEA (up to 15,200 μg/kg) and TRCLE (up to 26,000 μg/kg). Low levels of SVOCs and pesticides were also detected in these samples. Sample JBPMA, located between the Southern Main Pit and the Pushout Area, also had levels of PCBs (Aroclor 1254) up to 3,160 μg/kg. The highest concentrations of metals were found in sample JBPMB, located near the eastern boundary of the Northern Main Pit: lead (up to 79,800 mg/kg) and zinc (up to 1,000 mg/kg). The highest levels of arsenic (23 mg/kg), however, were found in JBPMA.

In December 1993, Argonne collected eight surface soil samples from four locations in the Pushout Area (OT29–OT32, Figure A.1-5). These samples were collected from depths of 0–6 in. (A samples) and 6–12 in. (B samples). The samples were analyzed for VOCs, SVOCs, and metals. Table A.34 summarizes the results. VOC contamination was found in all samples; however, the highest levels were in samples OT30B: TCLEA (2,500 μg/kg) and TRCLE (2,800 μg/kg). Only two SVOCs were detected: 2,4,6-trichloroaniline (up to 7,900 μg/kg in OT29B) and phenol (200 μg/kg in OT30A only). The only metals detected were copper, lead, and zinc. These were highest in samples OT31B and OT32A: copper (up to 3,126 mg/kg), lead (up to 21,930 mg/kg), and zinc (up to 84,485 mg/kg).

In January 1994, 22 soil samples were collected from nine locations (CLP1–CLP9, Figure A.1-5) in the Pushout Area. Individual soil samples were collected at depths of 0–6 in., 6–24 in., and 24–48 in. at locations CLP1–CLP5 and CLP7. Soil samples were also collected at

TABLE A.1-34 Analytical Results for Various Parameters in Surface Soil Samples Collected from the Pushout Area in the TBP AOC: 1993[a]

	Concentration by Sample Location								
Parameter	OT29A (0–6 in.)	OT29B (6–12 in.)	OT30A (0–6 in.)	OT30B (6–12 in.)	OT31A (0–6 in.)	OT31B (6–12 in.)	OT32A (0–6 in.)	OT32B (6–12 in.)	Background (mg/kg)[c]
VOCs (μg/kg)									
Benzene	<20	<20	<20	50	50	50	50	<20	
Bis(2-chloroethyl)ether	<20	50	<20	<20	<20	<20	<50	<20	
Chlorobenzene	<20	<20	<20	50	<20	100	<50	<20	
Chloroform	50	<20	50	<20	<20	50	50	<20	
1,1-Dichloroethene	<20	<20	50	100	<20	<20	50	<20	
1,2-Dichloroethene	<20	<20	100	<20	<20	<20	<50	<20	
Hexachloroethane	50	50	50	50	<20	<20	<50	<20	
Methylene chloride	50	50	100	50	100	100	50	<20	
1,1,2,2-Tetrachloroethane	50	50	800	2,500	<20	<20	<50	<20	
Tetrachloroethene	50	50	100	100	200	400	1,000	<20	
Toluene	<20	<20	<20	50	50	<20	<50	<20	
Trichloroethene	50	100	1,800	2,800	100	100	<50	<20	
SVOCs (μg/kg)									
Phenol	<20	<20	200	<20	<20	<20	<20	<20	
2,4,6-Trichloroaniline	6,500	7,900	2,900	4,900	100	300	<20	<20	
Metals[b] (mg/kg)									
Antimony	NT[c]	NT	NT	NT	NT	NT	NT	NT	3.8
Arsenic	<10	<10	<10	<10	<10	<10	<10	NT	5.0
Beryllium	NT	NT	NT	NT	NT	NT	NT	NT	1.0
Cadmium	<10	<10	<10	<10	<10	***13***	<50	NT	0.7
Copper	***251***	***281***	***544***	***879***	***928***	***511***	***3,126***	NT	20
Lead	***845***	***665***	***729***	***1,671***	***21,775***	***21,930***	***2,758***	NT	61
Zinc	***1,048***	***1,070***	***481***	***610***	***2,547***	***9,570***	***84,485***	NT	118

[a] Notation: NT = not tested. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Metals from the OT sample series were analyzed with laboratory x-ray fluorescence.

[c] Background values were derived from soil data in ICF Kaiser Engineers (1995)

depths of 0–6 in. and 6–24 in. at location CLP6 and 0–6 in. at locations CLP8 and CLP9. All the CLP samples, except CLP7, were taken between the VX and Mustard Pits. Sample CLP7 was taken from south of the Mustard Pit. All samples were analyzed for VOCs, SVOCs, metals, PAHs, TPH, PCBs, and TNT. The results are summarized in Tables A.1-35 through A.1-38. The results of the samples from CLP6 and CLP7 are described in Section A.1.2.4 because they are near the Mustard Pit.

Only a few VOCs were detected at low levels in samples CLP1–CLP5, CLP8, and CLP9 (Table A.1-35). The VOCs with the highest concentrations were found in sample CLP4 at 24–48 in.: TCLEA (5,600 μg/kg), 112TCE (500 μg/kg), 12DCE (600 μg/kg), TCLEE (1,500 μg/kg), and TRCLE (3,100 μg/kg). Low levels of SVOCs were also found (Table A.1-36). The main contamination present in the Pushout Area is from metals: antimony (up to 501 mg/kg), arsenic (up to 47 mg/kg), copper (up to 2,170 mg/kg), lead (up to 94,200 mg/kg), and zinc (up to 6,690 mg/kg) (Table A.1-37). The highest levels of metals were found in the upper 2 ft, although levels exceeding background were detected at depths greater than 2 ft.

Low levels of PAHs were detected in samples CLP2 and CLP3 (Table A.1-38). TPH levels were found to be less than 100 mg/kg for most samples (except CLP5). No PCBs were detected above 1 mg/kg. The explosive compound TNT was detected at low concentrations in samples CLP1 and CLP5.

In 1995, three surface soil samples (TBDGS1, TBDGS2, and TBDGS3, Figure A.1-5) were collected in the southeastern part of the Pushout Area between the Mustard Pit and the HE Demolition Ground. All samples were analyzed for metals and cyanide. Sample TBDGS3 was also analyzed for explosives-related compounds. Sample TPDGS2 was the only sample that showed a copper level (128 mg/kg) significantly above the calculated background (20 mg/kg) (Table A.1-39). That sample also showed a slightly elevated barium level (120 mg/kg compared with 93.8 mg/kg for background). Low levels of cadmium were detected in TPDGS1 (1.1 mg/kg) and TPDGS2 (0.92 mg/kg), slightly higher than the calculated background of 0.7 mg/kg. No cyanide was detected in any sample. Nitroglycerin was detected in sample TPDGS4.

A.1.2.3.2 Subsurface Soil. Since 1992, three borings (JVXPC, JSDPC, and FTBOR1) have been drilled in the Pushout Area (Figure A.1-6). Borings JVXPC and JSDPC were drilled by Weston and originally designed to delineate the VX Pit and the Liquid Smoke Disposal Pit on the basis of the Nemeth (1989) study. However, a later geophysical survey (Davies et al. 1995) confirmed that these borings were not in the designated pit. Instead, boring JVXPC is located south of the VX Pit, and boring JSDPC is near the northwestern boundary of the Pushout Area, near an old access road to the VX Pit. Boring FTBOR1, which was designed to delineate an old, filled trench connected to the Northern Main Pit, was later determined to be in an area between the old, filled trench and the

TABLE A.1-35 Analytical Results for VOCs in Surface Soil Samples Collected from the Pushout Area in the TBP AOC: 1994[a]

	Concentration (µg/kg) by Sample Location								
Parameter	CLP1 (0–6 in.)	CLP1 (6–20 in.)	CLP1 (24–48 in.)	CLP2 (0–6 in.)	CLP2 (6–24 in.)	CLP2 (24–48 in.)	CLP3 (0–6 in.)	CLP3 (6–24 in.)	CLP3 (24–48 in.)
Acetone	21 B	24 B	<13	<13	54 B	220 B	55 B	27 B	<29
2-Butanone	<15	<13	<13	<13	<13	36	<18	<15	<29
Carbon disulfide	<15	<13	<13	<13	<13	<15	<18	<15	<29
Chlorobenzene	<15	8 J	7 J	<13	<13	<15	<18	<15	<29
1,2-Dichloroethane (total)	<15	<13	<13	<13	<13	<15	<18	<15	<29
1,1,2,2-Tetrachloroethane	<15	<13	<13	<13	<13	<15	<18	<15	<29
Tetrachloroethene	<15	3 J	<13	<13	<13	<15	<18	<15	<29
Toluene	<15	4 J	5 J	<13	<13	8 J	<18	<15	60
1,1,2-Trichloroethane	<15	<13	<13	<13	<13	<15	<18	<15	<29
Trichloroethene	5 J	5 J	3 J	<13	<13	<15	<18	<15	<29

	Concentration (µg/kg) by Sample Location							
Parameter	CLP4 (0–6 in.)	CLP4 (6–24 in.)	CLP4 (24–48 in.)	CLP5 (0–6 in.)	CLP5 (6–24 in.)	CLP5 (24–48 in.)	CLP8 (0–6 in.)	CLP9 (0–6 in.)
Acetone	<14	16 B	62 B	<13	<12	110 B	<31	<12
2-Butanone	<14	<13	<26	<13	<12	20	<31	<12
Carbon disulfide	<14	<13	29	<13	<12	<14	<31	<12
Chlorobenzene	<14	<13	<26	<13	<12	<14	<31	<12
1,2-Dichloroethane (total)	<14	<13	600	16	13	180	28 J	20 J
1,1,2,2-Tetrachloroethane	<14	<13	5,600 D	<13	<12	<14	<31	<12
Tetrachloroethene	<14	<13	1,500 D	<13	<12	<14	<31	<12
Toluene	<14	<13	99	12 J	27	33	<31	<12
1,1,2-Trichloroethane	<14	<13	500	<13	<12	<14	<31	<12
Trichloroethene	<14	<13	3,100 D	22	17	9 J	<31	11 J

[a] Sampled by Argonne and analyzed by Weston (1994). Notation: B = analyte also found in the associated blank; D = sample was diluted for analysis; J = estimated value; ND = not detected.

TABLE A.1-36 Analytical Results for SVOCs in Surface Soil Samples Collected from the Pushout Area in the TBP AOC: 1994[a]

	Concentration (µg/kg) by Sample Location								
Parameter	CLP1 (0–6 in.)	CLP1 (6–24 in.)	CLP1 (24–48 in.)	CLP2 (0–6 in.)	CLP2 (6–24 in.)	CLP2 (24–48 in.)	CLP3 (0–6 in.)	CLP3 (6–24 in.)	CLP3 (24–48 in.)
Benzo[a]anthracene	<500	<420	<420	<420	<430	<500	<590	<490	<970
Benzo[b]fluoranthene	<500	<420	<420	<420	<430	<500	<590	<490	<970
Bis(2-ethylhexyl)phthalate	190 JB	220 JB	110 JB	210 JB	70 JB	<500	230 JB	260 JB	460 JB
Chrysene	<500	<420	<420	<420	<430	<500	90 J	<490	<970
Di-n-butylphthalate	95 JB	93 JB	89 JB	130 JB	150 JB	140 JB	210 JB	220 JB	380 JB
1,2-Dichlorobenzene	<500	<420	<420	<420	<430	<500	<590	<490	420 J
1,3-Dichlorobenzene	<500	<420	<420	<420	<430	<500	<590	<490	210 J
Diethylphthalate	<500	<420	44 J	<420	450	93 J	<590	2,000	<970
2,4-Dimethylphenol	<500	<420	<420	59 J	360 J	<500	<590	<490	<970
Fluoranthene	<500	<420	<420	<420	<430	<500	70 J	<490	<970
Hexachlorobenzene	160	<420	59 J	420 J	51 J	59 J	2,600	3,100	710 J
Hexachloroethane	<500	<420	<420	420 J	<430	<500	210 J	<490	<970
2-Methylnaphthalene	<500	<420	<420	<420	81 J	140 J	<590	200 J	97 J
2-Methylphenol	<500	<420	<420	340 J	7,200 D	10,000 D	<590	130 J	140 J
4-Methylphenol	<500	<420	<420	500	6,600 D	9,400 D	<590	180 J	190 J
Naphthalene	<500	<420	<420	420 J	610 J	71 J	<590	90 J	<970
2-Nitrophenol	<500	<420	<420	<420	<430	<500	<590	<490	1,400
n-Nitrosodiphenylamine	<500	<420	<420	420 J	170 J	<500	<590	240 J	<970
Phenanthrene	<500	<420	<420	420 J	<430	<500	<590	<490	<970
Phenol	<500	<420	<420	88	130 J	92 J	<590	<490	<970
Pyrene	<500	<420	<420	<420	<430	53 J	170 J	53 J	<970
1,2,4-Trichlorobenzene	<500	<420	<420	<420	<430	<500	<590	<490	<970

TABLE A.1-36 (Cont.)

	Concentration (μg/kg) by Sample Location							
Parameter	CLP4 (0–6 in.)	CLP4 (6–24 in.)	CLP4 (24–48 in.)	CLP5 (0–6 in.)	CLP5 (6–24 in.)	CLP5 (24–48 in.)	CLP8 (0–6 in.)	CLP9 (0–6 in.)
Benzo[a]anthracene	69 J	<420	<4,300	<420	<400	<440	<2,000	<820
Benzo[b]fluoranthene	200 J	<420	<4,300	<420	<400	<440	<2,000	<820
Bis(2-ethylhexyl)phthalate	170 JB	140 JB	440 JB	870 B	<400	140 JB	480 JB	120 JB
Chrysene	110 J	<420	<4,300	<420	<400	<440	<2,000	<820
Di-n-butylphthalate	230 JB	120 JB	<4,300	200 JB	85 JB	120 JB	<2,000	120 JB
1,2-Dichlorobenzene	<470	<440	<4,300	<420	<400	<440	<2,000	<820
1,3-Dichlorobenzene	<470	<440	<4,300	<420	<400	<440	<2,000	<820
Diethylphthalate	<470	<440	<4,300	<420	<400	49 J	<2,000	<820
2,4-Dimethylphenol	<470	<440	<4,300	<420	<400	<440	<2,000	<820
Fluoranthene	150 J	62 J	<4,300	<420	<400	<440	<2,000	<820
Hexachlorobenzene	430 J	<440	<4,300	<420	<400	<440	490 J	500 J
Hexachloroethane	<470	<440	<4,300	100 J	<400	<440	<2,000	<820
2-Methylnaphthalene	<470	200 J	<4,300	<420	<400	<440	<2,000	<820
2-Methylphenol	<470	110 J	<4,300	<420	<400	<440	<2,000	<820
4-Methylphenol	<470	<420	<4,300	<420	<400	<440	<2,000	<820
Naphthalene	<470	120 J	<4,300	<420	<400	<440	<2,000	<820
2-Nitrophenol	<470	<420	<4,300	<420	<400	<440	<2,000	<820
n-Nitrosodiphenylamine	<470	<440	<4,300	<420	<400	<440	<2,000	<820
Phenanthrene	59 J	120 J	<4,300	<420	<400	<440	<2,000	<820
Phenol	<470	<420	<4,300	<420	<400	<440	<2,000	<820
Pyrene	130 J	86 J	<4,300	<420	<400	<440	<2,000	44 J
1,2,4-Trichlorobenzene	<470	<440	<4,300	<420	<400	<440	<2,000	<820

[a] Sampled by ANL, analyzed by Weston (1994) (CLP/HSL semivolatile organics). Notation: B = analyte also found in the associated blank; J = estimated value; ND = not detected.

TABLE A.1-37 Analytical Results for Selected Metals in Soil Samples Collected from the Pushout Area in the TBP AOC: 1994[a]

	Concentration (mg/kg) by Sample Location								
Parameter	CLP1 (0–6 in.)	CLP1 (6–24 in.)	CLP1 (24–48 in.)	CLP2 (0–6 in.)	CLP2 (6–24 in.)	CLP2 (24–48 in.)	CLP3 (0–6 in.)	CLP3 (6–24 in.)	CLP3 (24–48 in.)
Antimony	***360***	***54***	***5.1***	***119***	***198***	***134***	***17***	***77***	***15***
Arsenic	***18***	***47***	***19***	***37***	***32***	***40***	***24***	***21***	***21***
Beryllium	0.44	0.31	0.56	0.34	0.23	0.42	0.95	0.59	0.78
Cadmium	***6.5***	***9.1***	***3.4***	***6.4***	***8.9***	***8.1***	***1.6***	***7.0***	***5.8***
Copper	***616***	***2,170***	***301***	***1,840***	***4,320***	***1,380***	***530***	***1,120***	***320***
Lead	***41,000***	***6,460***	***1,060***	***16,500***	***24,200***	***18,900***	***3,190***	***15,500***	***2,800***
Zinc	***2,760***	***5,760***	***1,530***	***5,330***	***5,730***	***5,950***	***2,490***	***6,690***	***2,960***

	Concentration (mg/kg) by Sample Location								
Parameter	CLP4 (0–6 in.)	CLP4 (6–24 in.)	CLP4 (24–48 in.)	CLP5 (0–6 in.)	CLP5 (6–24 in.)	CLP5 (24–48 in.)	CLP8 (0–6 in.)	CLP9 (0–6 in.)	Background (mg/kg)[b]
Antimony	***30***	***25***	***13***	***5.3***	***<4.7***	***5.5***	***501***	***20***	3.8
Arsenic	***18***	***16***	4.6	***13***	***5.7***	3.1	***41***	***17***	5.0
Beryllium	0.56	0.58	***1.3***	0.39	0.41	0.57	0.45	0.31	1.0
Cadmium	***5.5***	***5.0***	***2.2***	***2.4***	***2.2***	***0.71***	***2.1***	***4.5***	0.70
Copper	***608***	***552***	***73***	***760***	***252***	***226***	***1,040***	***449***	20
Lead	***4,580***	***5,040***	***371***	***791***	***458***	21	***94,200***	***2,050***	61
Zinc	***2,880***	***2,940***	***1,400***	***732***	***845***	***114***	***1,420***	***1,250***	118

[a] Inorganics from the CLP sample series were analyzed with CLP analytical methods. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

TABLE A.1-38 Analytical Results for PAHs, TPH, PCBs, and TNT in Surface Soil Samples Collected from the Pushout Area in the TBP AOC[a]

	Concentration (mg/kg) by Soil Sample Location							
Parameter	CLP1 (0–6 in.)	CLP1 (6–24 in.)	CLP2 (0–6 in.)	CLP2 (6–24 in.)	CLP2 (24–48 in.)	CLP3 (0–6 in.)	CLP3 (6–24 in.)	CLP3 (24–48 in.)
Polynuclear aromatic hydrocarbons	1 U	1 U	1 U	1 U	10 U 1	10 U 1	10 U1	1 U
Total petroleum hydrocarbons	10 U	10 U	10 U	10 U	100 U 10	100 U 10	10 U	10 U
Polychlorinated biphenyls	10 U 1	1 U	1 U	1 U	1 U	10 U 1	1 U	1 U
Trinitrotoluene	0.7 U	0.96	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U

	Concentration (mg/kg) by Sample Location							
Parameter	CLP4 (0–6 in.)	CLP4 (6–24 in.)	CLP4 (24–48 in.)	CLP5 (0–6 in.)	CLP5 (6–24 in.)	CLP5 (24–48 in.)	CLP8 (0–6 in.)	CLP9 (0–6 in.)
Polynuclear aromatic hydrocarbons	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Total petroleum hydrocarbons	10 U	100 U 10	100 U 10	10 U	100 U 10	100 G	10 U	10 U
Polychlorinated biphenyls	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trinitrotoluene	0.7 U	0.7 U	0.7 U	0.7 U	1.95	1.67	0.7 U	0.7 U

[a] Sampled and analyzed on-site by Argonne. Notation: 10 U 1 = <10 mg/kg but >1 mg/kg; 100 U 10 = <100 mg/kg but >10 mg/kg; G = > value given; U = < value given.

TABLE A.1-39 Analytical Results for Various Parameters in Soil Samples Collected near the HE Demolition Ground in the Pushout Area at the TBP AOC[a]

	Concentration by Sample Location					
Parameter	TPDGS1	TPDGS2	TPDGS3	TPDGS4	TPDGS5	Background[b]
Metals (mg/kg)						
Antimony	0.92	0.51	<0.21	<0.21	<0.21	3.8
Arsenic	3.4	4.0	3.2	3.6	3.3	5.0
Barium	82	***120***	71	91	76	94
Beryllium	0.52	0.92	0.61	0.55	0.51	1.0
Cadmium	***1.1***	***0.92***	0.68	***0.93***	***0.90***	0.70
Copper	***33***	***128***	12	18	15	20
Lead	57	53	25	24	12	61
Zinc	94	79	46	68	44	118
Explosives (mg/kg)						
Nitroglycerin	NT	NT	ND	15	ND	-

[a] Notation: A hyphen denotes that this is not a natural constituent of soil and was not detected in the background sample; ND = not detected; NT = not tested. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

VX Pit. Soil samples from these three borings provided additional information on the extent of contamination in the Pushout Area.

Soil samples were collected from borings JVXPC and JSDPC at depths of 4 and 6 ft. The samples were analyzed for VOCs, SVOCs, metals, pesticides, and PCBs. For boring FTBOR1, soil samples were collected at 2-ft intervals from the surface to a depth of 12 ft. These samples were analyzed for VOCs and SVOCs. FTBOR1 (8-10 ft) was analyzed only for metals. Tables A.1-40 and A.1-41 summarize the analytical results for these soil samples. Only low levels of metal were found in FTBOR1: arsenic, 1.8 mg/kg; chromium, 8.1 mg/kg; lead, 5.4 mg/kg; and zinc, 25 mg/kg.

Soil samples at depths of 4 and 6 ft from borings JSDPC and JVXPC contained VOCs, including TCLEA, 112TCE, acetone, chloroform, TCLEE, toluene, trans-12DCE, and TRCLE (Table A.1-40). No VOCs, except for a low level of TCLEA, were detected in any soil samples from boring FTBOR1. Significant levels of TCLEA (15,200 µg/kg), 112TCE (81 µg/kg), acetone (344 µg/kg), trans-12DCE (78 µg/kg), and TRCLE (345 µg/kg) were detected in sample JSDPC (4 ft). However, these VOCs were detected at much lower levels in the deeper samples from the same boring. No VOC data were available for surface soil samples from the two borings.

TABLE A.1-40 Analytical Results for VOCs in Soil Samples Collected from the Pushout Area in the TBP AOC: 1993[a]

	Concentration (µg/kg) by Sample Location					
Parameter	FTBOR1 (0–2 ft)	FTBOR1 (2–4 ft)	FTBOR1 (4–6 ft)	FTBOR1 (6–8 ft)	FTBOR1 (8–10 ft)	FTBOR1 (10–12 ft)
Acetone	<12	<11	<12	<12	<14	<12
Carbon disulfide	<12	<11	<12	<12	<14	<12
Chloroform	<12	<11	<12	<12	<14	<12
trans-1,2-Dichloroethene	<12	<11	<12	<12	<14	<12
Methylene chloride	<12	<11	<12	<12	<14	<12
1,1,2,2-Tetrachloroethane	<12	<11	<12	<12	<14	<12
Tetrachloroethene	<12	<11	<12	<12	<14	<12
Toluene	<12	<11	<12	<12	<14	<12
1,1,2-Trichloroethane	<12	<11	<12	<12	<14	<12
Trichloroethene	<12	<11	<12	<12	<14	<12
Xylenes	<12	<11	<12	<12	<14	<12

	Concentration (µg/kg) by Sample Location			
Parameter	JSDPC (4 ft)	JSDPC (6 ft)	JVXPC (4 ft)	JVXPC (6 ft)
Acetone	344	<13	<13	<14
Carbon disulfide	<33	<7	<7	<7
Chloroform	<33	<7	<7	6
trans-1,2-Dichloroethene	78	<7	<7	<7
Methylene chloride	44 B	12 B	7 B	8 B
1,1,2,2-Tetrachloroethane	15,200	26	167	39
Tetrachloroethene	27 J	<7	<7	<7
Toluene	<33	4 J	3	4
1,1,2-Trichloroethane	81	<7	<7	<7
Trichloroethene	345 D	3 J	3 J	16
Xylenes	<33	<7	<13	<7

[a] Notation: B = analyte also found in the associated blank; D = sample was diluted for analysis; J = estimated value.

TABLE A.1-41 Analytical Results for SVOCs in Soil Samples Collected from the Pushout Area in the TBP AOC: 1993[a]

Parameter	Concentration (µg/kg) by Sample Location FTBOR1 (0–2 ft)	FTBOR1 (2–4 ft)	FTBOR1 (4–6 ft)	FTBOR1 (6–8 ft)	FTBOR1 (8–10 ft)	FTBOR1 (10–12 ft)
Bis(2-ethylhexyl)phthalate	4,600 B	4,300 B	4,500 B	3,200 B	<460	3,200 B
Di-n-butylphthalate	170 J	140 J	130 J	120 J	200 JB	<410
Diethylphthalate	<390	<380	<390	<400	<460	<410
Fluoranthene	<390	<380	<390	<400	<460	<410
Hexachloroethane	<390	<380	<390	<400	<460	<410
2-Methylnaphthalene	<390	<380	<390	<400	<460	<410
Naphthalene	<390	<380	<390	<400	<460	<410
Phenanthrene	<390	<380	<390	<400	<460	<410
Pyrene	<390	<380	<390	<400	<460	<410

Parameter	Concentration (µg/kg) by Sample Location JSDPC (4 ft)	JSDPC (6 ft)	JVXPC (4 ft)	JVXPC (6 ft)
Bis(2-ethylhexyl)phthalate	<442	<432	<435	<465
Di-n-butylphthalate	<442	<432	<435	<465
Diethylphthalate	<442	<432	<435	<465
Fluoranthene	<442	<432	<435	<465
Hexachloroethane	<442	<432	<435	<465
2-Methylnaphthalene	<442	<432	<435	<465
Naphthalene	<442	<432	<435	<465
Phenanthrene	<442	<432	<435	<465
Pyrene	<442	<432	<435	<465

[a] Notation: B = analyte also found in the associated blank; D = sample was diluted for analysis; J = estimated value.

Low levels of two SVOCs, bis(2-ethylhexyl)phthalate and di-n-butylphthalate, were present in soil samples from borings FTBOR1 and JVXPC (Table A.1-41). No metals were detected above the calculated background levels in any of the samples tested. Neither PCBs nor pesticides were found in samples from borings FTBOR1 and JVXPC.

A.1.2.4 Mustard Pit

A.1.2.4.1 Surface Soil. Five surface soil samples were collected at two locations (CLP6 and CLP7) near the Mustard Pit and in the Pushout Area (Figure A.1-5). The samples were analyzed for VOCs, SVOCs, metals, PAHs, TPH, PCBs, and TNT. The results are summarized in Table A.1-42.

TABLE A.1-42 Analytical Results for Various Parameters in Surface Soil Samples Collected near the Mustard Pit[a]

	Concentration by Sample Location				
Parameter	CLP6 (0–6 in.)	CLP6 (6–24 in.)	CLP7 (0–6 in.)	CLP7 (6–24 in.)	CLP7 (24–48 in.)
VOCs (µg/kg)					
Acetone	<13	20	<16	<13	<13
2-Butanone	<13	<13	<16	<13	<13
Carbon disulfide	<13	4 J	<16	<13	<13
Chlorobenzene	<13	<13	<16	<13	<13
1,2-Dichloropropane (total)	11 J	48	<16	<13	<13
1,1,2,2-Tetrachloroethane	<13	<13	<16	<13	<13
Tetrachloroethene	<13	<13	<16	<13	<13
Toluene	17	24	<16	<13	<13
1,1,2-Trichloroethane	<13	<13	<16	<13	<13
Trichloroethene	5 J	5 J	<16	<13	<13
SVOCs (µg/kg)					
Benzo[a]anthracene	<880	86 J	<510	<420	<420
Benzo[b]fluoranthene	<880	<420	<510	<420	<420
Bis(2-ethylhexyl)phthalate	180 JB	160 JB	170 JB	140 JB	85 JB
Chrysene	<880	97 J	<510	<420	<420
Di-n-butylphthalate	<880	170 JB	190 JB	94 JB	100 JB
1,2-Dichlorobenzene	<880	<420	<510	<420	<420
1,3-Dichlorobenzene	<880	<420	<510	<420	<420
Diethylphthalate	<880	<420	<510	<420	<420
2,4-Dimethylphenol	<880	<420	<510	<420	<420
Fluoranthene	<880	140 J	<510	<420	<420
Hexachlorobenzene	<880	75 J	<510	<420	<420
Hexachloroethane	<880	<420	<510	<420	<420
2-Methylnaphthalene	<880	120 J	<510	<420	<420
2-Methylphenol	<880	80 J	<510	<420	<420
4-Methylphenol	<880	92 J	<510	<420	<420
Naphthalene	<880	67 J	<510	<420	<420
2-Nitrophenol	<880	<420	<510	<420	<420
n-Nitrosodiphenylamine	<880	<420	<510	<420	<420
Phenanthrene	<880	74 J	<510	<420	<420
Phenol	<880	<420	<510	<420	<420
Pyrene	<880	180 J	<510	<420	<420
1,2,4-Trichlorobenzene	<880	46 J	<510	<420	<420

TABLE A.1-42 (Cont.)

Parameter	CLP6 (0–6 in.)	CLP6 (6–24 in.)	CLP7 (0–6 in.)	CLP7 (6–24 in.)	CLP7 (24–48 in.)	Back-ground[b]
	Concentration by Sample Location					
Metals (mg/kg)						
Antimony	***21***	***39***	***6.3***	***5.3***	***5.2***	3.8
Arsenic	***39***	***23***	***12***	4.5	***6.2***	5.0
Beryllium	0.54	0.42	0.98	0.55	0.52	1.0
Cadmium	***2.5***	***6.2***	***1.4***	***0.90***	<0.67	0.70
Copper	***439***	***559***	***62***	***29***	***26***	20
Lead	***2,440***	***5,340***	***163***	***135***	***107***	61
Zinc	***3,720***	***4,450***	***176***	92	103	118
Polynuclear aromatic hydrocarbons	<1	1-10	<1	<1	<1	–
Total petroleum hydrocarbons	<10	10-100	<10	<10	<10	–

[a] Sampled by Argonne and analyzed by Weston (1994) (Contract Laboratory Program/Hazardous Substance List semivolatile organics). Inorganics from the CLP sample series analyzed with CLP methods. Notation: B = analyte also found in the associated blank; J = estimated value; a hyphen indicates not applicable. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

The five surface soil samples showed the same metal contaminants (antimony, arsenic cadmium, copper, lead, and zinc) as samples from the Pushout Area. Samples from the eastern end of the Mustard Pit (CLP6) had significantly higher levels of metals than samples from CLP7. For example, sample CLP6 (0–6 in.) contained 2,440 mg/kg of lead, while CLP7 (0–6 in.) contained only 163 mg/kg of lead. Sample CLP6 (6–24 in.) also showed low levels of VOCs, SVOCs, PAHs, and TPH. These contaminants were either not detected or detected in both blanks and samples from CLP7. PCBs and TNT were not detected in either sample.

A.1.2.4.2 Subsurface Soil. In 1994–1995, three borings (HBOR1, HBOR2 and HBOR4) were drilled to verify and delineate the Mustard Pit (Figure A.1-6) HBOR3 was a blind duplicate sample. To avoid potential unexploded ordnance, the borings could not be drilled at locations where major disposal activities had previously occurred (on the basis of aerial photographs). Instead, the borings were located either downgradient of the target area in the pit or next to the pit. Soil samples from borings HBOR1 and HBOR2 were analyzed for VOCs, SVOCs, metals, TPH, PAHs, and PCBs. Samples from boring HBOR4 were analyzed for VOCs, metals, CSM/CSM degradation products, and cyanide. Table A.1-43 presents the analytical matrix; sample depths are also given.

TABLE A.1-43 Analytical Matrix of Soil Boring Samples Collected from the Mustard Pit[a]

Sample Location	Depth (ft)	VOCs	SVOCs	Metals	PCBs	Others
		Chemical Constituents Analyzed				
HBOR1	0-2	X	X	X	X	PAHs, TPH
	2-4	X	X	X	X	PAHs, TPH
	4-6	X	X	X	X	PAHs, TPH
	6-8	X	X	X		PAHs, TPH
	8-10	X	X	X		TPH
HBOR2	0-2	X	X	X	X	PAHs, TPH
	2-4	X	X	X		
	4-6	X	X	X	X	PAHs, TPH
	6-8	X	X	X		
	8-10	X	X	X		
HBOR4	0-2			X		Cyanide
	4-6	X				
	6-8	X				CSM
	8-10	X				CSM
	10-12					CSM
	12-14					
	14-16	X				CSM

[a] X = analyzed; blank = not analyzed; PAH = polynuclear aromatic hydrocarbon; TPH = total petroleum hydrocarbons; CSM = chemical surety material/CSM degradation products. Pesticides and dioxins/furans were not analyzed.

Samples from the Mustard Pit had low levels of VOCs in the upper and the lower parts of the borings but not in the middle (Table A.1-44). For example, the highest levels of 111TCE, TCLEA, and TRCLE in the HBOR1 boring were detected at 0–2 ft, 6–8 ft, and 8–10 ft intervals, respectively. Trace levels of TCLEA and TRCLE were also detected at a depth of 8–10 ft in boring HBOR2. In boring HBOR4, TRCLE (57 µg/kg), TCLEA (480 µg/kg), 12DCE (450 µg/kg), TCLEE (32 µg/kg), and TRCLE (450 µg/kg) were detected at a depth of 14–16 ft, but not in the shallower samples. Moderate levels of acetone (2,100 and 780 µg/kg) were detected in samples from boring HBOR4 at depths of 8–10 and 14–16 ft. Acetone and methylene chloride, which are common laboratory contaminants, were also detected in other soil samples from boring HBOR4 as well as in blank samples.

TABLE A.1-44 Analytical Results for VOCs in Subsurface Soil Samples Collected from the Mustard Pit in the TBP AOC: 1993[a]

	Concentration (µg/kg) by Sample Location						
Parameter	HBOR1 (0–2 ft)	HBOR1 (2–4 ft)	HBOR1 (4–6 ft)	HBOR1 (6–8 ft)	HBOR1 (8–10 ft)	HBOR2 (0–2 ft)	HBOR2 (2–4 ft)
Acetone	<13	15 B	<120	<58	14 B	<12	<12
Carbon disulfide	<13	<12	<120	<58	<12	<12	<12
Chlorobenzene	<13	5 J	<120	<58	<12	<12	<12
Chloroform	<13	<12	<120	<58	<12	<12	<12
1,2-Dichloroethene	120	17	<120	<58	<12	<12	<12
Methylene chloride	<13	<12	<120	<58	<12	<12	<12
1,1,2,2-Tetrachloroethane	<13	44	<120	17 J	96	<12	<12
Tetrachloroethene	<13	<12	<120	<58	<12	<12	<12
1,1,1-Trichloroethane	18	<12	<120	60	22	<12	<12
1,1,2-Trichloroethane	<13	<12	<120	<58	<12	<12	<12
Trichloroethene	130	9 J	<120	<58	30	3 J	<12
Xylene	<13	<12	<120	<58	<12	<12	<12

TABLE A.1-44 (Cont.)

Parameter	Concentration (µg/kg) by Sample Location HBOR2 (4–6 ft)	HBOR2 (6–8 ft)	HBOR2 (8–10 ft)	HBOR4 (4–6 ft)	HBOR4 (6–8 ft)	HBOR4 (8–10 ft)	HBOR4 (14–16 ft)
Acetone	<12	16 B	26 B	1500 JD	27	2,100	250 D
Carbon disulfide	<12	<12	<12	<12	<12	<57	2.8 J
Chlorobenzene	<12	<12	<12	<12	<12	<57	<12
Chloroform	<12	<12	<12	<12	<12	<57	<12
1,2-Dichloroethene	<12	<12	<12	<12	<12	<57	1,200 D
Methylene chloride	<12	<12	<12	40 J	4 BJ	38 J	8 J
1,1,2,2-Tetrachloroethane	<12	<12	5 J	<12	<12	<57	520 JD
Tetrachloroethene	<12	<12	<12	<12	<12	<57	32
1,1,1-Trichloroethane	<12	<12	<12	<12	<12	<57	<12
1,1,2-Trichloroethane	<12	<12	<12	<12	<12	<57	57
Trichloroethene	<12	<12	5 J	<12	<12	<57	1,100 D
Xylene	<12	<12	<12	<12	<12	<57	<12

[a] Notation: J = estimated value; B = analyte also found in the associated blank; D = sample was diluted for analysis.

Low levels of a few SVOCs were detected in the surface soil (0–2 ft) in borings HBOR1 and HBOR2 (Table A.1-45). No SVOCs were detected at a depth of more than 2 ft in HBOR1 or HBOR2.

Surface soil collected from HBOR1 at a depth of 0–2 ft had levels of antimony, arsenic, cadmium, copper, lead, and zinc higher than the calculated backgrounds (Table A.1-46). The samples collected from HBOR2 at depths of 0–2 and 2–4 ft also had elevated levels of arsenic, copper, lead, and zinc. The metal contamination in HBOR2 did not extend beyond a depth of 4 ft. Lead was the only metal in HBOR4 that exceeded the calculated background.

Samples from HBOR1 and HBOR2 were analyzed for TPH, PAHs, PCB, and TNT (Table A.1-47). Samples from HBOR1 from depths of 0–2 and 8–10 ft had TPH levels between 10 and 100 mg/kg.

Low levels of two CSM degradation products (diisopropylmethyl phosphonate and 1,4-dithiane) were detected in soil samples from boring HBOR4 at depths of 6–8, 8–10, and 10–12 ft. No cyanide was detected in soil from boring HBOR4, the only one tested for cyanide.

A.1.2.5 High Explosives Demolition Ground

A.1.2.5.1 Surface Soil. Surface soil samples were collected from two locations (TPDGS4 and TPDGS5) in the HE Demolition Ground (Figure A.1-5). The samples were analyzed for metals, explosives, and cyanide. Only cadmium was found at a level exceeding the calculated background. These analytical results are consistent with the XRF measurements discussed in Section A.1.1.2. Nitroglycerin, an explosive compound, was also detected in sample TPDGS4. No cyanide was detected in either of the samples.

A.1.2.5.2 Subsurface Soil. No soil borings were drilled in the HE Demolition Ground.

A.1.2.6 Square Pit and Southwestern Suspect Burning Area

A.1.2.6.1 Surface Soil. In 1995, nine surface soil samples (SQPS1–9) were collected from the Square Pit and the Southwestern Suspect Burning Area south of the pit (Figure A.1-5). All samples were analyzed for cyanide and metals. Samples SQPS4, SQPS5, SQPS8, and SQPS9 were also analyzed for explosives-related compounds. Samples SQPS8 (from a soil mound where XRF measurements showed anomalously high metals) and SQPS5 were also analyzed for VOCs and

TABLE A.1-45 Analytical Results for SVOCs in Soil Samples Collected from the Mustard Pit in the TBP AOC: 1993[a]

	Concentration (µg/kg) by Sample Location				
Parameter	HBOR1 (0–2 ft)	HBOR1 (2–4 ft)	HBOR1 (4–6 ft)	HBOR1 (6–8 ft)	HBOR1 (8–10 ft)
Anthracene	<430	<400	<400	<390	<380
Benzo[a]anthracene	310 J	<400	<400	<390	<380
Benzo[b]fluoranthene	660	<400	<400	<390	<380
Benzo[k]fluoranthene	120 J	<400	<400	<390	<380
Benzo[g,h,i]perylene	110 J	<400	<400	<390	<380
Benzo[a]pyrene	400 J	<400	<400	<390	<380
Bis(2-ethylhexyl)phthalate	<430	<400	42 J	950	42 J
Butylbenzylphthalate	<430	49 J	46 J	54 J	46 J
Chrysene	390 J	<400	<400	<390	<380
Dibenzo[a,h]anthracene	55 J	<400	<400	<390	<380
Di-n-butylphthalate	290 JB	260 JB	270 JB	210 JB	210 JB
Di-n-octylphthalate	<430	<400	<400	190 JB	<380
Fluoranthene	260 J	<400	<400	<390	<380
Fluorene	<430	<400	<400	<390	<380
Hexachlorobutadiene	<430	58 J	<400	<390	<380
Indeno[1,2,3-c,d]pyrene	120 J	<400	<400	<390	<380
Phenanthrene	73 J	<400	<400	<390	<380
Pyrene	200 J	<400	<400	<390	<380

	Concentration (µg/kg) by Sample Location				
Parameter	HBOR2 (0–2 ft)	HBOR2 (2–4 ft)	HBOR2 (4–6 ft)	HBOR2 (6–8 ft)	HBOR2 (8–10 ft)
Anthracene	<390	<390	<390	<400	<420
Benzo[a]anthracene	<390	<390	<390	<400	<420
Benzo[b]fluoranthene	50 J	<390	<390	<400	<420
Benzo[k]fluoranthene	<390	<390	<390	<400	<420
Benzo[g,h,i]perylene	<390	<390	<390	<400	<420
Benzo[a]pyrene	<390	<390	<390	<400	<420
Bis(2-ethylhexyl)phthalate	39 J	200 J	41 J	<400	<420
Butylbenzylphthalate	<390	<390	<390	<400	<420
Chrysene	<390	<390	<390	<400	<420

TABLE A.1-45 (Cont.)

	Concentration (µg/kg) by Sample Location				
Parameter	HBOR2 (0–2 ft)	HBOR2 (2–4 ft)	HBOR2 (4–6 ft)	HBOR2 (6–8 ft)	HBOR2 (8–10 ft)
Dibenzo[a,h]anthracene	<390	<390	<390	<400	<420
Di-n-butylphthalate	210 JB	270 JB	190 JB	180 JB	190 J
Di-n-octylphthalate	<390	<390	<390	<400	<420
Fluoranthene	62 J	<390	<390	<400	<420
Fluorene	<390	<390	<390	<400	<420
Hexachlorobutadiene	<390	<390	<390	<400	<420
Indeno[1,2,3-c,d]pyrene	<390	<390	<390	<400	<420
Phenanthrene	<390	<390	<390	<400	<420
Pyrene	55 J	75 J	<390	<400	<420

[a] Notation: ND = not detected; B = analyte also found in the associated blank; J = estimated value.

SVOCs. Table A.1-48 summarizes the results. None of the samples contained cyanide or explosives-related compounds. Arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc were common metal contaminants. Only low levels of VOCs and SVOCs were detected in Samples SQPS5 and SQPS8.

A.1.2.6.2 Subsurface Soil. No soil borings were drilled in the area.

A.1.2.7 Storage Area

A.1.2.7.1 Surface Soil. In 1995, a soil boring was drilled inside the fenced Storage Area. Two soil samples taken at depths of 2–4 and 6–8 ft were analyzed for VOCs to test for any potential spills. Only trace amounts of TCLEA (3 µg/kg) were found in the deeper sample. Low levels of two other VOCs, methylene chloride and acetone, were also found in the samples. Since both chemicals are common laboratory contaminants, their detection is not considered significant. Therefore, the Storage Area is not considered a contaminant source.

A.1.2.7.2 Subsurface Soil. No surface soil samples were collected in this area.

TABLE A.1-46 Analytical Results for Selected Metals in Soil Samples Collected from the Mustard Pit Area in the TBP AOC[a]

	Concentration (mg/kg) by Sample Location				
Parameter	HBOR1 (0–2 ft)	HBOR1 (2–4 ft)	HBOR1 (4–6 ft)	HBOR1 (6–8 ft)	HBOR1 (8–10 ft)
Antimony	***22***	<5.7	<5.7	<4.5	<5.3
Arsenic	***16***	4.6	2.7	1.8	1.7
Beryllium	***0.75***	0.45	0.45	0.35	0.33
Cadmium	1.7	0.57	<0.53	<0.42	<0.50
Copper	***204***	16	14	6.1	4.3
Lead	***4,960***	***165***	***110***	21	14
Zinc	***896***	82	59	24	19

	Concentration (mg/kg) by Sample Location						
Parameter	HBOR2 (0–2 ft)	HBOR2 (2–4 ft)	HBOR2 (4–6 ft)	HBOR2 (6–8 ft)	HBO2 (8–10 ft)	HBOR4 (0–2 ft)	Background (mg/kg)
Antimony	<5.5	<5.5	<5.5	<5.2	<6.0	<0.20	3.8
Arsenic	***8.3***	***12***	***5.4***	1.8	2.0	3.5	5.0
Beryllium	0.59	0.57	0.52	0.37	0.45	0.30	1.0
Cadmium	0.64	0.66	<0.52	<0.49	<0.57	<0.46	0.70
Copper	***55***	***86***	17	8.1	3.7	11	21
Lead	***859***	***256***	43	12	6.5	***131***	61
Zinc	***287***	***185***	58	29	16	50	118

[a] Only detected analytes are reported; for samples with duplicate analyses, the higher value is reported.

TABLE A.1-47 Analytical Results for PAHs, TPH, and PCBs in Soil Samples Collected from the Mustard Pit in the TBP AOC[a]

Sample Number (Depth Interval)	Average Depth (ft)	Concentration (mg/kg)		
		PAH	TPH	PCB
HBOR1 (0–2 ft)	1	1 U	100 U 10	10 U 1
HBOR1 (2–4 ft)	3	1 U	10 U	1 U
HBOR1 (4–6 ft)	5	1 U	10 U	10 U 1
HBOR1 (6–8 ft)	7	1 U	10 U	–
HBOR1 (8–10 ft)	9	–	100 U 10	–
HBOR2 (0–2 ft)	1	1 U	10 U	1 U
HBOR2 (4–6 ft)	5	1 U	10 U	1 U

[a] Sampled and analyzed on-site by Argonne. Notation: U = < value given; 100 U 10 = < 100 mg/kg but > 10 mg/kg; 10 U 1 = < 10 mg/kg but > 1 mg/kg.

A.1.2.8 Northwest Area

A.1.2.8.1 Surface Soil. In the Northwest Area, 22 surface soil samples were collected from depths of 0–6 in. (A samples) and 6–12 in. (B samples) at 11 locations (OT6–OT15, OT20) to the north and northwest of the Main Burning Pits (Figure A.1-5). The samples were analyzed for VOCs, SVOCs, and metals; Tables A.1-49 (VOCs) and A.1-50 (metals) summarize the results. Field tests were performed for TPH, PAHs, PCBs, and TNT on sample OT15B.

The only VOCs detected were 1,1-dichloroethene and methylene chloride (Table A.1-49). Trace amounts of 2,4,6-trichloroaniline, an SVOC, were detected in OT11A and OT15A.

Elevated levels of arsenic, copper, lead, and zinc were found in some samples (Table A.1-50).

Sample OT15B showed concentrations of both PAH and TPH to be between 10 and 100 mg/kg. No PCBs or TNT were detected.

A.1.2.8.2 Subsurface Soil. No soil borings were drilled in the area.

TABLE A.1-48 Analytical Results for Various Parameters in Surface Soil Samples Collected from the Square Pit Area[a]

	Concentration by Sample Location									
Parameter	SQPS1	SQPS2	SQPS3	SQPS4	SQPS5	SQPS6	SQPS7	SQPS8	SQPS9	Background[b]
VOCs (μg/kg)										
Acetone	NT	NT	NT	NT	3	NT	NT	13	NT	–
Carbon disulfide	NT	NT	NT	NT	<12	NT	NT	38	NT	–
Methyl chloride	NT	NT	NT	NT	6	NT	NT	11	NT	–
SVOCs (μg/kg)										
Benzo(k)fluoranthene	<412	NT	NT	NT	42	NT	NT	<686	NT	–
Metals (mg/kg)										
Antimony	<0.21	0.56	1.0	0.60	0.94	0.45	0.24	2.7	2.7	3.8
Arsenic	<0.22	3.0	5.0	3.6	3.0	3.0	3.8	***21***	***61***	5.0
Barium	***95***	***183***	***323***	***148***	***124***	***166***	***142***	***261***	***286***	94
Beryllium	***1.4***	0.42	0.54	0.41	0.30	0.52	0.53	0.30	0.31	1.0
Cadmium	***1.8***	***1.4***	***2.0***	***2.1***	***1.2***	***1.4***	***1.8***	***21***	***19***	0.70
Chromium	34	***67***	***85***	***71***	***92***	39	26	***42***	***43***	***41***
Copper	***98***	***216***	***267***	***215***	***355***	***120***	***65***	***561***	***758***	20
Lead	***229***	***66***	***92***	***95***	***70***	***70***	***64***	***165***	***289***	61
Mercury	***0.086***	***0.12***	***0.16***	***0.17***	***0.24***	***0.10***	***0.09***	***0.24***	***0.25***	0.080
Selenium	<0.20	***0.73***	***0.44***	<0.23	0.26	***0.46***	***0.47***	***0.71***	***0.48***	0.43
Silver	***2.2***	***4.0***	***3.2***	***3.3***	***4.2***	***1.9***	***1.8***	***5.6***	***15***	0.39
Zinc	79	***233***	***603***	***542***	***148***	***353***	***420***	***7,970***	***5,340***	118

[a] Notation: A hyphen denotes that this is not a natural constituent of soil and was not detected in the background sample; NT = not tested. Sample concentrations equal to or exceeding background are presented in bold italics.

[b] Background values were derived from freshwater pond data in ICF Kaiser Engineers (1995.)

TABLE A.1-49 Analytical Results for Selected VOCs in Surface Soil Samples Collected from the Northwest Area in the TBP AOC

	Concentration (µg/kg) by Sample Location					
Parameter	OT6A (0–6 in.)	OT6B (6–12 in.)	OT7A (0–6 in.)	OT7B (6–12 in.)	OT8A (0–6 in.)	OT8B (6–12 in.)
Benzene	<20	<20	<20	<20	<20	<20
Chlorobenzene	<20	<20	<20	<20	<20	<20
1,1-Dichloroethene	<20	<20	50	<20	<20	<20
1,2-Dichloroethene	<20	<20	<20	<20	<20	<20
Methylene chloride	<20	50	50	50	<20	<20
1,1,2,2-Tetrachloroethane	<20	<20	<20	<20	<20	<20
Tetrachloroethene	<20	<20	<20	<20	<20	<20
Toluene	<20	<20	<20	<20	<20	<20
Trichloroethene	<20	<20	<20	<20	<20	<20

	Concentration (µg/kg) by Sample Location				
Parameter	OT9A (0–6 in.)	OT9B (6–12 in.)	OT10A (0–6 in.)	OT11A (0–6 in.)	OT11B (6–12 in.)
Benzene	<20	<20	<20	<20	<20
Chlorobenzene	<20	<20	<20	<20	<20
1,1-Dichloroethene	<20	<20	50	<20	<20
1,2-Dichloroethene	<20	<20	<20	<20	<20
Methylene chloride	<20	<20	50	<20	<20
1,1,2,2-Tetrachloroethane	<20	<20	<20	<20	<20
Tetrachloroethene	<20	<20	<20	<20	<20
Toluene	<20	<20	<20	<20	<20
Trichloroethene	<20	<20	<20	<20	<20

TABLE A.1-49 (Cont.)

Parameter	Concentration (μg/mg) by Sample Location OT12A (0–6 in.)	OT12B (6–12 in.)	OT13A (0–6 in.)	OT13B (6–12 in.)	OT14A (0–6 in.)	OT14B (6–12 in.)
Benzene	<20	<20	<20	<20	<20	<20
Chlorobenzene	<20	<20	<20	<20	<20	<20
1,1-Dichloroethene	<20	<20	50	<20	<20	<20
1,2-Dichloroethene	<20	<20	<20	<20	<20	<20
Methylene chloride	<20	<20	50	50	<20	50
1,1,2,2-Tetrachloroethane	<20	<20	<20	<20	<20	<20
Tetrachloroethene	<20	<20	<20	<20	<20	<20
Toluene	<20	<20	<20	<20	<20	<20
Trichloroethene	<20	<20	<20	<20	<20	<20

Parameter	Concentration (μg/kg) by Sample Location OT15A (0–6 in.)	OT15B (6–12 in.)	OT20A (0–6 in.)	OT20B (6–12 in.)
Benzene	<20	<20	<20	<20
Chlorobenzene	<20	<20	<20	<20
1,1-Dichloroethene	<20	<20	50	<20
1,2-Dichloroethene	<20	<20	<20	<20
Methylene chloride	<20	50	50	50
1,1,2,2-Tetrachloroethane	<20	<20	<20	<20
Tetrachloroethene	<20	<20	<20	<20
Toluene	<20	<20	<20	<20
Trichloroethene	<20	<20	<20	<20

TABLE A.1-50 Analytical Results for Selected Metals in Surface Soil Samples Collected from the Northwest Area in the TBP AOC[a]

Parameter	Concentration (mg/kg) by Sample Location								
	OT6A (0–6 in.)	OT6B (6–12 in.)	OT7A (0–6 in.)	OT7B (6–12 in.)	OT8A (0–6 in.)	OT9A (0–6 in.)	OT10A (0–6 in.)	1.OT10B (6–12 in.)	OT11A (0–6 in.)
Antimony	NT	NT	NT	NT	NT	NT	NT	NT	NT
Arsenic	<10	<10	<10	***11***	<10	<10	<10	<10	***11***
Beryllium	NT	NT	NT	NT	NT	NT	NT	NT	NT
Cadmium	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chromium	12	30	26	17	32	26	26	30	22
Copper	14	***39***	***36***	<10	***27***	***58***	***70***	***20***	***40***
Lead	21	35	21	14	14	38	***201***	<10	36
Zinc	33	55	49	36	41	***146***	100	40	65

Parameter	Concentration (mg/kg) by Sample Location									Background (mg/kg)[b]
	OT12A (0–6 in.)	OT13A (0–6 in.)	OT13B (6–12 in.)	OT14A (0–6 in.)	OT14B (6–12 in.)	OT15A (0–6 in.)	OT15B (6–12 in.)	OT20A (0–6 in.)	OT20B (6–12)	
Antimony	NT	NT	NT	NT	NT	NT	NT	NT	NT	3.8
Arsenic	<10	<10	***11***	<10	<10	<10	<10	***11***	<10	5.0
Beryllium	NT	NT	NT	NT	NT	NT	NT	NT	NT	1.0
Cadmium	<10	<10	<10	<10	<10	<10	<10	<10	<10	0.70
Chromium	28	19	15	23	27	24	32	29	26	41
Copper	19	***22***	<10	***46***	10	***81***	***97***	***36***	<10	20
Lead	30	20	11	35	<10	***69***	***85***	19	<10	61
Zinc	67	47	22	79	23	***216***	***212***	52	35	118

[a] Inorganics from the OT sample series were analyzed with laboratory x-ray fluorescence. Notation: NT = not tested. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

A.1.3 Groundwater Analyses

A total of 44 monitoring wells (including wells, piezometers, and lysimeters) have been installed in the TBP AOC (Figure A.1-8). Table A.1-51 provides the dates of installation and construction details for these wells. The oldest wells at J-Field are the TH-series, installed during the 1977 environmental survey (Sonntag 1991). These wells were completed in the surficial aquifer. The only TH well in the TBP AOC, well TH4, was recently abandoned by the U.S. Army Corps of Engineers.

The P-series wells were installed in 1983 as part of a munitions disposal study (Princeton Aqua Science 1984). Additional wells (JF-series) were installed in 1988–1989 by the USGS (Sonntag 1991; Hughes 1993). These wells were completed in clusters of three so that each of the three hydrologic units (the surficial aquifer, confining unit, and confined aquifer) could be monitored. For these wells, a suffix of “3" indicates the well is completed in the surficial aquifer, “2" indicates the confining unit, and “1" indicates the confined aquifer.

Several new wells were installed during the RI and preliminary remediation studies at the TBP AOC. Wells 173 and 183 were completed in 1994 in the surficial aquifer to help further define the extent of the contamination plume in the surficial aquifer downgradient of the Main Pits. Wells JF201 and JF203 were also installed in 1994; JF203 was intended to monitor the area formerly monitored by well TH4. Piezometers JFPM1–5 were installed by the USGS in the marsh adjacent to the TBP AOC. In addition, well series JFP1–5 and JFL1–5 were completed in the surficial aquifer by the EPA ERT to monitor the efficacy of recent remedial activities (Weston 1997).

Several investigations have provided data on groundwater contamination at J-Field. For example, in 1977 well TH4 was sampled and found to contain organic contamination (Sonntag 1991). The P-series wells were sampled in 1983; well P4 was found to contain elevated gross beta concentrations (140 pCi/L). The most systematic data collection efforts at J-Field, however, began in 1986 with the RFA conducted by the USAEHA (Nemeth 1989). The data collected during that investigation are summarized first in the following paragraphs, followed by a discussion of the USGS investigation and then the results of the RI.

The P-series wells (P1–P4 and P9) were sampled in 1986 as part of the Edgewood Area RFA (Nemeth 1989). The samples were analyzed for VOCs, SVOCs, metals, explosives-related compounds, inorganic compounds, radioactivity, thiodiglycol (an organosulfur compound), and PCBs. Table A.1-52 summarizes the results. Elevated VOCs were found in wells P3 and P4; the highest concentrations of trans-12DCE and TRCLE were in well P4, located immediately downgradient of the Northern Main Pit. Gross beta activity (100 pCi/g) was higher in well P3 than in other wells because of elevated potassium-40 (120 pCi/g). The units are reported in activity per gram since gross alpha and beta measurements are made on total solids present in the water. Although groundwater from P4 sampled in 1984 had elevated gross beta activity (140 pCi/g), in

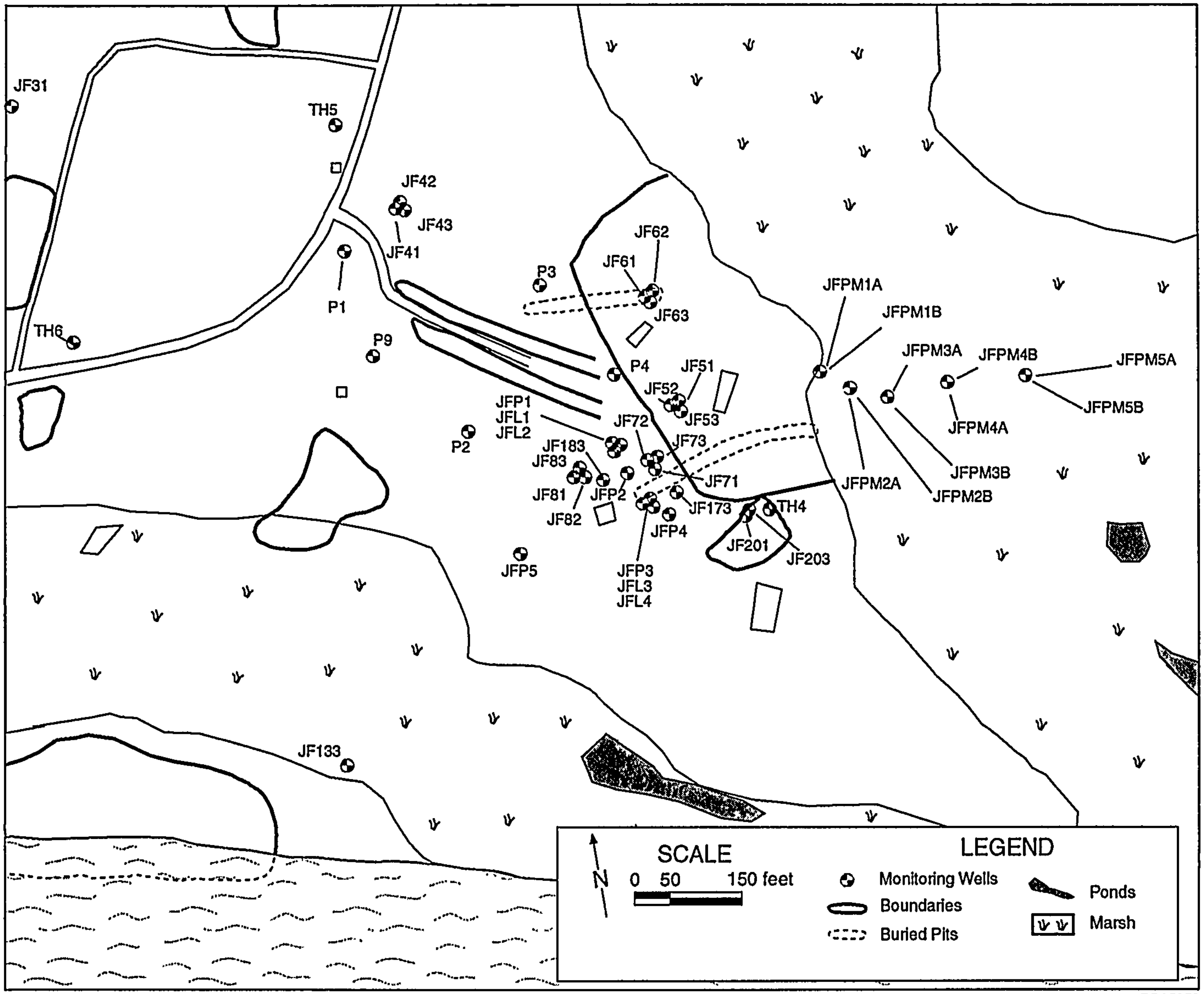

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FIGURE A.1-8 Locations of Monitoring Wells in the TBP AOC

TABLE A.1-51 Well Construction Data for Monitoring Wells at the TBP AOC

Well Number	Elevation of Land Surface (ft MSL)	Depth of Boring (ft)	Screened Interval (ft below surface)	Date Installed (Investigator)
P1	11.8	20	5–20	1983 (Princeton Aqua Science)
P2	8.4	20	5–20	1983 (Princeton Aqua Science)
P3	7.8	20	5–20	1983 (Princeton Aqua Science)
P4	7.5	17	2–17	1983 (Princeton Aqua Science)
P9	8.2	17	2–17	1983 (Princeton Aqua Science)
TH4	5.2	18	8–18	1977 (USATHAMA)
JF41	10.4	90	85–90	1987 (USGS)
JF42	10.4	62	57–62	1987 (USGS)
JF43	10.0	35	30–35	1987 (USGS)
JF51	5.7	115v	110–115	1987 (USGS)
JF52	5.2	65	60–65	1987 (USGS)
JF53	5.3	19	14–19	1987 (USGS)
JF61	4.3	100	95–100	1987 (USGS)
JF62	4.3	65	60–65	1987 (USGS)
JF63	4.2	19	16–19	1987 (USGS)
JF71	8.6	125	120–125	1987 (USGS)
JF72	7.4	81	76–81	1987 (USGS)
JF73	7.5	18	15–18	1987 (USGS)
JF81	10.1	123	120–123	1987 (USGS)
JF82	10.5	75	70–75	1987 (USGS)
JF83	10.5	20	15–20	1987 (USGS)
JF173	6.5	30.6	21.4–30.6	1994 (ANL)
JF183	10.5	39	13–39	1994 (ANL)
JF201	6.5	164	154–164	1995 (ANL)
JF203	6.2	23	13–23	1995 (ANL)
JFPM1-A	3.2	10.5	9–10.5	1994 (USGS)
JFPM1-B	3.2	6.5	5–6.5	1994 (USGS)
JFPM2-A	3.0	14.5	13–14.5	1994 (USGS)
JFPM2-B	3.0	8.5	7–8.5	1994 (USGS)
JFPM3-A	3.0	15.5	14–15.5	1994 (USGS)
JFPM3-B	3.0	10.5	9–10.5	1994 (USGS)
JFPM4-A	2.7	17.5	16–17.5	1987 (USGS)
JFPM4-B	2.7	10.5	9–10.5	1987 (USGS)
JFPM5-A	2.1	19.5	18–19.5	1987 (USGS)
JFPM-B	2.1	10.5	9–10.5	1987 (USGS)
JFP1	9.3	13.6	3.6–13.6	1996 (EPA ERT)
JFP2	8.7	13.5	3.5–13.5	1996 (EPA ERT)
JFP3	7.9	12.6	2.6–12.6	1996 (EPA ERT)
JFP4	8.3	13.5	3.5–13.5	1996 (EPA ERT)
JFP5	6.1	13.8	3.8–13.8	1996 (EPA ERT)
JFL1	NA[a]	4	3.5–4	1996 (EPA ERT)
JFL2	NA	7.5	7–7.5	1996 (EPA ERT)
JFL3	NA	4	3.5–4	1996 (EPA ERT)
JFL4	NA	7.5	7–7.5	1996 (EPA ERT)

[a] NA = not available.

TABLE A.1-52 Analytical Results for Groundwater Samples Collected from the P-Series Monitoring Wells in the TBP AOC: 1986[a]

	Concentration by Well Number				
Parameter[b]	P1	P2	P3	P4	P9
Dissolved metals (μg/L)					
Arsenic	<10	<10	24	<10	<10
Cadmium	<1	<1	<1	3	<1
Lead	<5	<5	<5	90	<5
Potassium	1,040	733	113,000	1,380	782
Selenium	<5	9	54	26	<5
Inorganic compounds (μg/L)					
Chloride	4,800	23,000	304,000	866,000	24,000
Nitrate/nitrite as N	490	12,000	<50	<50	8,000
Sulfate	54,000	105,000	362,000	93,000	94,000
Total phosphate as P	NT	NT	NT	NT	NT
Total dissolved solids	125,000	328,000	1,403,000	1,087,000	262,000
Radioactivity (pCi/L)					
Gross beta	1.3	2.5	100	<4.8	1.4
Potassium-40	NT	NT	120	NT	NT
Radium-226	NT	NT	0.43	NT	NT
VOCs (μg/L)					
Benzene	ND	ND	6	ND	ND
Carbon tetrachloride	ND	5	ND	ND	ND
Chlorobenzene	ND	ND	980	ND	ND
Chloroform	ND	ND	7	3	ND
trans-1,2-Dichloroethene	ND	ND	2,220	8,500	ND
Ethyl benzene	ND	ND	3	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	200	5
Tetrachloroethene	ND	ND	420	ND	ND
Toluene	ND	ND	5	ND	ND
1,1,2-Trichloroethane	ND	ND	7	130	ND
Trichloroethene	ND	ND	980	6,700	5
Vinyl chloride	ND	ND	550	48	ND

[a] Notation: NT = not tested; ND = not detected, detection limits unavailable.

[b] Includes all parameters that were detected at least once. Metals analyzed but not detected: barium (<300 μg/L), chromium (<10 μg/L), mercury (<0.2 μg/L), and silver (<25 μg/L).

Source: Nemeth (1989).

1986, the level had dropped to <4.8 pCi/g. SVOCs, explosives-related compounds, and PCBs were not detected.

In 1990, the USGS sampled existing wells and five new well clusters (JF4–8) in the TBP AOC (Sonntag 1991; Hughes 1993). The samples were analyzed for VOCs, SVOCs, organosulfur and explosives-related compounds, water quality parameters, metals, and radioactivity. Tables A.1-53 through A.1-56 summarize the results. The results show that in the surficial aquifer, a plume of VOC contamination extends downgradient from the Main Pits to the southeast. This situation is reflected in the elevated levels of 112TCE, 12DCE, TCLEA, TCLEE, and TRCLE in wells JF53, JFF73, and JF83 (Table A.1-53). The data also show that some contamination extends down into the leaky confining unit and confined aquifer (up to a depth of 123 ft), particularly at well JF8. Only groundwater from well JF63 contained known SVOCs: 2,4-dimethylphenol (4.3 μg/L). Unidentified SVOCs were detected in samples from JF42, JF53, JF61, JF63, JF73, JF81, JF82, and JF83. No SVOCs were found in samples from wells P3, TH4, JF41, and JF43.

Some organosulfur compounds (including mustard degradation products) were found in the surficial aquifer wells downgradient of the Main Pits (Table A.1-54). For example, sulfone was found in well JF83 at a concentration of 21 μg/L. In addition, 140 μg/L of diathiane was found in well P3, located immediately north of the western end of the Mustard Pit.

Results of analyses for water quality parameters and metals are presented in Table A.1-55. Concentrations of metals were below the detection limit in most wells; arsenic, nickel, and zinc were detectable in several wells in the surficial aquifer.

Uranium metal and radioactivity from thorium-230, cesium-137, and strontium-90 were measured in samples from selected wells. Of particular interest were the activity levels of cesium-137 (172 pCi/L) and strontium-90 (128 pCi/L), both beta emitters, in well JF81. The levels were an order of magnitude higher than those measured in other samples (Table A.1-56).

In 1992, the USGS sampled and analyzed groundwater at the TBP AOC for VOCs (Table A.1-57). These data indicated that VOCs are present in all three units (surficial aquifer, confining unit, and confined aquifer) below the TBP AOC. The highest concentrations were found in the surficial aquifer. The concentrations of several VOCs, including TRCLE, TCLEE, TCLEA, chloroform, 12DCE, and 112TCE, have increased significantly since 1990; 11DCE was not detected in any samples collected.

The highest VOC concentrations were found in well clusters JF5-8 in all three units; however, the greatest increases were detected in the surficial aquifer well JF83, to the south of the Main Burning Pits. From 1990 to 1992, TRCLE increased from 4,900 to 41,000 μg/L, TCLEE increased from 1,000 to 3,600 μg/L, TCLEA increased from 250 to 260,000 μg/L, and 12DCE

TABLE A.1-53 Analytical Results for Selected VOCs in Groundwater Samples Collected from the TBP AOC: 1990[a]

	Concentration (μg/L) by Well Number						
Parameter	P2	P3	P4	P5	P9	TH4	JF41
Acetone	ND	NT	NT	ND	ND	ND	NT
Benzene	ND	NT	NT	ND	ND	ND	NT
Carbon tetrachloride	2.2	NT	NT	ND	ND	ND	NT
Chlorobenzene	ND	NT	NT	ND	ND	ND	NT
1,1-Dichloroethene	ND	NT	NT	ND	ND	ND	NT
1,2-Dichloroethene (total)	10	NT	NT	ND	ND	ND	NT
1,1,2,2-Tertachloroethane	ND	NT	NT	ND	ND	ND	NT
Tetrachloroethene	101	NT	NT	ND	ND	ND	NT
1,1,2-Trichloroethane	4.0	NT	NT	ND	ND	ND	NT
Trichloroethene	440	NT	NT	ND	ND	ND	NT

	Concentration (μg/L) by Well Number						
Parameter	JF42	JF43	JF51	JF52	JF53	JF61	JF62
Acetone	ND	NT	128	ND	ND	146	ND
Benzene	ND	NT	ND	ND	ND	ND	ND
Carbon tetrachloride	ND	NT	ND	ND	ND	ND	ND
Chlorobenzene	ND	NT	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	NT	3.8	ND	8.0	ND	ND
1,2-Dichloroethene (total)	ND	NT	430	420	850	ND	ND
1,1,2,2-Tetrachloroethane	ND	NT	ND	ND	ND	ND	ND
Tetrachloroethene	ND	NT	ND	34	3,500	ND	ND
1,1,2-Trichloroethane	ND	NT	ND	10	110	ND	ND
Trichloroethene	ND	NT	520	52	820	1.8	2.7

	Concentration (μg/L) by Well Number						
Parameter	JF63	JF71	JF72	JF73	JF81	JF82	JF83
Acetone	ND	ND	140	ND	ND	111	ND
Benzene	ND	ND	ND	ND	ND	ND	4.9
Carbon tetrachloride	ND	ND	ND	6.8	ND	ND	11
Chlorobenzene	2.5	7.3	ND	ND	ND	ND	ND
1,1-Dichloroethene	7.3	ND	ND	7,150	ND	35	19
1,2-Dichloroethene (total)	ND	ND	33	ND	35	240	7,150
1,1,2,2-Tetrachloroethane	18	ND	ND	ND	ND	41	1,000
Tetrachloroethene	ND	ND	ND	340	290	ND	250
1,1,2-Trichloroethane	ND	ND	ND	67	7,100	ND	7,100
Trichloroethene	600	ND	4.5	1,800	230	1,200	4,900

[a] Notation: ND = not detected, detection limits unavailable; NT = not tested.

Source: USGS (1991).

TABLE A.1-54 Analytical Results for Organosulfur Compounds and Explosives-Related Compounds in Groundwater Samples Collected from the TBP AOC: 1990[a]

Parameter	Organosulfur Compound Concentration (µg/L) by Well Number																				
	P2	P3	P4	P5	P9	TH4	J41	JF42	JF43	JF51	JF52	JF53	JF61	JF62	JF63	JF71	JF72	JF73	JF81	JF82	JF83
4-Chlorophenyl-methsulfoxide	NT	ND	ND	NT	ND	ND	NT	NT	ND	ND	ND	ND	NT	NT	ND	NT	NT	ND	NT	NT	ND
Diathiane	NT	140	8.3	NT	ND	ND	NT	NT	ND	ND	ND	2.1	NT	NT	8.2	NT	NT	ND	NT	NT	ND
1,4-Oxithiane	NT	ND	ND	NT	ND	NT	NT	NT	ND	ND	ND	ND	NT	NT	8.2	NT	NT	ND	NT	NT	ND
Sulfone	NT	ND	ND	NT	ND	ND	NT	NT	ND	ND	ND	ND	NT	NT	ND	NT	NT	ND	NT	NT	21
Thiodiglycol	NT	NT	NT	NT	NT	ND	NT	NT	NT	ND	ND	ND	NT	NT	21	NT	NT	NT	NT	NT	NT

Parameter	Explosives-Related Compound Concentration (µg/L) by Well Number																				
	P2	P3	P4	P5	P9	TH4	J41	JF42	JF43	JF51	JF52	JF53	JF61	JF62	JF63	JF71	JF72	JF73	JF81	JF82	JF83
Cyclotrimethylene-trinitroamine	NT	ND	ND	NT	0.52	ND	NT	NT	ND	ND	ND	ND	NT	NT	ND	NT	NT	1.2	NT	NT	ND
Dinitrotoluene	NT	ND	ND	NT	ND	ND	NT	NT	ND	ND	ND	ND	NT	NT	ND	NT	NT	ND	NT	NT	ND
Nitrobenzene	NT	ND	ND	NT	ND	ND	NT	NT	ND	0.089	ND	ND	NT	NT	ND	NT	NT	ND	NT	NT	ND
Nitrocellulose	NT	ND	ND	NT	226	ND	NT	NT	21	ND	ND	ND	NT	NT	ND	NT	NT	ND	NT	NT	ND
Pentaerythritol-tetranitrate	NT	ND	ND	NT	ND	ND	NT	NT	ND	ND	ND	ND	NT	NT	16	NT	NT	ND	NT	NT	ND

[a] Notation: ND = not detected, detection limits unavailable; NT = not tested.

Source: USGS (1991).

TABLE A.1-55 Analytical Results for Selected Water Quality Parameters and Metals in Groundwater Samples Collected from the TBP AOC: 1990[a]

	Concentration by Well Number								
Parameter	P2	P3	P4	P9	TH4	JF51	JF52	JF53	JF61
Water quality (mg/L)									
Cyanide	NT	<0.0050	<0.0050	NT	<0.0050	0.014	<0.0050	<0.0050	<0.0050
Nitrate	NT	0.21	0.020	NT	NT	NT	NT	NT	NT
Phosphate	0.035	0.97	0.073	<0.010	0.020	0.14	0.061	0.011	0.028
Sulfate	160	270	140	94	23	34	25	9.9	20
Sulfide	NT	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total dissolved solids	300	850	910	170	410	460	330	270	460
Total organic carbon	<1.0	25	6.0	2.0	3.0	9.0	9.0	<1.0	160
Metals (μg/L)									
Arsenic	ND	30	ND	ND	ND	ND	ND	ND	8.0
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ND	62	ND	ND	ND	ND	ND	440	ND
Lead	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	ND	ND	292	ND	ND	ND	ND	36	ND

TABLE A.1-55 (Cont.)

Parameter	Concentration by Well Number							
	JF62	JF63	JF71	JF72	JF73	JF81	JF82	JF83
Water quality (mg/L)								
Cyanide	<0.0050	<0.0050	<0.0050	<0.0050	NT	NT	0.092	NT
Nitrate	NT	NT	NT	NT	NT	NT	NT	NT
Phosphate	0.067	0.26	0.47	0.015	<0.010	0.20	0.027	0.061
Sulfate	40	110	18	19	31	3.2	26	85
Sulfide	<1.0	<1.0	<1.0	4.0	<1.0	<1.0	<1.0	<1.0
Total dissolved solids	370	590	350	650	300	370	580	330
Total organic carbon	10	50	6.0	180	2.0	2.0	100	3.0
Metals (μg/L)								
Arsenic	ND	4.1	3.3	ND	5.5	ND	21	60
Antimony	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ND	NT	ND	ND	ND	ND	ND	NT
Mercury	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ND	ND	ND	ND	ND	ND	ND	ND
Lead	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	ND	19	NT	ND	ND	ND	ND	29

[a] ND = not detected, detection limits unavailable; NT = not tested.

Source: USGS (1991).

TABLE A.1-56 Analytical Results for Selected Radioactive Elements in Groundwater Samples Collected from the TBP AOC: 1990

	Concentration by Well Number						
Parameter	P3	P4	JF51	JF52	JF53	JF63	JF73
Cesium-137 (pCi/L)	62	4.8	172	14	2.4	2.8	32
Strontium-90 (pCi/L)	47	3.7	128	11	1.9	2.1	24
Thorium-230 (pCi/L)	0.84	1.5	1.1	1.7	0.64	0.16	1.5
Uranium (µg/L)	1.3	2.1	1.5	2.2	1.0	0.21	2.1

Source: USGS (1991).

TABLE A.1-57 Analytical Results for Selected VOCs in Groundwater Samples Collected from the TBP AOC: 1992[a]

	Concentration (µg/L) by Well Number													
Parameter	P3	P4	P9	JF51	JF52	JF53	JF61	JF62	JF63	JF71	JF73	JF81	JF82	JF83
1,2-Dichloroethene (total)	980	3,300	ND	210	140	10,000	2.0	4.0	120	ND	920	22	190	12,000
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	1.0	4,900	ND	ND	75	2.0	9,000	5.0	ND	260,000
Tetrachloroethene	3,400	ND	ND	ND	ND	ND	2.0	ND	130	ND	280	3.0	ND	3,600
1,1,2-Trichloroethane	ND	65	ND	ND	1.0	290	ND	ND	ND	ND	90	ND	ND	2,000
Trichloroethene	570	3,600	ND	97	3.0	4,200	10	13	4,400	3.0	5,100	220	1,800	4,100
Vinyl chloride	600	ND	10	ND	ND	95	ND	ND	ND	ND	ND	ND	ND	ND

[a] Notation: ND = not detected, detection limits unavailable.

Source: Hughes (1992).

increased from 7,150 to 12,000 µg/L. The concentrations of 112TCE decreased from 7,100 to 2,000 µg/L (Hughes 1992).

As part of the RI, groundwater samples were collected from all existing monitoring wells at the TBP AOC (except wells JF41 and JF42) and from two new wells, JF173 and JF183. All wells but JF173 and JF183 were sampled in May 1994. Well JF173 was sampled in June 1994 and JF183 in December 1994 during a pump test.

Well JF173 was installed to permit sampling of dense nonaqueous-phase liquids (DNAPLs), if present, in the surficial aquifer just downgradient of the Main Burning Pits. The well was constructed by placing the screened interval at the boundary between the confining unit and the surficial aquifer to capture any DNAPLs that might have migrated downward to the base of the surficial aquifer. The construction details are reported in Patton (1994).

Well JF183 was installed to serve as a prototype for a prospective groundwater extraction system at the TBP AOC. Like well JF173, well JF183 was installed so that its bottom rests at the base of the surficial aquifer. The screened interval of well JF183 (13–39 ft below the ground surface), however, is greater than other wells at the TBP AOC so that it could be used as a pumping well for the pump test. The construction details are reported in Quinn (1995).

Water level and quality in wells JF173 and JF183 were measured on several occasions with a Solinst® interface meter. The meter allows the operator to determine the presence of a medium less conductive than water (such as a DNAPL layer). To date, no DNAPLs have been detected in either of the newly installed monitoring wells.

In addition to the site monitoring well network, the USGS installed 10 piezometers in the marsh east of the Pushout Area in March 1994 (Figure A.1-8). The piezometers were sampled once in September 1994 by ANL and the USGS as part of the RI.

Groundwater samples from the monitoring wells and piezometers were generally analyzed for the parameters in the CLP analytical suite outlined in Table A.1-58. Some of the wells and piezometers were only sampled and analyzed for a subset of the CLP analytes. The other subset of CLP analytes were not analyzed because they are not mobile in the environment and were not present in previously sampled groundwater.

TABLE A.1-58 Contract Laboratory Program (CLP) Analytical Suite

CLP TCL organic compounds
CLP TAL metals
Chemical agent degradation products
Explosives and related compounds
TOX
TOC
Conductivity[a]
Major cations and anions[a]
Radioactivity (gross alpha and gross beta)

[a] For water samples only.

The results of VOC analyses indicated that no VOCs were present in wells P1, P2, and JF43, located upgradient of the Main Burning Pits (Table A.1-59). Several VOCs were detected, however, in monitoring wells located between the Main Burning Pits and the marsh. The most frequently detected contaminants were TCLEA, 12DCE (total), TCLEE, TRCLE, and vinyl chloride. The highest concentrations of most VOC contaminants were found in well JF83 — TCLEA (160,000 µg/L), 12DCE (total) (4,100 µg/L), TCLEE (1,100 µg/L), and TRCLE (21,000 µg/L). The highest concentrations of 12DCE (total) were found in well P4, located immediately downgradient of the Northern Main Pit.

VOCs were also present in groundwater samples from the adjacent marsh (Table A.1-60). The highest concentrations were found in JFPM1A, JFPM1B, JFPM2A, and JFPM3A, indicating that contamination is most pronounced near the Pushout Area-marsh boundary and in the piezometers placed at greater depths. No VOCs were found at concentrations above the detection limit in piezometers 3B, 4A, 4B, 5A, or 5B.

SVOCs were detected above the CLP required quantitation limit only in well JF83, in which 57 µg/L of ideno(1,2,3-c,d)pyrene was detected. No pesticides or PCBs were detected in any of the wells sampled.

The TAL metals analyses (total) indicated that several metals were present in concentrations exceeding maximum contaminant levels (MCLs): arsenic (JF83), cadmium (P4), chromium (JF53), lead (P4), and iron (all wells) (Table A.1-61). Only iron exceeded the MCL in the filtered samples (representing the dissolved phase) (Table A.1-62). Lead, iron, and chromium exceeded the ambient water quality criteria (AWQC) in some wells. The AWQC for hardness-dependent metals are listed in Tables A.1-63 and A.1-64.

Chemical agent degradation products (referred to as chemical surety materials, or CSM degradation products) were analyzed for in eight TBP AOC wells (Table A.1-65). Low levels of dithiane, 1,4-oxathiane, and diisopropylmethly phosphonate were found. The highest concentrations were found in well P3.

An explosives-related compound (hexahydro-1,3,5-trinitro-1,3,4-triazine [RDX]) was detected in two TBP AOC wells — 8.5 µg/L in well JF83 and 1.5 µg/L in well JF173. No other explosives-related compounds were detected.

The general chemistry of groundwater samples from the TBP AOC wells is presented in Table A.1-66. The deeper confined aquifer is more alkaline than the surficial aquifer, with pH ranging from 7.2 to 11.4 in the former and from 5.6 to 8.1 in the latter. Chloride, sulfate, and total organic halogen (TOX) levels tend to be higher in the surficial aquifer than the confined aquifer. Cyanide was not detected in any of the wells sampled.

TABLE A.1-59 Analytical Results for Selected VOCs in Groundwater Samples Collected from the TBP AOC: 1994[a,b]

Parameter	Concentration (µg/L) by Well Number									
	TH4	P1	P2	P3	P4	P9	JF43	JF51	JF52	JF53
Acetone	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzene	<10	<10	<10	4.0 J	4.0 J	<10	<10	<10	<10	<10
Carbon tetrachloride	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chlorobenzene	<10	<10	<10	200 DJ	<10	<10	<10	<10	<10	<10
Chloroform	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,2-Dichloroethane	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethene	<10	<10	<10	27	6.0 J	<10	<10	6.0 J	<10	<10
1,2-Dichloroethene (total)	<10	<10	<10	1,100 D	13,000 D	<10	<10	650 D	62	2,200 D
Methylene chloride	<10	<10	<10	<10	<10	<10	<10	<10	5.0 BJ	<10
1,1,2,2-Tetrachloroethane	<10	<10	<10	4.0 J	3,500 D	<10	<10	<10	<10	550 D
Tetrachloroethene	<10	<10	<10	2,400 D	19	<10	<10	<10	<10	7.0 J
Toluene	<10	<10	<10	6.0 J	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	<10	<10	<10	<10	68	<10	<10	<10	<10	58
Trichloroethene	<10	<10	<10	390 D	1,800 D	<10	<10	850 D	9.0 J	390 D
Vinyl chloride	<10	<10	<10	570 D	74	<10	<10	<10	30	41
Xylenes (total)	<10	<10	<10	3 J	<10	<10	<10	<10	<10	<10

Parameter	Concentration (µg/L) by Well Number										
	JF61	JF62	JF63	JF71	JF72	JF73	JF81	JF82	JF83	JF173	JF183
Acetone	<10	<10	<10	<10	52	<10	<10	<10	<10	<10	<10
Benzene	<10	<10	<10	<10	<10	<10	<10	<10	6.0 J	<10	3 J
Carbon tetrachloride	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	3 J
Chlorobenzene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chloroform	<10	<10	9.0 J	<10	<10	<10	<10	<10	44	<10	12
1,2-Dichloroethane	<10	<10	<10	<10	<10	10 J	<10	<10	6.0 J	<10	5
1,1-Dichloroethene	<10	<10	<10	<10	<10	15	28	11	12	<10	17
1,2-Dichloroethene (total)	<10	<10	100	<10	3.0 J	8,900 D	190	170	4,100 DJ	1,400 D	10,000 D
Methylene chloride	<10	6.0 BJ	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1,2,2-Tetrachloroethane	<10	<10	50	<10	<10	13,000 D	<10	<10	160,000 D	12,000 D	39,000 D
Tetrachloroethene	<10	<10	32	<10	<10	250 DJ	34	17	1,100[c]	170	8,300
Toluene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	<10	<10	<10	<10	<10	200[c]	<10	<10	990[c]	<10	600 D
Trichloroethene	6.0 J	<10	680 D	<10	<10	4,100 D	1,600 D	1,500 D	21,000 D	5,800 D	13,000 D
Vinyl chloride	<10	<10	12	<10	<10	230[c]	<10	23	34	13	68
Xylenes (total)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

[a] All wells sampled in May 1994 except JF173 and JF183, which were sampled in June 1994 and December 1994, respectively.

[b] Notation: B = analyte also found in associated blank; D = sample diluted; J = estimated value.

[c] Sample was diluted and reanalyzed; result given is an estimate.

TABLE A.1-60 Analytical Results for Selected VOCs Detected in Marsh Piezometers near the TBP AOC: 1994[a]

	Concentration (µg/L) by Piezometer Number									
Parameter	JFPM 1A	JFPM 1B	JFPM 2A	JFPM 2B	JFPM 3A	JFPM 3B	JFPM 4A	JFPM 4B	JFPM 5A	JFPM 5B
Benzene	2.0 J	<10	<10	<10	<10	<10	<10	<10	<10	<10
Carbon tetrachloride	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chlorobenzene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chloroform	13	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,2-Dichloroethane	13	4.0 J	27	<10	12	<10	<10	<10	<10	<10
1,1-Dichloroethene	24	2.0 J	5.0 J	<10	6.0 J	<10	<10	<10	<10	<10
1,2-Dichloroethene (total)	37,000 D	7,900 D	1,900 D	6.0 J	1,400 D	<10	<10	<10	<10	<10
1,1,2,2-Tetrachloroethane	8,600 D	50	720 D	<10	240 DJ	<10	<10	<10	<10	<10
Tetrachloroethene	29	<10	29	<10	26	<10	<10	<10	<10	<10
Toluene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	410 DJ	10	210 DJ	<10	170	<10	<10	<10	<10	<10
Trichloroethene	1,200 DJ	18	4,300 D	<10	7,300 D	<10	<10	<10	<10	<10
Vinyl chloride	3,200 D	1,300 D	32	5.0 J	25	<10	<10	<10	<10	<10
Xylenes	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

[a] Notation: D = sample was diluted for analysis; J = estimated value.

TABLE A.1-61 Analytical Results for Selected Total Metals in Groundwater Samples Collected from the TBP AOC: 1994[a,b]

Parameter	AWQC	MCL	Total Metal Concentration by Well Number									
			P3	P4	P9	JF43	JF53	JF63	JF73	JF83	JF173	JF183
Metal (µg/L)												
Arsenic	–	50	37	4.4 B	1.2 B	5.2 B	1.2 BW	2.6 B	4.3 B	64	12	39
Cadmium	*	10	<3.0	34	<3.0	<3.0	4.8 B	<3.0	4.0 B	<3.0	5.2	3.4
Calcium	–	–	13,000	309,000	21,000	13,400	39,100	97,400	93,200	33,800	31,600	58,300
Chromium	11[c]	50	<7.0	<7.0	<7.0	<5.0	73	<7.0	9.8 B	<7.0	<5.0	6.4
Copper	*	1,000	<3.0	99	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	6.2
Iron	1,000	300	9,820	5,890	3,130	4,440	18,100	21,600	3,960	818	21,500	2,020
Lead	*	50	1.6 B	92	2.6 B	1.5 B	<1.0	11	<1.0	<1.0	1.5 B	5.9
Magnesium	–	–	65,500	103,000	3,550 B	3,950 B	12,300	18,000	6,620	18,300	6,050	4,420
Mercury	0.012	2	<0.20	0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Zinc	*	5,000	56	1,680	17 B	<6.0	67	16	80	26	13 B	35
Hardness (mg/L)	–	–	594	1,195	NT	50	148	317	260	160	104	164

[a] All wells sampled in May 1994 except JF173 and JF183, which were sampled in June and December 1994, respectively.

[b] Notation: B = reported value is less than the contract-required detection limit but greater than the instrument detection limit; a hyphen denotes that no MCL value is set; * = hardness-dependent criteria, see Table A.1-63 for individual criteria for each well; NT = not tested.

[c] AWQC is for hexavalent chromium.

TABLE A.1-62 Analytical Results for Selected Dissolved Metals in Groundwater Samples Collected from the TBP AOC: 1994[a,b]

			Dissolved Metal Concentration by Well Number									
Parameter	AWQC	MCL	P3	P4	P9	JF43	JF53	JF63	JF73	JF83	JF173	JF183
Metal (µg/L)												
Arsenic	–	50	27	4.0 B	<1.0	2.4 BN	<1.0	2.1 B	4.6 B	79 S	7.2 BN	35.0
Cadmium	*	10	<3.0	33	<3.0	<3.0	<3.0	5.1	3.0 B	<3.0	<3.0	3.4
Calcium	–	–	13,200	327,000	20,800	14,000	39,600	98,700	93,800	34,300	32,600	61,200
Chromium	11[c]	50	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	6.4
Copper	*	1,000	<3.0	55	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	13.8
Iron	1,000	300	4,070	1,110	22 B	3,080	17,200	22,100	2,200	19 B	17,300	2,020
Lead	*	50	<1.0	39	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	9.9
Magnesium	–	–	69,000	110,000	3,120 B	4,110	12,900	18,900	6,620	19,000	6,220	4,760
Mercury	0.012	2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Zinc	*	5,000	36	1,760	13 B	9.7 B	82	12	69	28	16 B	54.6
Hardness (mg/L)	–	–	316	1,269	NT[d]	52	152	324	261	164	107	172

[a] All wells sampled in May 1994 except JF173 and JF183, which were sampled in June and December 1994, respectively.

[b] Notation: B = reported value is less than the contract-required detection limit but greater than the instrument detection limit; N = postdigestion spike for furnace atomic absorption spectrophotometry was out of control limits; a hyphen denotes that no MCL value is set; * = hardness-dependent criteria (see Table A.1-63 for individual criteria for each well); NT = not tested.

[c] AWQC is for hexavalent chromium.

TABLE A.1-63 Ambient Water Quality Criteria for Selected Hardness-Dependent Total Metals in Groundwater Samples Collected from the TBP AOC: 1994[a,b]

	AWQC Value by Well Number[c]								
Parameter	P3	P4	JF43	JF53	JF63	JF73	JF83	JF173	JF183
Total metal (µg/L)									
Cadmium	-	2.1	0.66	1.6	2.8	2.4	1.6	1.2	1.7
Copper	-	4.6	6.5	17	32	27	18	12	18
Lead	3.4	4.3	1.3	5.3	14	11	58	3.3	6.0
Zinc	4.6	6.8	59	148	282	238	158	109	161
Hardness (mg/L)	594	1,195	50	148	317	260	160	104	164

[a] Criteria derived from total calcium/magnesium values.

[b] Notation: A hyphen denotes that concentrations were below detection limits.

[c] All wells were sampled in May 1994 except JF173 and JF183, which were sampled in June and December 1994, respectively.

TABLE A.1-64 Ambient Water Quality Criteria for Selected Hardness-Dependent Dissolved Metals in Groundwater Samples Collected from the TBP AOC Surficial Aquifer[a,b]

	AWQC Value by Well Number[c]								
Parameter	P3	P4	JF43	JF53	JF63	JF73	JF83	JF173	JF183
Dissolved metal (μg/L)									
Cadmium	-	2.1	0.68	1.6	2.9	2.4	1.7	1.2	1.7
Copper	-	4.6	6.8	17	32	27	18	13	19
Lead	-	4.4	1.4	5.4	14	11	6.0	3.5	6.4
Zinc	5.6	6.8	61	151	287	239	161	112	168
Hardness (mg/L)	316	1,269	52	152	324	261	164	107	172

[a] Criteria derived from dissolved calcium/magnesium values.

[b] Notation: A hyphen denotes that analytical results were below detection limits.

[c] All wells were sampled in May 1994 except JF173 and JF183, which were sampled in June and December 1994, respectively.

TABLE A.1-65 Analytical Results for Selected CSM Degradation Products in Groundwater Samples Collected from the TBP AOC: 1994

	CSM Concentration (µg/L) by Well Number							
Parameter	P3	P4	P9	JF53	JF63	JF73	JF83	JF173
Diisopropyl methylphosphonate	35	<0.87	<0.87	<0.87	<0.87	<0.87	1.4	<0.87
Dimethyl methylphosphate	<9.4	<9.4	<9.4	<9.4	<9.4	<9.4	<9.4	<9.4
Dithiane	236	<1.3	<1.3	<1.3	<3.2	1.4	<1.3	<1.3
1,1-Oxathiane	18	<2.4	<2.4	<2.4	3.0	<2.4	<2.4	<2.4
Thiodiglycol	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2

TABLE A.1-66 Analytical Results for General Chemistry of Groundwater Samples Collected from the TBP AOC: 1994[a]

	Concentration (mg/L) by Well Number						
Parameter	P1	P2	P3	P4	P9	TH4	JF43
Alkalinity	28	23	338	34	22	252	59
Bicarbonate	28	23	338	34	22	249	59
Carbonate	<0.40	<0.40	<0.40	<0.40	<0.40	3.6	<0.40
Chloride	1.6	11	22	1,100	4.9	4.9	6.2
Cyanide	NT	NT	<0.010	<0.010	<0.010	NT	NT
Sulfate	83	74	120	100	70	22	17
TDS	117	146	484	2,360	102	293	107
TOX (µg/L)	NT	7.4	NT	6,900	NT	NT	7.7
pH (units)	5.7	6.4	6.8	5.6	6.3	8.1	6.2

	Concentration (mg/L) by Well Number						
Parameter	JF51	JF52	JF53	JF61	JF62	JF63	JF71
Alkalinity	377	331	51	219	274	27	330
Bicarbonate	375	331	51	2.9	274	27	330
Carbonate	1.7	0.60	<0.40	102	0.80	<0.40	0.70
Chloride	51	4.3	160	77	4.7	250	17
Cyanide	NT	NT	<0.010	NT	NT	<0.010	<0.010
Sulfate	19	0.75	8.8	9.5	0.94	65	11
TDS	431	411	304	723	355	741	355
TOX (µg/L)	NT	NT	2,300	NT	5.0	NT	NT
pH (units)	7.6	7.2	6.5	11.4	7.4	5.9	7.2

	Concentration (mg/L) by Well Number					
Parameter	JF72	JF73	JF81	JF82	JF83	JF173
Alkalinity	376	137	320	200	51	55
Bicarbonate	151	137	8.8	8.3	51	55
Carbonate	2.4	<0.40	224	134	<0.40	<0.40
Chloride	5.2	140	180	15	110	56
Cyanide	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Sulfate	19	22	1.4	15	59	38
TDS	370	426	414	253	743	237
TOX (µg/L)	NT	23	1,800	NT	120	9,500
pH (units)	11.7	6.6	11.3	11.2	6.0	6.3

[a] Notation: NT = not tested; TDS = total dissolved solids; TOX = total organic halides.

Wells JF53, JF63, JF73, JF83, and JF173 were tested for gross alpha and gross beta radioactivity. All samples had alpha and beta activity at levels well below the maximum levels permitted by the *Code of Maryland Regulations* (COMAR 26.08.02) for community water systems (15 pCi/L for gross alpha and 50 pCi/L for gross beta) and well below the mean background values (5.2 pCi/L and 3.0 pCi/L, respectively) as reported in ICF Kaiser Engineers (1995).

Groundwater at the TBP AOC was sampled again in 1997–1998. Samples were analyzed for VOCs, SVOCs (in well JF83 only), metals, CSM/CSM degradation products, explosives-related compounds, total organic carbon (TOC), and gross alpha and gross beta activity levels. Other parameters were also measured as part of a recent natural attenuation study — dissolved gases, major cations/anions, oxidation/reduction potential, conductivity, pH, and temperature.

The analyses indicated that VOCs were highest in the surficial aquifer wells JF73, JF83, JF183, and JFP5 (Table A.1-67). As in the 1994 sampling, the most frequently detected contaminants were TCLEA, 12DCE (total), TCLEE, TRCLE, and vinyl chloride. The highest concentrations of most VOC contaminants were found in well JF83 — TCLEA (140,000 µg/L), TCLEE (3,100 µg/L), and TRCLE (64,000 µg/L). The highest concentrations of cis-12DCE and trans-12DCE were found in well JF73 — 61,000 µg/L and 22,000 µg/L, respectively. In general, concentrations of most VOCs have increased since the 1994 sampling. No SVOCs were detected in well JF83.

The TAL metals (total) analyses indicated that some metals were present in concentrations exceeding MCLs — chromium (JBPM3B), lead (JF63), and iron (all wells but P3, P9, JF61, JFP1–JFP4, JFL2, and JFL4) (Table A.1-68).

Chemical agent (or CSM) degradation products were analyzed for in six TBP AOC wells (Table A.1-69). Low levels of dithiane, 1,4-oxathiane, and diisopropylmethyl phosphonate were found. The highest concentrations were found in well P3; however, these concentrations were lower than those measured in 1994.

Explosives-related compounds were analyzed for in seven wells (P9, JF51, JF63, JF73, JF83, JF173, and JFP5) but were detected in only one, JFP5 — RDX (2.7 µg/L) and cyclotetramethylene tetranitrate (HMX) (23.5 µg/L). No other explosives-related compounds were detected.

Wells JF81, JF83, and JFP1 were tested for gross alpha and gross beta activity. All samples had alpha and beta activity well below the levels required by the COMAR 26.08.02 for community water systems (15 pCi/L for gross alpha and 50 pCi/L for gross beta).

TABLE A.1-67 Analytical Results for Selected VOCs in Groundwater Samples Collected from the TBP AOC: 1997–1998[a]

	Concentration (µg/L) by Well Number							
Parameter	P1	P3	P4	P9	JF41	JF42	JF43	JF51
Acetone	<10	<10	<10	<10	<10	21	<10	<10
Benzene	<10	1 J	<10	<10	<10	<10	<10	<10
Carbon tetrachloride	<10	<10	<10	<10	<10	<10	<10	<10
Chlorobenzene	<10	29	<10	<10	<10	<10	<10	<10
1,1-Dichloroethene	<10	22	<10	<10	<10	<10	<10	<10
1,2-Dicholroethene (total)	NT	NT	NT	NT	NT	NT	<10	NT
cis-1,2-Dichloroethene	<10	850+	73	<10	<10	<10	<10	86
trans-1,2-Dichloroethene	<10	110	41	<10	<10	<10	<10	5 J
Ethylbenzene	<10	<10	<10	<10	<10	<10	<10	<10
Methylene chloride	3 JB	2 JB	1 JB	7 JB	7 JB	3 JB	3 JB	7 JB
1,1,2,2-Tetrachloroethane	<10	4 JB	7 JB	2 JB	<10	<10	<10	<10
Tetrachloroethene	<10	560+	<10	<10	<10	<10	<10	<10
Toluene	<10	2 J	<10	<10	<10	1 J	<10	<10
1,1,2-Trichloroethane	<10	1 J	<10	<10	<10	<10	<10	<10
Trichloroethene	<10	100	20	<10	<10	<10	<10	35
Vinyl chloride	<10	510+	<10	<10	<10	<10	<10	6 J
Xylenes	<10	2 J	<10	<10	<10	<10	<10	<10

	Concentration (µg/L) by Well Number							
Parameter	JF52	JF53	JF61	JF62	JF63	JF71	JF72	JF73
Acetone	<10	<250	27	<10	<10	<10	41	<1,000
Benzene	<10	<250	<10	<10	<10	<10	<10	<1,000
Carbon tetrachloride	<10	<250	<10	<10	<10	<10	<10	<1,000
Chlorobenzene	<10	<250	<10	<10	<10	<10	<10	<1,000
1,1-Dichloroethene	<10	<250	<10	<10	<10	<10	<10	150 J
1,2-Dicholroethene (total)	NT	NT	NT	NT	NT	NT	NT	NT
cis-1,2-Dichloroethene	<10	1,700	1 J	<10	110	1 J	1 J	81,000 D
trans-1,2-Dichloroethene	<10	590	<10	<10	<10	<10	<10	29,000 D
Ethylbenzene	<10	<250	<10	<10	<10	<10	<10	<1,000
Methylene chloride	3 J	27 JB	3 JB	6 JB	14 JB	2 JB	6 JB	200 JB
1,1,2,2-Tetrachloroethane	<10	1,200	<10	<10	8 JB	<10	<10	1,600 B
Tetrachloroethene	<10	<10	<10	<10	28 J	<10	<10	<1,000
Toluene	<10	<250	1 J	<10	<10	<10	<10	<1,000
1,1,2-Trichloroethane	<10	37	<10	<10	<10	<10	<10	850 J
Trichloroethene	<10	700	1 J	<10	460	1 J	<10	4,400
Vinyl chloride	<10	<250	<10	<10	15 J	<10	<10	1,800
Xylenes	<10	<250	<10	<10	<10	<10	<10	<1,000

	Concentration (µg/L) by Well Number							
Parameter	JF81	JF82	JF83	JF173	JF183	JF201	JF203	JFPM1A
Acetone	<20	12	13	<250	<1,000	<10	<500	<500
Benzene	<20	<250	19	<250	<1,000	<10	<500	<500
Carbon tetrachloride	<20	<250	<10	<250	<1,000	<10	<500	<500
Chlorobenzene	<20	<250	<10	<250	<1,000	<10	<500	<500
1,1-Dichloroethene	28 J	4 J	130	<250	<1,000	<10	<500	<500
1,2-Dicholroethene (total)	NT	NT	NT	NT	NT	NT	NT	NT
cis-1,2-Dichloroethene	280	56	61,000 D	1,000	58,000 D	<10	180 J	3,000
trans-1,2-Dichloroethene	44 J	23	22,000 D	320	21,000 D	<10	52 J	3,000
Ethylbenzene	<10	<250	<10	<250	<1,000	<10	<500	<500
Methylene chloride	180 JB	3 JB	25 B	62 JB	1,000 JB	7 JB	54 JB	140 JB
1,1,2,2-Tetrachloroethane	44 JB	<250	140,000 D	1,000 B	70,000 BD	<10	1,100 B	<500
Tetrachloroethene	42 J	3 J	3,100 D	46 J	100 J	<10	52J	<500
Toluene	<10	<10	<10	<250	<1,000	<10	<500	<500
1,1,2-Trichloroethane	<10	<250	5,500 D	59 J	2,600	<10	<500	<500
Trichloroethene	2,700	340 D	64,000 D	1,300	31,000 D	<10	2,600	<500
Vinyl chloride	<10	45	330E	<250	690 J	<10	<500	4,200
Xylenes	<10	<250	<10	<250	<1,000	<10	<500	<500

TABLE A.1-67 (Cont.)

Parameter	Concentration (µg/L) by Well Number JFPM1B	JFPM2A	JFPM2B	JFPM 3A	JFPM3B	JFPM4B	JFP1	JFP2
Acetone	10 J	<10	<10	<10	<10	10	<100	<10
Benzene	<10	<10	<10	<10	<10	<10	<100	1 J
Carbon tetrachloride	<10	<10	<10	<10	<10	<10	<100	<10
Chlorobenzene	<10	<10	<10	<10	<10	<10	<100	<10
1,1-Dichloroethene	2 J	<10	<10	<10	<10	<10	<100	12
1,2-Dicholroethene (total)	NT	NT	NT	NT	NT	NT	NT	NT
cis-1,2-Dichloroethene	4,000	3,000	36	2,800	<10	<10	80 J	5,200
trans-1,2-Dichloroethene	2,700	690	11	350 J	<10	<10	31 J	2,100
Ethylbenzene	<10	<10	<10	<10	<10	<10	<100	<10
Methylene chloride	3 JB	68 JB	2 JB	120 JB	3 JB	2 JB	56 JB	9 JB
1,1,2,2-Tetrachloroethane	280	1,400 B	15 B	150 JB	<10	<10	790	7,200
Tetrachloroethene	2 J	27 J	<10	<10	<10	<10	230	190
Toluene	<10	<10	<10	<10	<10	<10	<100	<10
1,1,2-Trichloroethane	24	200 J	2 J	97 J	<10	<10	15 J	150
Trichloroethene	89	3,100	47	5,500	<10	<10	1,100	5,300
Vinyl chloride	4,200	270	7 J	740	<10	<10	<100	51
Xylenes	<10	<10	<10	<10	<10	<10	<100	<10

Parameter	Concentration (µg/L) by Well Number JFP3	JFP4	JFP5	JFL2	JFL4
Acetone	<10	<10	<10	<10	<10
Benzene	<10	4 J	1 J	<10	<10
Carbon tetrachloride	<10	<10	<10	<10	<10
Chlorobenzene	<10	<10	<10	<10	<10
1,1-Dichloroethene	1 J	<10	12	<10	<10
1,2-Dicholroethene (total)	NT	NT	NT	NT	NT
cis-1,2-Dichloroethene	170	<10	2,800	430 D	43
trans-1,2-Dichloroethene	75	<10	1,000	190	17
Ethylbenzene	<10	<10	<10	<10	<10
Methylene chloride	5 JB	3 JB	5 JB	3 JB	3 JB
1,1,2,2-Tetrachloroethane	4,500	4 J	12,000	1,200 D	2,100 D
Tetrachloroethene	140	<10	360	34	27
Toluene	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	52	<10	230	27	19
Trichloroethene	2,800	<10	6,000	1,500 D	890 D
Vinyl chloride	<10	<10	13	<10	<10
Xylenes	<10	<10	<10	<10	<10

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[a] Notation: B = analyte also found in the associated blank; D = sample was diluted for analysis; J = estimated value; NT = not tested.

TABLE A.1-68 Analytical Results for Selected Total Metals in Groundwater Samples Collected from the TBP AOC: 1997–1998[a]

	Concentration (µg/L) by Well Number						
Parameter	P1 (12-05-97)	P2 (12-08-97)	P3 (12-05-97)	P4 (12-03-97)	P9 (12-05-97)	JF41 (12-09-97)	JF43 (12-05-97)
Arsenic	<3.0	<3.0	32	<3.0	<3.0	<3.0	<3.0
Cadmium	<0.30	<0.30	0.30	<0.30	<0.30	0.58	<0.30
Calcium	15,700	20,200	9,940	81,800	22,500	75,800	9,650
Chromium	1.8	1.4	0.51	3.3	1.0	1.6	1.3
Copper	3.8	2.6	2.9	12	2.7	4.4	3.7
Iron	22	***316***	***4,230***	***428***	90	***7,280***	***822***
Lead	<1.0	<1.0	<1.0	5.4	<1.0	1.6	4.7
Magnesium	3,850	3,120	40,200	30,700	3,160	5,430	2,890
Mercury	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Zinc	7.2	3.4	19	13	3.6	7.0	8.2

	Concentration (µg/L) by Well Number						
Parameter	JF51 (1-22-98)	JF53 (12-03-97)	JF61 (1-21-98)	JF63 (12-04-97)	JF71 (1-21-98)	JF81 (12-08-97)	JF83 (12-02-97)
Arsenic	<4.0	<3.0	8.8	<3.0	<4.0	4.1	20
Cadmium	<1.0	1.1	<1.0	1.1	<1.0	<0.30	0.71
Calcium	88,400	62,400	54,200	111,000	52,700	63,800	72,000
Chromium	3.2	17	12	<0.50	21	0.81	1.6
Copper	6.4	34	8.3	2.6	8.3	4.0	1.9
Iron	***1,330***	***12,200***	287	***4,180***	***6,240***	***888***	***527***
Lead	<2.0	7.5	3.2	***68***	<2.0	<1.0	6.2
Magnesium	42,100	22,600	5,070	23,300	38,800	5,650	34,900
Mercury	<0.10	<0.10	<0.10	<0.01	<0.10	<0.10	<0.10
Zinc	12	214	12	16	358	13	28

	Concentration (µg/L) by Well Number						
Parameter	JF173 (12-03-97)	JF183 (12-03-97)	JF201 (12-08-97)	JF203 (12-03-97)	JBPM1A (12-05-97)	JBPM1B (12-04-97)	JBPMA2A (12-04-97)
Arsenic	<3.0	<3.0	3.2	<3.0	5.7	<3.0	3.3
Cadmium	1.2	1.2	<0.30	<0.30	4.9	0.82	4.8
Calcium	16,000	35,500	67,900	58,500	495,000	209,000	188,000
Chromium	<0.50	<0.50	0.88	<0.50	15	1.1	49
Copper	1.7	2.1	3.1	1.8	33	2.8	25
Iron	***37,900***	***73,500***	***1,720***	***314***	***143,000***	***4,650***	***196,000***
Lead	<1.0	<1.0	<1.0	<1.0	***78***	9.3	42
Magnesium	5,490	24,900	12,300	1,820	172,000	329,000	145,000
Mercury	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Zinc	2.3	5.5	8.4	2.1	199	8.2	154

	Concentration (µg/L) by Well Number						
Parameter	JBPM2B (12-04-97)	JBPM3A (12-04-97)	JBPM3B (12-04-97)	JBPM4B (12-04-97)	JFP1 (12-01-97)	JFP2 (12-02-97)	JFP3 (12-02-97)
Arsenic	<3.0	<3.0	3.4	<3.0	4.6	5.7	6.2
Cadmium	0.66	1.2	5.4	0.30	0.50	<0.30	<0.30
Calcium	108,000	90,200	198,000	87,800	191,000	90,600	92,900
Chromium	6.9	22	***578***	2.3	0.65	1.1	0.84
Copper	2.8	6.9	10	3.3	4.6	1.7	1.6
Iron	***1,810***	***35,500***	***174,000***	***5,930***	259	92	120
Lead	31	3.4	4.5	<1.0	<1.0	<1.0	<1.0
Magnesium	237,000	108,000	172,000	296,000	26,700	2,640	4,390
Mercury	<0.10	<0.10	0.95	<0.10	<0.10	<0.10	<0.10
Zinc	156	14	1,810	12	7.1	1.8	3.0

TABLE A.1-68 (Cont.)

Parameter	JFP4 (12-02-97)	JFP5 (12-02-97)	JFL2 (12-05-97)	JFL4 (12-05-97)	MCL[b]
	Concentration (µg/L) by Well Number				
Arsenic	<3.0	7.0	<5.0	<4.3	50
Cadmium	<0.30	0.42	<0.50	2.5	10
Calcium	61,700	26,000	31,400	104,000	NA
Chromium	0.96	<0.50	2.5	<0.72	50
Copper	1.9	2.0	5.2	6.5	1,000
Iron	15.6	***10,600***	<17	<15	300
Lead	<1.0	<1.0	<1.7	<1.4	50
Magnesium	1,140	4,830	21,100	11,400	NA
Mercury	<0.10	<0.10	<0.10	<0.10	2
Zinc	1.8	6.8	14	15	5,000

[a] Notation: NA = not available. Sample concentrations equal to or exceeding the MCL are presented in bold italics.

[b] MCL = maximum contaminant level.

TABLE A.1-69 Analytical Results for Selected CSM Degradation Products in Groundwater Samples Collected from the TBP AOC: 1997–1998

Parameter	P3	P4	JF53	JF63	JF73	JF83
	CSM Concentration (µg/L) by Well Number					
Diisopropyl methylphosphonate	<2.5	<2.5	0.60 J	<25	1.4 J	2.0 J
Dimethyl methylphosphate	<30	<30	<30	<30	<30	<2.0
Dithiane	2.0	<0.30	<0.30	4.1	2.2	2.0
Isopropylmethylphosphonic acid	<50	<50	<50	<50	<50	<50
1,4-Oxathiane	1.4	<0.60	<0.60	3.0	1.7	1.7
Thiodiglycol	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0

Groundwater from well JF83 was sampled in 1997 as part of an aquatic toxicity evaluation conducted by the University of Maryland's Agricultural Experiment Station (Burton and Turley 1997). The groundwater was analyzed for water chemistry, VOCs, metals, base neutral and acid compounds, PCBs, pesticides, herbicides, and explosives-related compounds. Of particular note were the elevated concentrations of several VOCs, including vinyl chloride (13 µg/L), trans-12DCE (1,800 µg/L), 1,1,2-TCE (1,700 µg/L), TCLEE (2,300 µg/L), TCLEA (130,000 µg/L), and TRCLE (32,000 µg/L). Hexachloroethane (a base neutral compound) was detected at 97 µg/L. No metals were found to exceed MCLs for groundwater. No acid compounds, PCBs, pesticides, herbicides, or explosives-related compounds were detected.

A.1.4 Surface Water and Sediment Analyses

A.1.4.1 Offshore Sampling

Nearshore surface water and sediment samples were collected in 1988 by the USGS (Figure A.1-9) and in 1992 by the EPA (Figure A.1-10). Since these samples pertain to offshore conditions at J-Field as a whole, the discussion of these two sampling events are not broken down by AOC. The data for surface water indicate that the level of contamination offshore is very low. The contaminants that are present appear to be associated with the suspended solids.

In 1988, filtered and unfiltered surface water samples were analyzed for water quality parameters, metals, and a few organic compounds (Figure A.1-9). Nitrate concentrations in USGS samples 3, 7, and 13 ranged from 280 to 400 µg/L. The metals data showed the presence of lead (from not detected [ND][1] to 28 µg/L) and zinc (50–133 µg/L) at locations 1 through 4. Lead and zinc concentrations at the other locations ranged from ND to 2.7 and 48 µg/L. Mercury and nickel concentrations were slightly elevated at location 1 (0.54 and 34 µg/L, respectively). No elevated concentrations of arsenic, barium, or chromium were found. A comparison of results from filtered and unfiltered samples shows that metals concentrations were higher in the unfiltered samples (Phelan 1994).

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[1] The detection limits for analyses were not reported.

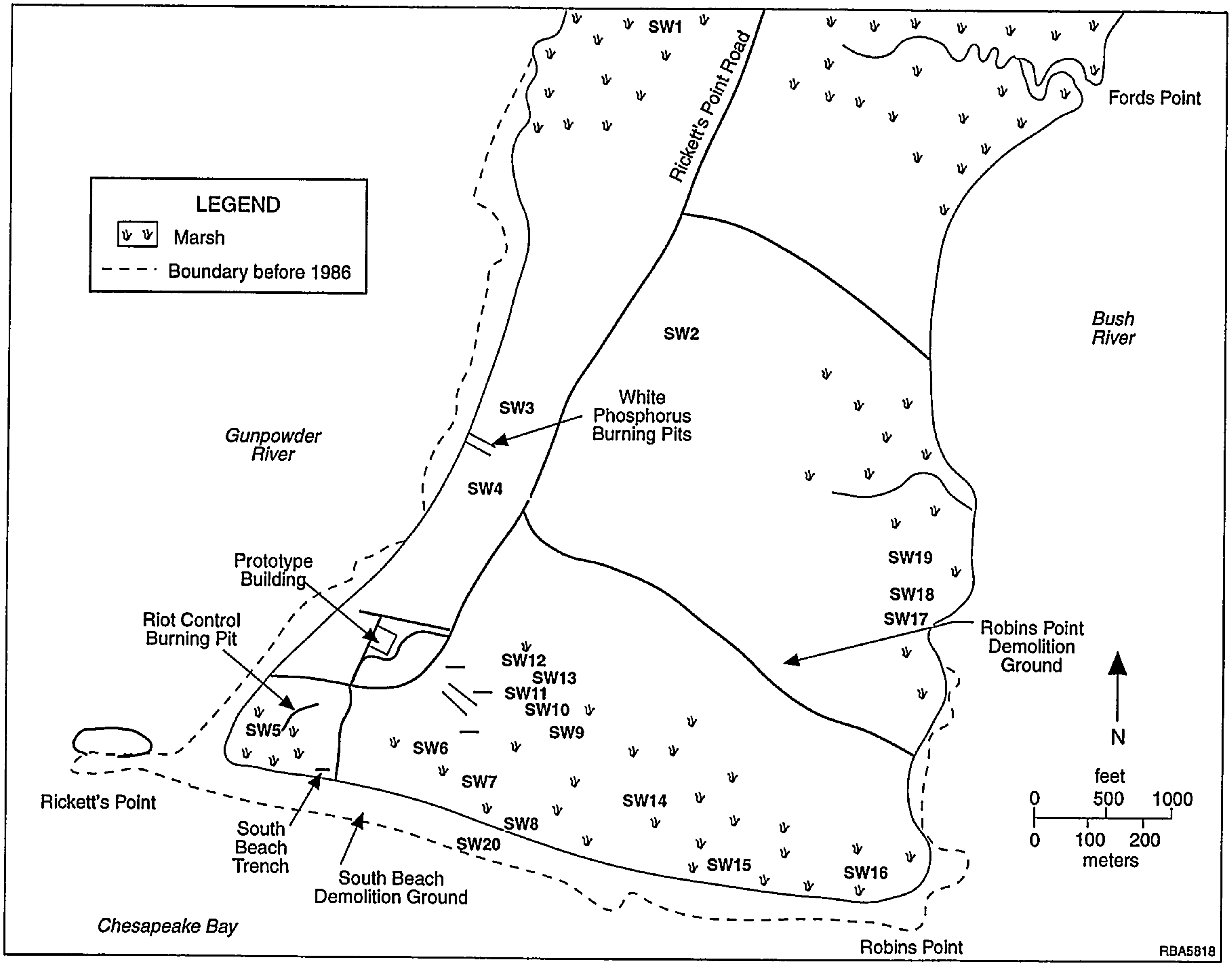

FIGURE A.1-9 Locations of Surface Water and Sediment Samples Collected by the U.S. Geological Survey from 1988 through 1993 (Sources: Phelan 1994; Martino and Stull 1995)

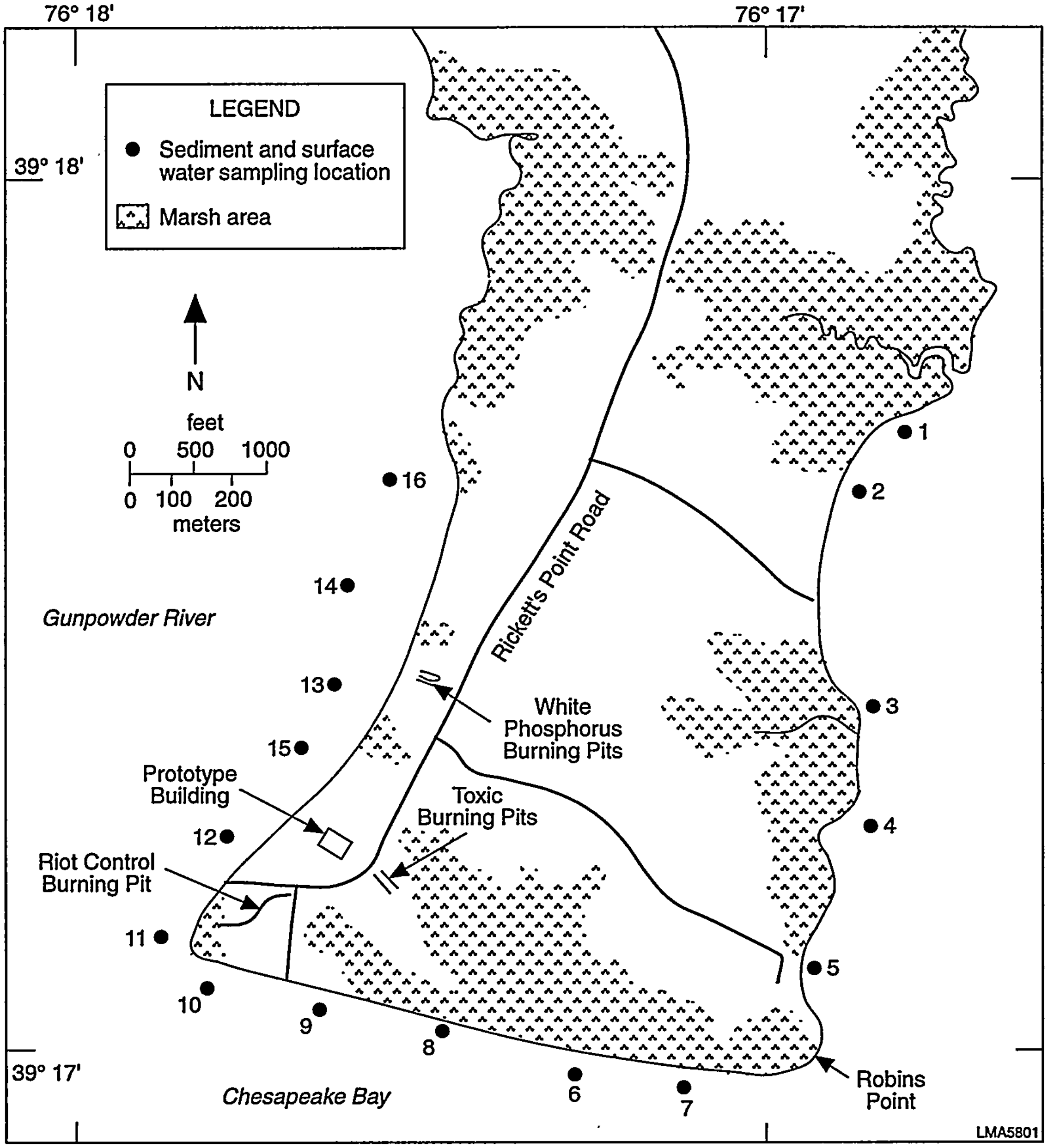

FIGURE A.1-10 Locations of Surface Water and Sediment Samples Collected by the U.S. Environmental Protection Agency in 1992 (Source: EPA 1993)

Acetone, toluene, phenol, total organic carbon (TOC), and TOX were analyzed in the filtered and unfiltered samples from nine locations. Phenol (ND to 52 µg/L), TOC (4,000–7,000 µg/L), and TOX (22–30 µg/L) were detected in the unfiltered samples only. The presence of acetone in some of the samples may represent laboratory contamination. Toluene (3.1 µg/L) was found at location 1 (Phelan 1994).

In August 1992, the EPA ERT collected nearshore surface water and sediment samples at 17 locations around the peninsula — in the Gunpowder River and in the Chesapeake Bay (EPA 1993) (Figure A.1-10). Filtered surface water samples were analyzed for VOCs, base neutral and acid extractable organic compounds (BNAs), TAL metals, pesticides, PCBs, and inorganic parameters (sulfate, total Kjeldahl nitrogen [TKN], total phosphorus, and cyanide). The data showed that beryllium, lead, and mercury were below their respective detection limits of 6,000, 6,000, and 200 µg/L). Zinc concentrations ranged from 11,000 µg/L at locations 2, 4, and 16 to 96,000 µg/L at location 6. Nickel concentrations ranged from 28,000 µg/L at most locations to 38,000 µg/L at location 9. No cyanide, VOCs, pesticides, or PCBs were detected.

Sediment samples, collected at the same locations as the surface water, were analyzed for CSM/CSM degradation products, explosives-related compounds, VOCs, BNAs, TAL metals, pesticides, PCBs, and other parameters (TOC, sulfate, total phosphorus, TKN, and percent solids). The results indicate that there is essentially no contamination in sediments at these locations, although lead was detected at concentrations ranging from 2 mg/kg at location 11 to 22 mg/kg at location 17. Arsenic and cadmium were also detected — arsenic at concentrations ranging from <0.5 to 3 mg/kg (at location 6) and cadmium at concentrations ranging from 0.5 to 2.6 mg/kg. The only VOC detected was acetone, up to 101 µg/kg (location 7).

In 1993, the USGS also collected an offshore surface water sample south of the TBP AOC (SW20, Figure A.1-9). This sample was analyzed for VOCs and CSM/CSM degradation products; none were detected.

In 1994, ANL collected an offshore surface water sample at USGS location SW20 (Figure A.1-9). It was analyzed for VOCs only; none were detected.

A.1.4.2 On-Site Sampling

In 1993, the USGS collected surface water samples from around J-Field, including 10 locations at the TBP AOC (SW6–15) (Figure A.1-9) (Phelan 1994). The samples were analyzed for VOCs (all but SW9), metals (total), pesticides, and PCBs. A subset of samples (SW7, SW10–12) was analyzed for SVOCs. Another subset of samples (SW7, SW10, SW12, SW13, and SW14) was also analyzed for CSM/CSM degradation products. The results are reported in Tables A.1-70–A.1-72.

TABLE A.1-70 Analytical Results for Selected VOCs in Surface Water Samples Collected from the TBP AOC: 1993[a]

	Concentration (µg/L) by Sample Location				
Parameter	SW6	SW7	SW8	SW10	SW11
Acetone	9.0 J	17	6.0 J	110 DJ	8.0 J
Benzene	<10	<10	<10	<10	<10
Carbon tetrachloride	<10	<10	<10	<10	<10
Chlorobenzene	<10	<10	<10	<10	<10
1,1-Dichloroethene	<10	<10	<10	<10	<10
cis-1,2-Dichloroethene	NT	NT	<10	NT	NT
trans-1,2-Dichloroethene	NT	NT	<10	NT	NT
1,2-Dichloroethene (total)	<10	19	<10	1,400	16
Ethylbenzene	NT	<10	<10	NT	<10
Methylene chloride	NT	1.0 BJ	<10	278 DJ	<10
1,1,2,2-Tetrachloroethane	NT	190	<10	<10	8.0 J
Tetrachloroethene	NT	1.0J	<10	40 DJ	<10
Toluene	NT	1.0 J	<10	<10	<10
1,1,2-Trichloroethane	NT	13	2.0 J	2,300 D	1.0 J
Trichloroethene	NT	59	<10	<10	<10
Vinyl chloride	NT	<10	<10	<10	2.0 J
Xylenes	NT	<10	<10	<10	<10

	Concentration (µg/L) by Sample Location			
Parameter	SW12	SW13	SW14	SW15
Acetone	8.0 J	11	<10	<10
Benzene	<10	<10	<10	<10
Carbon tetrachloride	<10	<10	<10	<10
Chlorobenzene	<10	<10	<10	<10
1,1-Dichloroethene	<10	<10	<10	<10
cis-1,2-Dichloroethene	NT	NT	NT	NT
trans-1,2-Dichloroethene	NT	NT	NT	NT
1,2-Dichloroethene (total)	<10	<10	<10	<10
Ethylbenzene	<10	<10	<10	<10
Methylene chloride	<10	<10	<10	<10
1,1,2,2-Tetrachloroethane	<10	<10	<10	<10
Tetrachloroethene	<10	<10	<10	<10
Toluene	<10	<10	<10	<10
1,1,2-Trichloroethane	<10	<10	<10	<10
Trichloroethene	<10	<10	<10	<10
Vinyl chloride	<10	<10	<10	<10
Xylenes	<10	<10	<10	<10

[a] Notation: B = analyte also found in associated blank; D = value obtained from dilution; J = estimated value; NT = not tested.

TABLE A.1-71 Analytical Results for Selected Total Metals in Surface Water Samples Collected from the TBP AOC: 1993[a]

	Concentration (µg/L) by Sample Location					
Parameter	SW6	SW7	SW8	SW9	SW10	SW11
Arsenic	***2.3 B***	<2.0	<2.0	<2.0	***3.8 B***	***2.2 B***
Cadmium	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Calcium	27,700	33,500	123,000	63,500	78,500	43,800
Chromium	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0
Copper	***15 B***	***11 B***	***6.9 B***	***7.5 B***	<5.0	***18 B***
Iron	***181,100***	***3,740***	2,980	458	1,170	1,050
Lead	***6.1***	<1.0	<1.0	<1.0	<1.0	7.8
Magnesium	19,500	25,100	52,000	24,900	15,800	58,000
Mercury	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Zinc	***73***	43	18 B	33	22	***262***

	Concentration (µg/L) by Sample Location				Freshwater Marsh Background[b] (µg/L)	Estuarine Marsh Background[b] (µg/L)
Parameter	SW12	SW13	SW14	SW15		
Arsenic	<2.0	<2.0	***3.4 B***	***2.9 B***	NA	2
Cadmium	<4.0	<4.0	<2.5	<2.5	NA	NA
Calcium	23,600	19,400	101,000	99,500	NA	NA
Chromium	<6.0	<6.0	<5.2	<5.2	15	7
Copper	***14 B***	***12 B***	<4.0	***4.7 B***	10	4
Iron	3,190	1,890	2,900	1,310	18,810	3,385
Lead	***20***	2.4 B	2.4 B	<1.0	6	4
Magnesium	49,900	15,600	218,000	224,000	NA	NA
Mercury	<0.10	<0.10	<0.05	<0.05	NA	NA
Zinc	***782***	36	57	30	61	22

[a] Notation: B = analyte also found in associated blank; NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from freshwater and estuarine marsh data in ICF Kaiser Engineers (1995).

TABLE A.1-72 Analytical Results for CSM Degradation Products in Surface Water Samples Collected from the TBP AOC: 1993

Parameter	SW7	SW10	SW12	SW13	SW14	SW22
Diisopropylmethyl phosphonate	<0.39	0.45	<0.39	<0.39	<0.39	<0.39
Dimethylmethyl phosphate	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Dithiane	<1.3	2.5	<1.3	<1.3	<1.3	<1.3
Isopropylmethyl phosphonic acid	<100	<100	<100	<100	<100	<100
1,1-Oxathiane	<2.4	12	<2.4	<2.4	<2.4	<2.4
Thiodiglycol	<10	<10	<10	<10	<10	<10

The highest concentrations of VOCs were detected in sample SW10, located near the Pushout Area-marsh boundary (Figure A.1-9). Low levels of arsenic, lead, copper, and zinc were detected in some samples; the highest levels were typically found in samples nearest the Pushout Area-marsh boundary. No SVOCs, pesticides, or PCBs were detected. Low levels of 1,1-oxathiane (12 µg/L) and dimethylmethyl phosphonate (0.45 µg/L) were detected in sample SW10.

In 1994, ANL collected surface water samples at USGS locations SW7, SW10, SW11, and SW12. These samples were analyzed for VOCs, SVOCs, metals (total), major cations and anions, pesticides, CSM/CSM degradation products, and explosives-related compounds. Twelve other surface water samples were also collected from within the TBP AOC marsh: SW21, Q55SW, Q56SW, Q58SW, Q59SW, Q60SW, Q62SW, Q64SW, Q65SW, Q93SW, and Q95SW (Figure A.1-11). Sample SW21 and the Q-series samples (except for Q64SW) were analyzed only for VOCs. A subset of samples (SW7 and SW10) was analyzed for gross alpha and gross beta radioactivity; samples SW11 and SW12 were analyzed for cesium-137 only. The results are reported in Tables A.1-73 and A.1-74.

The highest levels of VOCs were detected in sample SW10 — cis-12DCE (1,809 µg/L), trans-DCE (239 µg/L), 112TCE (138 µg/L), TCLEA (4,348 µg/L), and TRCLE (3,615 µg/L) (Table A.1-73). The concentrations of these contaminants were notably higher than in samples collected from the same location in 1993. Elevated levels of arsenic, copper, lead, and zinc were detected in samples SW11 and SW12; the highest concentrations were in SW11 — 36 µg/L for arsenic, 525 µg/L for copper, 1,590 µg/L for lead, and 4,040 µg/L for zinc. No SVOCs, pesticides, or PCBs were detected. Low levels of RDX were detected in samples SW11 (0.98 µg/L) and SW12 (1.0 µg/L).

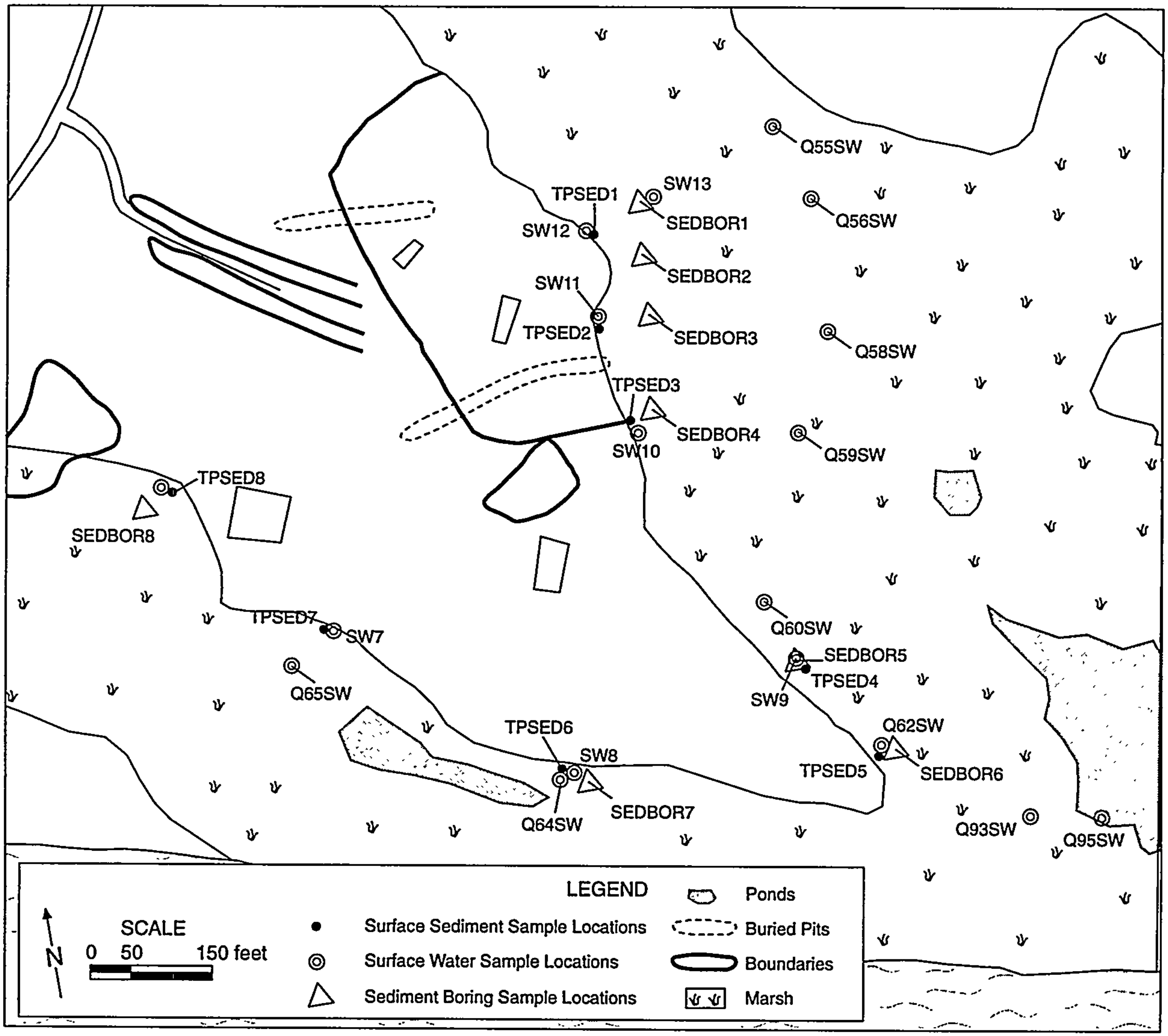

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FIGURE A.1-11 Locations of Surface Water and Sediment Samples Collected near the TBP AOC: 1994 and 1995

TABLE A.1-73 Analytical Results for Selected VOCs in Surface Water Samples Collected from the TBP AOC: 1994[a]

	Concentration (µg/L) by Sample Location					
Parameter	SW7[b]	SW7[c]	SW10[b]	SW10[c]	SW11[b]	SW11[c]
Acetone	<10	<10	30	<10	<10	<10
Benzene	<10	<10	<10	<10	<10	<10
Carbon tetrachloride	<10	<10	<10	<10	<10	<10
Chlorobenzene	<10	<10	<10	<10	<10	<10
1,1-Dichloroethene	<10	<10	5.0 J	3.0 J	<10	<10
cis-1,2-Dichloroethene	7.0 J	NT	1,809	NT	2.0 J	NT
trans-1,2-Dichloroethene	2.0 J	NT	239	NT	<10	NT
1,2-Dichloroethene (total)	NT	<10	NT	1,700	NT	86
Ethylbenzene	<10	<10	<10	<10	<10	<10
Methylene chloride	<10	<10	<10	<10	<10	<10
1,1,2,2-Tetrachloroethane	211	<10	4,348	910 E	<10	3.0J
Tetrachloroethene	<10	<10	<10	<10	<10	<10
Toluene	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	<10	<10	138	95	2.0 J	3.0 J
Trichloroethene	37	3.0 J	3,615	94	<10	13
Vinyl chloride	<10	<10	29	26	<10	22
Xylenes	<10	<10	<10	<10	<10	<10

	Concentration (µg/L) by Sample Location					
Parameter	SW12	SW21	Q55SW	Q56SW	Q58SW	Q59SW
Acetone	<10	<10	18 B	14 B	15 J	12 B
Benzene	<10	<10	<10	<10	<10	<10
Carbon tetrachloride	<10	<10	<10	<10	<10	<10
Chlorobenzene	<10	<10	<10	<10	<10	<10
1,1-Dichloroethene	<10	<10	<10	<10	<10	<10
cis-1,2-Dichloroethene	NT	NT	<10	NT	<10	<10
trans-1,2-Dichloroethene	NT	NT	<10	<10	<10	<10
1,2-Dichloroethene (total)	<10	<1.0	NT	<10	NT	NT
Ethylbenzene	<10	<10	<10	<10	<10	<10
Methylene chloride	<10	<10	<10	<10	<10	<10
1,1,2,2-Tetrachloroethane	<10	<10	4.7 J	<10	<10	<10
Tetrachloroethene	<10	<10	<10	<10	<10	<10
Toluene	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	<10	<10	<10	<10	<10	<10
Trichloroethene	<10	<10	<10	<10	<10	<10
Vinyl chloride	<10	<10	<10	<10	<10	<10
Xylenes	<10	<10	<10	<10	<10	<10

TABLE A.1-73 (Cont.)

Parameter	Concentration (µg/L) by Sample Location Q60SW	Q62SW	Q65SW	Q93SW	Q95SW
Acetone	<10	14	21 B	8.0 BJ	22 B
Benzene	<10	<10	<10	<10	<10
Carbon tetrachloride	<10	<10	<10	<10	<10
Chlorobenzene	<10	<10	<10	<10	<10
1,1-Dichloroethene	<10	<10	<10	<10	<10
cis-1,2-Dichloroethene	6.0 J	5.0 J	<10	6.0 J	11
trans-1,2-Dichloroethene	<10	<10	<10	<10	<10
1,2-Dichloroethene (total)	NT	NT	NT	NT	NT
Ethylbenzene	<10	<10	<10	<10	<10
Methylene chloride	<10	<10	<10	<10	<10
1,1,2,2-Tetrachloroethane	<10	<10	5.0 J	6.0 J	15
Tetrachloroethene	<10	7.0 J	<10	6.0 J	15
Toluene	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	<10	<10	<10	<10	1.0 J
Trichloroethene	<10	<10	<10	<10	<10
Vinyl chloride	<10	<10	<10	<10	<10
Xylenes	<10	<10	<10	<10	<10

[a] Notation: J = estimated value; NT = not tested.

[b] Sample collected in February 1994.

[c] Sample collected in May 1994.

Gross beta activity in both SW7 (22 pCi/g) and SW10 (17 pCi/g) was found to exceed the mean background as reported in ICF Kaiser Engineers (1995). No cesium-137 was detected in SW11 or SW12.

In 1997, investigators from the University of Maryland's Agricultural Experiment Station collected surface water from locations SW10, SW11, and SW12. The samples were analyzed for water chemistry, VOCs, metals, base neutral and acid compounds, PCBs, pesticides, herbicides, and explosives-related compounds (Burton and Turley 1997). VOCs were detected in surface water from location SW10, including vinyl chloride (57 µg/L), trans-12DCE (94 µg/L), 112TCE (11 µg/L), TCLEA (230 µg/L), and TRCLE (61 µg/L). Elevated levels (as dry weight) of chromium (99 mg/kg), lead (2,500 mg/kg), and zinc (2,200 mg/kg) were detected in water from SW11. Copper (50 µg/L), lead (200 µg/L), and zinc (630 µg/L) in sample SW12 exceeded the calculated background for

TABLE A.1-74 Analytical Results for Selected Total Metals in Surface Water Samples Collected from the TPB AOC: 1994[a]

	Concentration (µg/L) by Sample Location				Freshwater Marsh
Parameter	SW7	SW10	SW11	SW12	Background[b] (µg/L)
Arsenic	2.4 B	6.4 B	36	18	NA
Cadmium	<3.0	<3.0	<4.0	<4.0	NA
Calcium	35,800	106,000	98,700	33,800	NA
Chromium	<5.0	5.6 B	***65***	8.0 B	15
Copper	<3.0	<3.0	***525***	***105***	10
Iron	***21,000***	3,470	***128,000***	13,000	18,810
Lead	2.1 B	***6.5***	***1,590 S***	***169***	6.0
Magnesium	44,500	28,500	110,000	68,900	NA
Mercury	<0.20	<0.20	1.7	<0.20	NA
Zinc	***12***	***18***	***4,040 E***	***968 E***	61

[a] Notation: B = analyte also found in the associated blank; E = estimated value; S = reported value determined by the method of standard additions; NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background data were derived frrm freshwater marsh data in ICF Kaiser Engineers (1995).

freshwater marsh as reported in ICF Kaiser Engineers (1995). No acid or base neutral compounds, PCBs, pesticides, herbicides, or explosives-related compounds were detected.

Sixteen sediment samples (SEDBOR1–8 and TPSED1–8) were collected from the TBP AOC marsh in 1994 and 1995 (Figure A.1-11). Samples in the SEDBOR series (1994) were collected at 2-ft depth intervals up to a total depth of 10 ft in most cases; the TPSED series (1995) consisted of surface samples collected at depths of 0–6 in. The SEDBOR series samples were analyzed for VOCs, SVOCs, and metals (Tables A.1-75 and A.1-76). The TPSED series samples were analyzed for VOCs, metals, cyanide, pesticides, PCBs, CSM/CSM degradation products, and explosives (Tables A.1-77 and A.1-78).

Only low levels of VOCs were detected in the 1994 SEDBOR series samples. For example, toluene was found at 150 µg/kg in SEDBOR2 (3–5 ft), and TRCLE was found at 170 µg/kg in SEDBOR3 (6–8 ft) (Table A.1-75). Both samples were from locations within 50 ft of the Pushout Area-marsh boundary. SVOCs were found at levels above the detection limits only in sample SEDBOR7. Several SVOCs were found in that sample — benzo[a]anthracene (1,200 µg/kg), benzo[a]pyrene (900 µg/kg), benzo[b]fluoranthene (1,700 µg/kg), benzo[g,h,i]perylene (700 µg/kg),

TABLE A.1-75 Analytical Results for Selected VOCs in Sediment Samples Collected from the TBP AOC: 1994[a]

	Concentration (µg/kg) by Sample Location				
Parameter	SEDBOR1 (6–8 ft)	SEDBOR1 (8–10 ft)	SEDBOR1 (10–12 ft)	SEDBOR2 (3–5 ft)	SEDBOR2 (5–8 ft)
Acetone	<15	43 B	<14	1,100 DB	40 B
Benzene	<15	<13	<12	<26	<14
Carbon tetrachloride	<15	<13	<12	<26	<14
Chlorobenzene	<15	<13	<12	<26	<14
1,1-Dichloroethene	<15	<13	<12	<26	<14
cis-1,2-Dichloroethene	NT	NT	NT	NT	NT
trans-1,2-Dichloroethene	NT	NT	NT	NT	NT
1,2-Dichloroethene (total)	<15	<13	<12	<26	<14
Ethylbenzene	<15	<13	<12	<26	<14
Methylene chloride	<15	<13	<12	<26	<14
1,1,2,2-Tetrachloroethane	<15	<13	<12	<26	<14
Tetrachloroethene	<15	<13	<12	<26	<14
Toluene	<15	<13	<12	150	20
1,1,2-Trichloroethane	<15	<13	<12	<26	<14
Trichloroethene	<15	<13	<12	<26	<14
Vinyl chloride	<15	<13	<12	<26	<14
Xylenes	<15	<13	<12	<26	<14

TABLE A.1-75 (Cont.)

Parameter	SEDBOR2 (8–10 ft)	SEDBOR3 (6–8 ft)	SEDBOR3 (8–10 ft)	SEDBOR4 (5–8 ft)	SEDBOR4 (8–10 ft)
	Concentration (µg/kg) by Sample Location				
Acetone	<12	17 B	<12	<20	19 B
Benzene	<12	<13	<12	<20	<13
Carbon tetrachloride	<12	<13	<12	<20	<13
Chlorobenzene	<12	<13	<12	<20	<13
1,1-Dichloroethene	<12	<13	<12	<20	<13
cis-1,2-Dichloroethene	NT	NT	NT	NT	NT
trans-1,2-Dichloroethene	NT	NT	NT	NT	NT
1,2-Dichloroethene (total)	<12	89	<12	2,200	360
Ethylbenzene	<12	<13	<12	<20	<13
Methylene chloride	<12	<13	<12	<20	<13
1,1,2,2-Tetrachloroethane	<12	<13	31	99	<13
Tetrachloroethene	<12	<13	<12	<20	<13
Toluene	<12	<13	<12	<20	<13
1,1,2-Trichloroethane	<12	<13	10 J	76	<13
Trichloroethene	<12	170	91	<20	<13
Vinyl chloride	<12	<13	<12	54	<13
Xylenes	<12	<13	<12	<20	<13

TABLE A.1-75 (Cont.)

Parameter	SEDBOR5 (2–4 ft)	SEDBOR5 (4–6 ft)	SEDBOR5 (6–8 ft)	SEDBOR5 (8–10 ft)	SEDBOR6 (2–4 ft)	SEDBOR6 (4–6 ft)
	Concentration (µg/kg) by Sample Location					
Acetone	<12	16 B	<12	<12	<12	<12
Benzene	<12	<12	<12	<12	3.0 J	<12
Carbon tetrachloride	<12	<12	<12	<12	<12	<12
Chlorobenzene	<12	<12	<12	<12	<12	<12
1,1-Dichloroethene	<12	<12	<12	<12	<12	<12
cis-1,2-Dichloroethene	NT	NT	NT	NT	NT	NT
trans-1,2-Dichloroethene	NT	NT	NT	NT	NT	NT
1,2-Dichloroethene (total)	<12	<12	<12	<12	<12	<12
Ethylbenzene	<12	<12	<12	<12	<12	<12
Methylene chloride	<12	<12	<12	<12	<12	<12
1,1,2,2-Tetrachloroethane	<12	<12	<12	<12	<12	<12
Tetrachloroethene	<12	<12	<12	<12	<12	<12
Toluene	<12	<12	<12	<12	<12	<12
1,1,2-Trichloroethane	<12	<12	<12	<12	<12	<12
Trichloroethene	<12	<12	<12	<12	<12	<12
Vinyl chloride	<12	<12	<12	<12	<12	<12
Xylenes	<12	<12	<12	<12	<12	<12

TABLE A.1-75 (Cont.)

	Concentration (μg/kg) by Sample Location					
	SEDBOR6 (6–8 ft)	SEDBOR6 (8–10 ft)	SEDBOR7 (2–4 ft)	SEDBOR7 (4–6 ft)	SEDBOR7 (6–8 ft)	SEDBOR7 (8–10 ft)
Acetone	<12	<12	<12	<12	<12	1,100 DB
Benzene	4.0 J	<12	<12	<12	<12	<12
Carbon tetrachloride	<12	<12	<12	<12	<12	<12
Chlorobenzene	<12	<12	<12	<12	<12	<12
1,1-Dichloroethene	<12	<12	<12	<12	<12	<12
cis-1,2-Dichloroethene	NT	NT	NT	NT	NT	NT
trans-1,2-Dichloroethene	NT	NT	NT	NT	NT	NT
1,2-Dichloroethene (total)	<12	<12	<12	<12	<12	<12
Ethylbenzene	<12	<12	<12	<12	<12	<12
Methylene chloride	<12	<12	<12	<12	<12	<12
1,1,2,2-Tetrachloroethane	<12	<12	<12	<12	<12	<12
Tetrachloroethene	<12	<12	<12	<12	<12	<12
Toluene	<12	<12	<12	<12	<12	<12
1,1,2-Trichloroethane	<12	<12	<12	<12	<12	<12
Trichloroethene	<12	<12	<12	<12	<12	<12
Vinyl chloride	<12	<12	<12	<12	<12	<12
Xylenes	<12	<12	<12	<12	<12	<12

TABLE A.1-75 (Cont.)

	Concentration (µg/kg) by Sample Location				
Parameter	SEDBOR8 (0–2 ft)	SEDBOR8 (2–4 ft)	SEDBOR8 (4–6 ft)	SEDBOR8 (6–8 ft)	SEDBOR8 (8–10 ft)
Acetone	20 B	<12	23 B	20 B	88 B
Benzene	<13	<12	<12	<12	<12
Carbon tetrachloride	<13	<12	<12	<12	<12
Chlorobenzene	<13	<12	<12	<12	<12
1,1-Dichloroethene	<13	<12	<12	<12	<12
cis-1,2-Dichloroethene	NT	NT	NT	NT	NT
trans-1,2-Dichloroethene	NT	NT	NT	NT	NT
1,2-Dichloroethene (total)	<13	<12	<12	<12	<12
Ethylbenzene	<13	<12	<12	<12	<12
Methylene chloride	<13	<12	<12	<12	<12
1,1,2,2-Tetrachloroethane	<13	<12	<12	<12	<12
Tetrachloroethene	<13	<12	<12	<12	<12
Toluene	<13	<12	<12	<12	<12
1,1,2-Trichloroethane	<13	<12	<12	<12	<12
Trichloroethene	<13	<12	<12	<12	<12
Vinyl chloride	<13	<12	<12	<12	<12
Xylenes	<13	<12	<12	<12	<12

[a] Notation: B = analyte also found in the associated blank; D = sample was diluted for analysis; NT = not tested.

TABLE A.1-76 Analytical Results for Selected Metals in Sediment Samples Collected from the TBP AOC: 1994[a]

Parameter	SEDBOR1 (6–8 ft)	SEDBOR1 (8–10 ft)	SEDBOR1 (10–12 ft)	SEDBOR1 (3–5 ft)	SEDBOR2 (5–8 ft)
	Concentration (mg/kg) by Sample Location				
Arsenic	4.4	11	1.2	14	5.6
Cadmium	<0.57	<0.59	<0.51	2.6	<0.58
Calcium	596	421	351	1,300	691
Chromium	18	20	14	36	14
Copper	18	18	11	319	11
Iron	14,100	16,500	9,350	14,200	9,750
Lead	13	21	12	318	13
Magnesium	2,200	2,370	1,360	2,030	1,630
Mercury	<0.11	<0.11	<0.095	0.38	<0.14
Zinc	57	46	60	445	32

Parameter	SEDBOR2 (8–10 ft)	SEDBOR3 (6–8 ft)	SEDBOR3 (8–10 ft)	SEDBOR4 (5–8 ft)	SEDBOR4 (8–10 ft)
	Concentration (mg/kg) by Sample Location				
Arsenic	1.4	0.96	0.31	6.7	1.9
Cadmium	<0.48	<0.46	<0.48	<0.85	<0.54
Calcium	471	413	275	1,150	346
Chromium	12	7.0	7.1	10	5.4
Copper	11	1.5	3.5	16	4.5
Iron	14,000	6,710	4,530	10,600	4,800
Lead	7.9	5.6	8.3	62	7.4
Magnesium	1,650	552	973	907	350
Mercury	<0.090	0.094	<0.11	<0.15	<0.12
Zinc	64	12	39	193	43

TABLE A.1-76 (Cont.)

	Concentration (mg/kg) by Sample Location				
Parameter	SEDBOR5 (2–4 ft)	SEDBOR5 (4–6 ft)	SEDBOR5 (6–8 ft)	SEDBOR5 (8–10 ft)	SEDBOR6 (2–4 ft)
Arsenic	3.4	3.4	3.2	3.9	3.1
Cadmium	<0.52	<0.46	<0.52	<0.49	<0.56
Calcium	503	506	284	258	427
Chromium	12	18	11	12	12
Copper	5.4	8.9	5.0	7.4	4.3
Iron	10,900	17,400	12,000	12,000	12,300
Lead	11	8.7	5.7	11	6.7
Magnesium	1,620	1,980	1,180	1,360	1,390
Mercury	<0.080	<0.080	0.16	<0.10	<0.11
Zinc	27	33	25	46	21

	Concentration (mg/kg) by Sample Location				
Parameter	SEDBOR6 (4–6 ft)	SEDBOR6 (6–8 ft)	SEDBOR6 (8–10 ft)	SEDBOR7 (2–4 ft)	SEDBOR7 (4–6 ft)
Arsenic	3.8	2.1	2.6	1.9	1.2
Cadmium	<0.52	<0.50	<0.48	<0.60	<0.47
Calcium	493	369	614	754	504
Chromium	15	8.8	17	9.5	12
Copper	8.3	5.0	9.0	5.8	5.8
Iron	14,600	8,430	12,000	8,570	8,070
Lead	10	4.4	7.4	7.7	5.6
Magnesium	1,560	1,200	2,050	1,260	1,160
Mercury	<0.090	<0.10	<0.10	<0.11	<0.10
Zinc	24	24	43	33	26

TABLE A.1-76 (Cont.)

	Concentration (mg/kg) by Sample Location			
Parameter	SEDBOR7 (6–8 ft)	SEDBOR7 (8–10 ft)	SEDBOR8 (0–2 ft)	SEDBOR8 (2–4 ft)
Arsenic	3.1	3.1	3.4	3.5
Cadmium	<0.55	<0.52	<0.58	<0.49
Calcium	428	393	606	253
Chromium	14	16	13	7.1
Copper	8.7	7.7	22	3.9
Iron	11,600	11,500	6,600	6,020
Lead	10	9.6	20	3.5
Magnesium	1,400	40	1,050	642
Mercury	<0.12	<0.080	<0.11	<0.11
Zinc	***47***	***33***	***64***	***27***

	Concentration (mg/kg) by Sample Location			Estuarine Marsh Background[b] (mg/kg)
Parameter	SEDBOR8 (4–6 ft)	SEDBOR8 (6–8 ft)	SEDBOR8 (8–10 ft)	
Arsenic	1.7	3.5	2.7	9
Cadmium	<0.49	<0.54	<0.56	2
Calcium	141	131	94	NA
Chromium	5.2	4.9	4.0	60
Copper	3.2	2.6	2.2	90
Iron	3,740	4,110	3,250	NA
Lead	4.2	3.6	2.4	80
Magnesium	515	519	436	NA
Mercury	***0.62***	<0.12	<0.090	0.46
Zinc	***17***	***14***	***17***	1.1

[a] Notation: NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from estuarine marsh data in ICF Kaiser Engineers (1995).

TABLE A.1-77 Analytical Results for Selected VOCs in Sediment Samples Collected from the TBP AOC: 1995[a]

Parameter	Concentration (mg/kg) by Sample Location TPSED1	TPSED2	TPSED3	TPSED4
Acetone	6.1	170	200	120
Benzene	<32	<17	<24	<24
Carbon tetrachloride	<32	<17	<24	<24
Chlorobenzene	<32	<17	<24	<24
1,1-Dichloroethene	<32	<17	<24	<24
cis-1,2-Dichloroethene	NT	NT	NT	NT
trans-1,2-Dichloroethene	NT	NT	NT	NT
1,2-Dichloroethene (total)	<32	72	45	<24
Ethylbenzene	<32	<17	<24	<24
Methylene chloride	<32	5.0	<24	13
1,1,2,2-Tetrachloroethane	<32	<17	23	<24
Tetrachloroethene	<32	<17	<24	<24
Toluene	<32	2.0	18	7.0
1,1,2-Trichloroethane	<32	<17	4.0	<24
Trichloroethene	<32	11	29	<24
Vinyl chloride	<32	5.4	<24	<24
Xylenes	<32	<17	<24	<24

Parameter	Concentration (mg/kg) by Sample Location TPSED5	TPSED6	TPSED7	TPSED8
Acetone	<20	<22	2.0	<14
Benzene	<20	<22	<15	<14
Carbon tetrachloride	<20	<22	<15	<14
Chlorobenzene	<20	<22	<15	<14
1,1-Dichloroethene	<20	<22	<15	<14
cis-1,2-Dichloroethene	NT	NT	NT	NT
trans-1,2-Dichloroethene	NT	NT	NT	NT
1,2-Dichloroethene (total)	<20	<22	4.0	<14
Ethylbenzene	<20	<22	<15	<14
Methylene chloride	6.0 BJ	13	<15	7.0
1,1,2,2-Tetrachloroethane	<20	<22	6.0	<14
Tetrachloroethene	<20	<22	<15	<14
Toluene	<20	<22	<15	<14
1,1,2-Trichloroethane	<20	<22	9.0	<14
Trichloroethene	<20	<22	15	<14
Vinyl chloride	<20	<22	<15	<14
Xylenes	<20	<22	<15	<14

[a] Notation: B = analyte also found in the associated blank; J = estimated value; NT = not tested.

TABLE A.1-78 Analytical Results for Selected Metals in Sediment Samples Collected from the TBP AOC: 1995[a]

	Concentration (mg/kg) by Sample Location			
Parameter	TPSED1	TPSED2	TPSED3	TPSED4
Arsenic	***12***	***14***	7.0	1.5
Cadmium	***7.0***	1.3	1.6	1.1
Calcium	2,470	1,530	3,300	5,720
Chromium	***80***	46	8.7	7.2
Copper	***515***	***209***	55	15
Iron	33,400	25,700	9,870	5,740
Lead	***1,780***	***1,260***	35	24
Magnesium	5,110	3,080	994	1,760
Mercury	***1.7***	***0.75***	0.16	0.25
Zinc	***3,410***	***1,410***	***240***	***107***

	Concentration (mg/kg) by Sample Location				Estuarine Marsh Background[b] (mg/kg)
Parameter	TPSED5	TPSED6	TPSED7	TPSED8	
Arsenic	1.7	2.9	3.0	1.1	9
Cadmium	0.89	<0.66	0.57	0.65	2
Calcium	2,720	3,870	3,520	1,020	NA
Chromium	8.7	10	46	9.0	60
Copper	13	16	13	34	90
Iron	4,920	9,620	35,600	5,780	NA
Lead	18	21	8.3	21	80
Magnesium	1,700	1,840	1,080	793	NA
Mercury	<0.10	0.11	<0.072	<0.056	0.46
Zinc	***69***	***67***	***52***	***29***	1.1

[a] Notation: NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from estuarine marsh data in ICF Kaiser Engineers (1995).

chrysene (1,200 µg/kg), fluoranthene (2,300 µg/kg), ideno(1,2,3)pyrene (610 µg/kg), phenanthrene (1,400 µg/kg), and pyrene (1,800 µg/kg).

Only low levels of metals were detected in most SEDBOR samples (Table A.1-76). The highest metal contamination was found in sample SEDBOR2 (3–5 ft) — arsenic at 14 mg/kg, lead at 318 mg/kg, mercury at 0.38 mg/kg, and zinc at 445 mg/kg. Metal concentrations in sample SEDBOR4 (5–8 ft) were also fairly high.

The contamination patterns of the 1995 TPSED samples were similar to those of the 1994 SEDBOR samples. VOCs were highest in three samples: TPSED1, TPSED2, and TPSED3 (Table A.1-78). Each sample site is along the Pushout Area-marsh boundary. Lead and zinc concentrations were significantly higher in the TPSED samples than in the SEDBOR samples, especially in TPSED1, in which lead was detected at 1,780 mg/kg and zinc at 3,410 mg/kg. It is likely that the concentrations are higher in these samples than in the SEDBOR samples because the TPSED samples represent sediment that was eroded directly from the Pushout Area. The SEDBOR samples were collected at least 50 ft east of the Pushout Area-marsh boundary.

Pesticides were detected in samples TPSED2, TPSED3, and TPSED7. The highest concentrations were in TPSED3 — DDD (up to 22 µg/kg), DDE (up to 16 µg/kg), and DDT (up to 7.9 µg/kg). Dinitrobenzene, an explosives-related compound, was found in TPSED1 (2,110 µg/kg). No other explosives were detected. No cyanide or CSM/CSM degradation products were detected.

A.2 WHITE PHOSPHORUS BURNING PITS AREA OF CONCERN

A.2.1 Screening Investigations

A.2.1.1 Soil Gas

A Phase II passive soil gas survey (EMFLUX) was conducted at nine sampling points: one near the Northwestern Suspect Burning Area (200), two in the Northwestern Suspect Burning Area (201 and 202), one in the Southwestern Suspect Burning Area (166), four near the Southwestern Suspect Burning Area (165, 170, 171 and 174), and one near the Suspect Storage Area (167) (Prasad and Martino 1995) (Figure A.2-1). In the Northwestern Suspect Burning Area, emissions of acetone (11 ng/m^2/min) and styrene (4.1 ng/m^2/min) were detected at sampling point 200. The other two samples (201 and 202) did not have any VOCs above the corresponding detection limits. Acetone (4.0–8.3 ng/m^2/min) was detected at all five sampling points around the Southwestern Suspect Burning Area. Low levels of chloromethane were found at sampling points 165 and 171 (4.8 and 5.2 ng/m^2/min), and a low styrene level was found at sampling point 165 (4.0 ng/m^2 /min). In the Suspect Storage Area, a low emission of acetone (6.6 ng/m^2/min) was detected at sampling point 167. The significance of these acetone emissions is questionable because acetone is a common laboratory contaminant and product of many natural processes.

A.2.1.2 In Situ X-Ray Fluorescence

Field XRF measurements were conducted at 16 locations in the Northwestern and Southwestern Suspect Burning Areas (Figure A.2-2). Slightly elevated levels of strontium were detected at XRWPBP4 in the Northwestern Suspect Burning Area and at XRWPBP14 and XRWPBP15 in the Southwestern Suspect Burning Area.

A.2.1.3 Geophysical Surveys

In 1993, a geophysical survey was conducted at the WPP AOC, including the Suspect Storage Area at the southeastern corner of the AOC (Daudt et al. 1994). The methods used included seismic refraction, seismic reflection, electrical resistivity soundings, electromagnetic conductivity, magnetometer, and GPR. No significant geophysical anomalies were found.

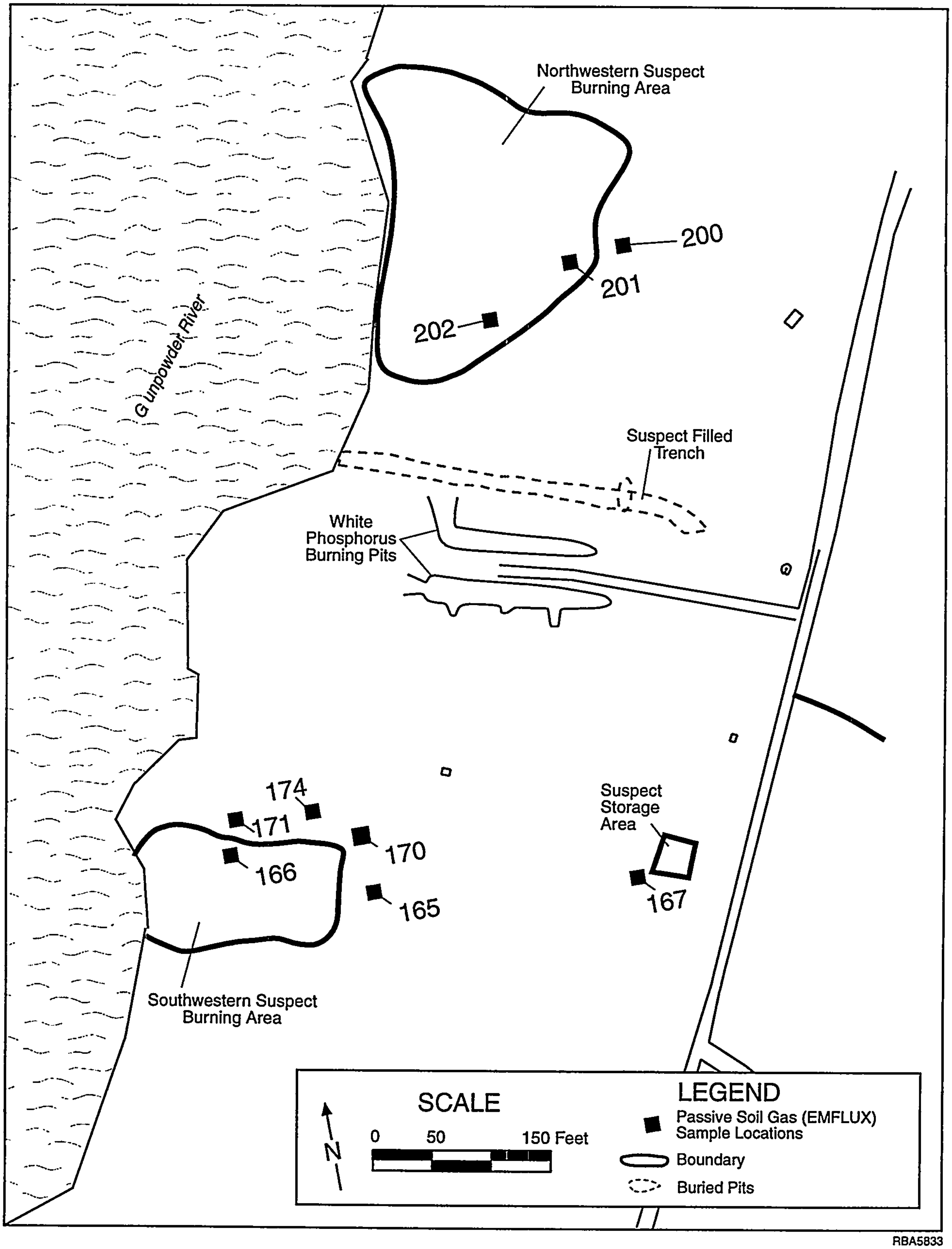

FIGURE A.2-1 Locations of Soil Gas Samples in the WPP AOC and PAOCs in the Area

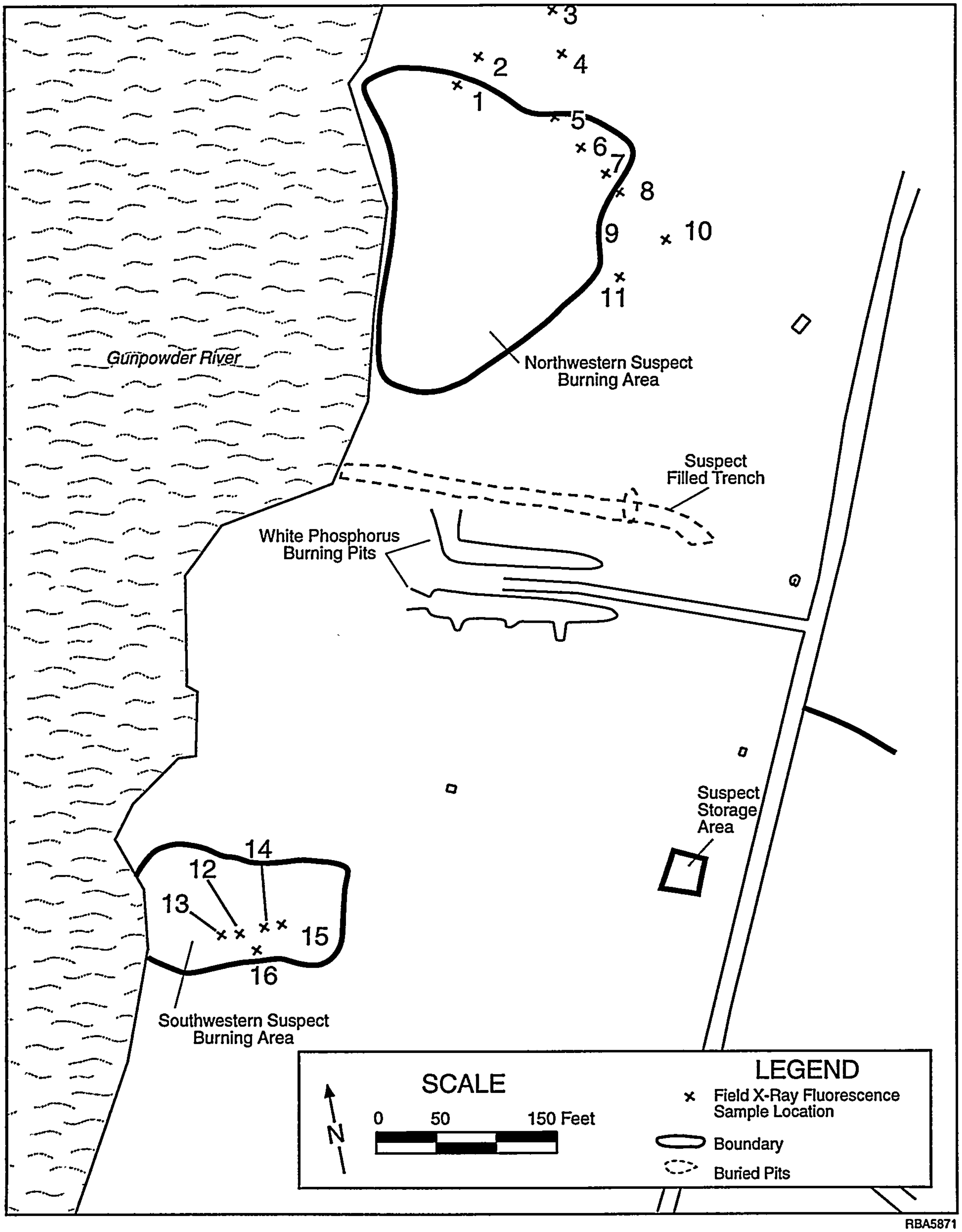

FIGURE A.2-2 Locations of X-Ray Fluorescence Measurements at the WPP AOC

In 1995, a more focused geophysical survey was conducted at the Suspect Storage Area by using electromagnetic conductivity, electromagnetic induction, magnetometer, and GPR methods (Davies et al. 1995). A linear conductivity anomaly was present in the eastern portion of the Suspect Storage Area and was associated with a utility post. The anomalies were most likely caused by a buried cable or a utility line. No evidence of organized burials was revealed by the magnetics, electromagnetic induction, or GPR surveys in the area (Davies et al. 1995).

A.2.2 Soil Analyses

A.2.2.1 Surface Soil

In 1991, the USGS collected one surface soil sample near the Northwestern Suspect Burning Area (sampling point 4) and one near the Southwestern Suspect Burning Area (sampling point 9) (Figure A.2-3). The samples were analyzed for VOCs, SVOCs, metals, and explosives-related compounds (Hughes 1992). The concentrations of VOCs, SVOCs, and explosives were lower than the detection limits of the analytical methods. Most of the metals concentrations measured in these samples were lower than the calculated background levels derived from ICF Kaiser Engineers (1995).

In 1994, one soil boring (CLPW99) was drilled to a depth of 1 ft near the Suspect Storage Area (Figure A.2-3), and two samples were collected: one from 0–6 in. and the other from 6–12 in. These samples were analyzed for VOCs, SVOCs, and metals. Analytical results indicate that VOCs were below the corresponding method detection limits. Di-n-butylphthalate, an SVOC, was detected in both samples (190 µg/kg at 0–6 in. and 86 µg/kg at 6–12 in.). However, this chemical was also detected in a blank sample. Table A.2-1 summarizes the metals results. No metals exceeded the calculated background levels.

In 1995, five surface soil samples were collected to a depth of 6 in.: three from the Northwestern Suspect Burning Area (WPNWS1–3), one north of the Southwestern Suspect Burning Area (WPSWS1), and one in the Southwestern Suspect Burning Area (WPSWS2) (Figure A.2-3). Two additional samples (0–6 in. and 6–12 in.) were collected at one location (WPSTS1) near the Suspect Storage Area. These samples were analyzed for SVOCs, metals, cyanide, and soil pH. Table A.2-2 summarizes the results. Sample WPSTS1 (6–12 in.) was also analyzed for VOCs.

Low levels of acetone (99 µg/kg) and methylene chloride (6.0 µg/kg) were detected in WPSTS (6–12 in.), the only sample analyzed for VOCs. Low levels of SVOCs were detected in all surface soil samples from the WPP AOC. The highest levels were found in sample WPNWS1, from

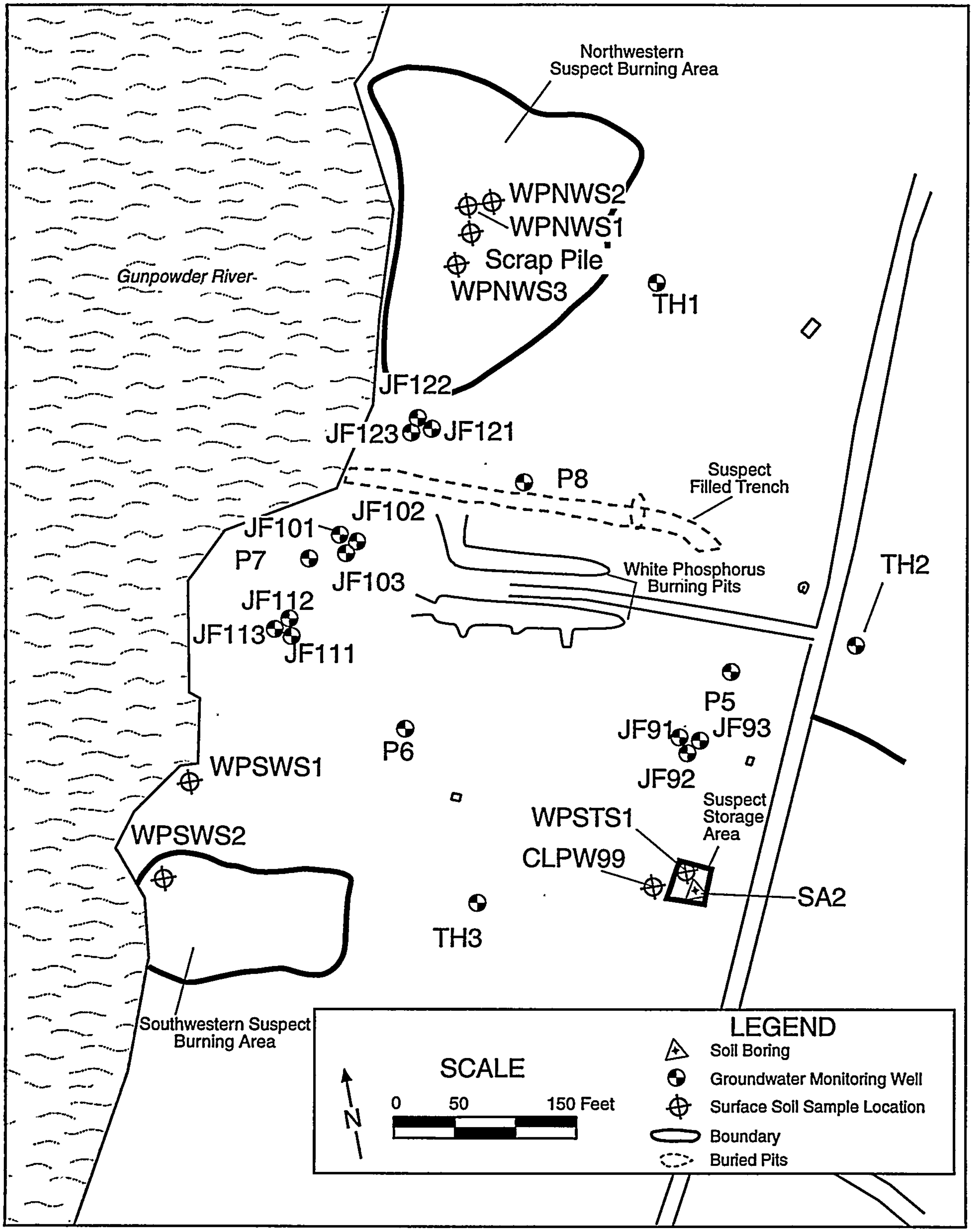

FIGURE A.2-3 Locations of Surface Soil Samples, Monitoring Wells, and Soil Borings at the WPP AOC

TABLE A.2-1 Analytical Results for Selected Metals in Surface Soil Samples Collected from the WPP AOC: 1994[a]

	Concentration (mg/kg) by Sample Location		
Parameter	CLPW99 (0–6 in.)	CLP299 (6–12 in.)	Background (mg/kg)[b]
Arsenic	2.6	***5.0***	5.0
Cadmium	<0.88	<0.80	0.70
Calcium	929	848	NA
Chromium	11	11	41
Copper	8.5	3.4	20
Iron	10,600	11,400	23,400
Lead	15	11	61
Magnesium	903	1,010	NA
Mercury	<0.10	<0.12	0.10
Zinc	52	25	118

[a] Notation: NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

the Northwestern Suspect Burning Area. Several metals, including barium, cadmium, copper, lead, mercury, selenium, and zinc, were found at levels exceeding the calculated background (Table A.2-2). The highest concentrations of metals were found in samples from the Northwestern Suspect Burning Area. Metals concentrations in the WPSTS samples from the Suspect Storage Area did not exceed the calculated background levels. Cyanide was not detected in any of the samples.

In 1995, a soil boring (SA2) was drilled into the Suspect Storage Area. Samples were collected from three depths: 0–2 ft, 2–4 ft, and 6–8 ft. The surface soil sample (0–2 ft) was analyzed for metals only. The deeper samples were analyzed for VOCs and TPH. Table A.2-2 summarizes the metals results for the surface soil sample. Only arsenic was found at levels slightly above background. The results of the deeper samples collected are discussed in the following section (Section A.2.2.2).

TABLE A.2-2 Analytical Results for Various Parameters in Surface Soil Samples Collected from the WPP AOC: 1995[a]

	Concentration by Sample Location								
Parameter	WPNWS1 (0–6 in.)	WPNWS2 (0–6 in.)	WPNWS3 (0–6 in.)	WPSWS1 (0–6 in.)	WPSWS2 (0–6 in.)	WPST1 (0–6 in.)	WPST1 (6–12 in.)	SA2 (0–2 ft)	Background[b]
SVOCs (µg/kg)									
Benzo[a]anthracene	***140***	<524	<502	<485	<347	<370	NT	NT	135
Benzo[b]fluoranthene	***420***	57	<502	130	<347	<370	NT	NT	183
Benzo[k]fluoranthene	<749	<524	69	<485	<347	<370	NT	NT	102
Benzo[a]pyrene	120	<524	<502	72	<347	<370	NT	NT	259
Bis(2-ethylhexyl)phthalate	<749	120	<502	<485	<347	<370	NT	NT	NA
Chrysene	***290***	<524	<502	88	<347	<370	NT	NT	197
Di-n-butylphthalate	<749	78	<502	51	<347	<370	NT	NT	NA
Fluoranthene	***290***	<524	<502	160	<347	<370	NT	NT	173
Indeno[1,2,3-c,d]pyrene	76	<524	<502	<485	<347	<370	NT	NT	165
Pyrene	190	<524	<502	107	<347	<370	NT	NT	290
Metals (mg/kg)									
Arsenic	***5.0***	4.6	3.2	1.1	0.35	2.5	2.9	***5.3***	5.0
Barium	***115***	***108***	***96***	10	<2.2	31	26	21	94
Beryllium	0.86	0.83	0.60	0.23	<0.12	0.19	0.23	0.20	1.0
Cadmium	<0.69	***1.5***	***0.85***	0.62	<0.31	<0.45	<0.46	<0.46	0.70
Copper	***34***	***29***	***29***	10	<2.4	2.5	2.6	4.3	20
Lead	***80***	***76***	58	7.5	1.8	7.7	5.5	5.5	61
Mercury	***0.13***	***0.10***	***0.080***	0.070	<0.044	0.056	<0.048	<0.056	0.080
Nickel	17	15	12	6.1	<2.2	4.3	6.5	4.6	20
Selenium	***1.2***	***0.48***	***0.64***	***0.62***	<0.17	***0.65***	***0.61***	0.28	0.43
Zinc	***187***	***290***	***193***	***123***	8.5	20	23	21	118
pH (standard units)	5.4	5.3	5.4	5.7	5.2	NT	NT	NT	–

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[a] Notation: NA = not available; NT = not tested; a hyphen indicates not applicable. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

A.2.2.2 Subsurface Soil

In 1995, two subsurface soil samples were collected from soil boring SA2 (Figure A.2-3). The samples were analyzed for VOCs and TPH. Low levels of VOCs were detected at both depths: acetone (up to 45 µg/kg at 6–8 ft), methylene chloride (up to 7 µg/kg at 6–8 ft), and TCLEE (1 µg/kg at 2–4 ft). No TPHs were detected.

A.2.3 Groundwater

The major direction of groundwater movement in the surficial aquifer appears to be away from the WPP AOC toward the Gunpowder River in the spring and the reverse in the fall. However, the lateral gradients in the surficial and the confined aquifers are quite small (USGS 1991). The vertical movement of groundwater appears to be downward from the surficial aquifer to the confined aquifer; however, groundwater offshore may flow upward from each aquifer into the Gunpowder River.

In 1977, three monitoring wells (TH1–3) were installed at the WPP AOC as part of an environmental contamination survey conducted by USATHAMA (Nemeth 1989). The wells were 16–18 ft deep and screened in the surficial aquifer (Sonntag 1991). Table A.2-3 provides the dates of installation and construction details for all wells at the WPP AOC. Water samples collected from the wells in 1977 were analyzed for indicator chemicals, VOCs, metals, white phosphorus, mustard degradation products, cholinesterase inhibitors, and base neutral and acid extractable organic compounds.

A mustard degradation product (6 µg/L of 1,3-dithiane) was found in well TH1 near the Northwestern Suspect Burning Area. Aliphatic and aromatic organic compounds were found at levels of up to 200 µg/L in most of the well samples. Organic compounds introduced by the well construction procedure or possible sample contamination were also found at elevated concentrations (e.g., up to 8,000 µg/L of tetrahydrofuran in TH1).

Four additional wells were installed around the WPP AOC (P5–P8 in Figure A.2-3) as part of a munitions disposal study (Princeton Aqua Science 1984). The wells were 17–20 ft deep and screened with 15-ft-long screens in the surficial aquifer (Sonntag 1991). Samples collected from the wells in 1983 were analyzed for metals, nitrate, TOX, TOC, radioactivity, some pesticides and herbicides, and secondary drinking water contaminants. Analyses indicated no major concentrations of metals, pesticides, or herbicides.

TABLE A.2-3 Well Construction Data for Monitoring Wells at the WPP AOC

Well Number	Elevation of Land Surface (ft MSL)	Depth of Boring (ft)	Screened Interval (ft below surface)	Date Installed (Investigator)
P5	10.5	17	2–17	1983 (Princeton Aqua Science)
P6	8.5	17	2–17	1983 (Princeton Aqua Science)
P7	5.2	20	5–20	1983 (Princeton Aqua Science)
P8	6.1	20	5–20	1983 (Princeton Aqua Science)
TH1	3.4	16	6–16	1977 (USATHAMA)
TH2	9.5	18	8–18	1977 (USATHAMA)
TH3	6.1	18	8–18	1977 (USATHAMA)
JF91	10.2	79	74–79	1988–1989 (USGS)
JF92	10.6	55.5	50.5–55.5	1988–1989 (USGS)
JF93	10.3	25	20–25	1988–1989 (USGS)
JF101	5.4	76	73–76	1988–1989 (USGS)
JF102	5.7	55	52–55	1988–1989 (USGS)
JF103	5.4	28	25–28	1988–1989 (USGS)
JF111	6.5	75	69.1–75.0	1988–1989 (USGS)
JF112	6.2	50	47–50	1988–1989 (USGS)
JF113	6.8	25	22–25	1988–1989 (USGS)
JF121	4.2	70	67–70	1988–1989 (USGS)
JF122	4.4	55	52–55	1988–1989 (USGS)
JF123	4.2	28	25–28	1988–1989 (USGS)

In 1986, samples were collected from wells P5-P8 as part of an RFA (Nemeth 1989) and analyzed for indicator parameters, VOCs, SVOCs, metals, explosives-related compounds, radioactivity, and thiodiglycol. Sulfate, total dissolved solids, and TRCLE (560 µg/L in well P7) were the only parameters that were found at elevated concentrations.

In 1988 and 1989, the USGS installed 12 additional monitoring wells at the WPP AOC (Sonntag 1991; Hughes 1993). Three well nests were installed at four different locations (JF9–12; Figure A.2-3). At each site, the three wells were screened in the confined aquifer, leaky confining unit, and surficial aquifer of the Talbot Formation. The groundwater samples collected from these wells were analyzed for VOCs, SVOCs, metals, other inorganic parameters, organosulfur, explosives-related compounds, and radioactivity. Wells were selected on the basis of their proximity to potential disposal areas for these materials (USGS 1991). Low levels of VOCs were detected. Only one well, P7, which is in the active area, had TRCLE contamination (40 µg/L). Potassium concentrations varied considerably, ranging from not detected to 10 µg/L. All of the elevated values (above 50 µg/L) occurred in the leaky confining unit or the confined aquifer. Movement of river water into the groundwater does not appear to be the source of the potassium because the wells with elevated potassium concentrations did not also have elevated chloride concentrations. No other contamination was detected in these groundwater samples.

In 1994, groundwater from the 12 monitoring wells around the WPP AOC was sampled and analyzed for VOCs, metals, general chemistry, and explosives-related compounds (Table A.2-4). The only VOC detected at a level above the MCL was TRCLE (86 µg/L in well P7). No other VOCs were detected. TOX levels were measured as follows: 39 µg/L (well P6), 76 µg/L (well P7), 15 µg/L (well P8), and 8.9 µg/L (well JF93). Table A.2-5 summarizes the metals results. The only metals exceeding MCLs in both filtered (yielding dissolved phase values) and unfiltered (yielding total metals values) samples were iron and manganese. The results indicate that iron tends to be associated with the suspended solids while manganese tends to be mostly in the dissolved phase. The levels of iron and magnesium do not pose an environmental problem.

TABLE A.2-4 Types of Analyses Performed for Samples Collected from the WPP AOC: 1994

	Type of Analysis			
Well	Explosives	General Chemistry	VOCs	Metals
P5			X	
P6	X	X	X	
P7		X	X	X
P8		X	X	X
TH1	X	X	X	X
TH3			X	
JF91			X	
JF93		X	X	
JF101			X	
JF111			X	
JF121			X	
JF123	X	X	X	

TABLE A.2-5 Analytical Results for Selected Metals in Groundwater Samples Collected from the WPP AOC: 1994[a]

	Concentration by Location			
Parameter	P7	P8	TH1	MCL
Dissolved metals (mg/kg)				
Arsenic	1.8 B	1.5 B	<1.0	50
Cadmium	<4.0	<4.0	<4.0	10
Calcium	14,100	29,600	3,470	NA
Cobalt	56	27	21	NA
Iron	***720***	<6.0	<6.0	300
Lead	3.8	<1.0	9.9	50
Manganese	***162***	***182***	***62***	50
Nickel	80	27	20	100
Potassium	414	429	498	NA
Zinc	202	68	33	5,000
Magnesium	12,100	19,500	7,000	NA
Hardness (mg/L)	85	154	37	–
Total metals (mg/kg)				
Arsenic	1.8 B	1.5 B	1.1 B	50
Cadmium	9.6	<4.0	<4.0	10
Calcium	14,600	31,300	3,270	NA
Cobalt	59	23	<7.0	NA
Iron	***3,240***	***958***	***2,460***	300
Lead	9.5	<1.0	42	50
Manganese	***170***	***201***	***117***	50
Nickel	80	61	21	100
Potassium	365	514	640	NA
Zinc	164	91	24	5,000
Magnesium	12,700	20,700	6,960	NA
Hardness (mg/L)	89	163	37	–

[a] Notation: B = analyte found in the associated blank; NA = not available; a hyphen indicates not applicable. Sample concentrations equal to or exceeding the MCLs are presented in bold italics.

A.2.4 Surface Water and Sediments

Nearshore surface water samples were collected in 1988 by the USGS and in 1992 by the EPA. The results are discussed in detail in Section A.1.4.1. The data for surface water and sediment samples indicated that the level of contamination offshore is very low.

In 1994, two surface water samples were collected near the pits at the WPP AOC: WPP-A and WPP-C (Figure A.2-4). The samples were analyzed for VOCs, SVOCs, metals, TOX, PCBs, pesticides, CSM/CSM degradation products, and explosives-related compounds. No sediment samples were collected. VOCs, SVOCs, PCBs, pesticides, and CSM/CSM degradation products were not detected in any of the samples. Table A.2-6 summarizes the metals results. Several metals, including chromium, iron, lead, and zinc, were above the calculated background. The explosive RDX was detected in both samples: at 1.7 µg/L in WPP-A and 1.2 µg/L in WPP-C.

In 1995, four surface water samples were collected at the WPP AOC: two from the marsh near the Northwestern Suspect Burning Area (WPSW2 and WPSW3), one offshore and adjacent to the Southwestern Suspect Burning Area (WPSW4), and one to the south of the Southwestern Suspect Burning Area (WPSW5) (Figure A.2-4). The samples were analyzed for metals, cyanide, CSM/CSM degradation products, and explosives-related compounds. No sediment samples were collected. Table A.2-6 summarizes the metals results. Metals exceeding the calculated background included iron, lead, and zinc. Cyanide and CSM/CSM degradation products were not detected in any of the samples. Very low levels of explosives-related compounds were detected in WPSW5.

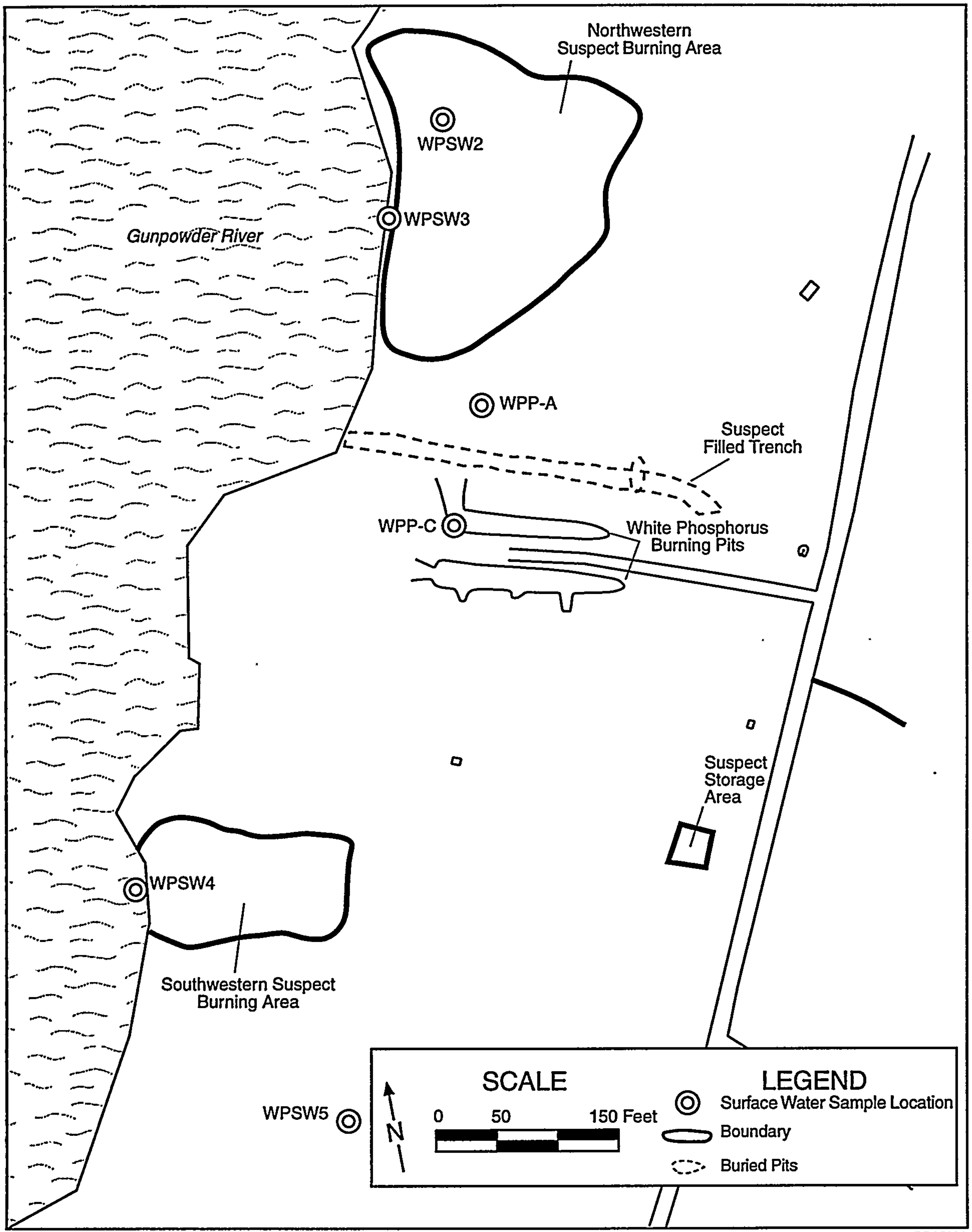

FIGURE A.2-4 Locations of Surface Water Samples at the WPP AOC: 1994–1995

TABLE A.2-6 Analytical Results for Selected Metals in Surface Water Samples Collected from the WPP AOC: 1995[a]

	Concentration (μg/L) by Sample Location						Freshwater Marsh Background[b]	Estuarine River Background[c]
Parameter	WPP-A	WPP-C	WPSW2	WPSW3	WPSW4	WPSW5		
Arsenic	3.3 B	8.2 B	2.9	<3.6	<3.6	<1.8	NA	NA
Cadmium	<4.0	<4.0	<3.0	<3.0	<3.0	<3.0	NA	NA
Calcium	6,700	24,400	12,600	49,300	48,000	15,500	NA	NA
Chromium	6.5 B	***16***	<8.0	<8.0	<8.0	<8.0	8.0	NA
Copper	4.8 B	25	<23	28	<23	<23	NA	5.0
Iron	2,240	***18,000***	***27,300***	2,170	368	8,060	5,750	2,140
Lead	***14***	***71***	***21***	***7.6***	2.8	4.9	6.0	3.0
Magnesium	3,790 B	9,820	23,700	131,000	***131,000***	9,100	NA	216
Mercury	<0.20	<0.20	<0.10	<0.10	<0.10	0.10	NA	NA
Zinc	50 E	***411 E***	62	41	***24***	96	76	15

[a] Notation: E = estimated value; NA = not available. Sample concentrations equal to or exeeding the calculated background are presented in bold italics.

[b] Freshwater marsh calculated background values were used as comparison criteria for WPSW2, WPSW3 (samples from the marsh area), WPP-A, WPP-C, and WPSW5.

[c] Estuarine river calculated background values were used as comparison criteria for WPSW4 (offshore sample).

A.3 RIOT CONTROL BURNING PIT AREA OF CONCERN

A.3.1 Screening Investigations

A.3.1.1 Soil Gas

During Phase I of the hydrological assessment, the USGS conducted a soil gas survey at the RCP AOC for TRCLE, TCLEE, alkanes, combined hydrocarbons, and simple aromatic compounds (Hughes 1993). Two general areas with anomalous readings of chlorinated solvents, phthalates, and aromatic compounds were identified: the northeastern part of the burning pit and an area south of the central section of the pit (Figure A.3-1).

In 1994, Argonne conducted a passive soil gas survey at 40 locations (122–162; Figure A.3-2). The sampling points covered both dry land and marsh areas at the RCP. Chlorinated hydrocarbons (chloromethane, 111TCE, chloroform, and TCLEE) were detected at 10 locations (123, 124, 129, 131, 138, 142, 144, 147, 149, and 153) around the RCP. These sampling locations were far apart, and no pattern of anomalies could be found. The emission rates ranged from 1.3 to 60 ng/m^2/min; most were less than 7 ng/m^2 /min. The three highest readings were recorded in samples 149, 142, and 144 (60, 13, and 10 ng/m^2/min, respectively). Low emissions (1.0–3.7 ng/m^2/min) of benzene, toluene, and xylenes (BTX) were detected at 10 sampling locations (126, 129–132, 135–137, 144, and 149). Most of these samples were taken near the northeastern end of the burning pit (Prasad and Martino 1994a).

In 1995, Argonne conducted active soil gas sampling at 16 locations (Figure A.3-2). Nine samples were collected along the two sides of Rickett's Point Road: ASG39–43 (on the north side) and ASG55–58 (on the south side). Elevated levels of isooctane were detected in samples ASG41 (1.3 ppm) and ASG58 (4.2 ppm). Low levels of 11DCE were detected in samples ASG40 (0.19 ppm) and ASG43 (0.36 ppm).

Seven soil gas samples were collected near the northeast end of the RCP: ASG44–47, ASG55, ASG56, and ASG76. Sample ASG44 had an elevated level of isooctane (7.9 ppm) and low levels of benzene (0.030 ppm) and methylene chloride (0.030 ppm). Low levels of benzene and TRCLE (0.010 and 0.020 ppm, respectively) were detected in sample ASG45, and these compounds were also detected in blanks. Low levels of 12DCE (0.010 ppm) and carbon tetrachloride (0.030 ppm) were detected in ASG47. Sample ASG76 had an elevated 11DCE level (0.21 ppm) and low levels of benzene (0.060 ppm) and methylene chloride (0.01 ppm).

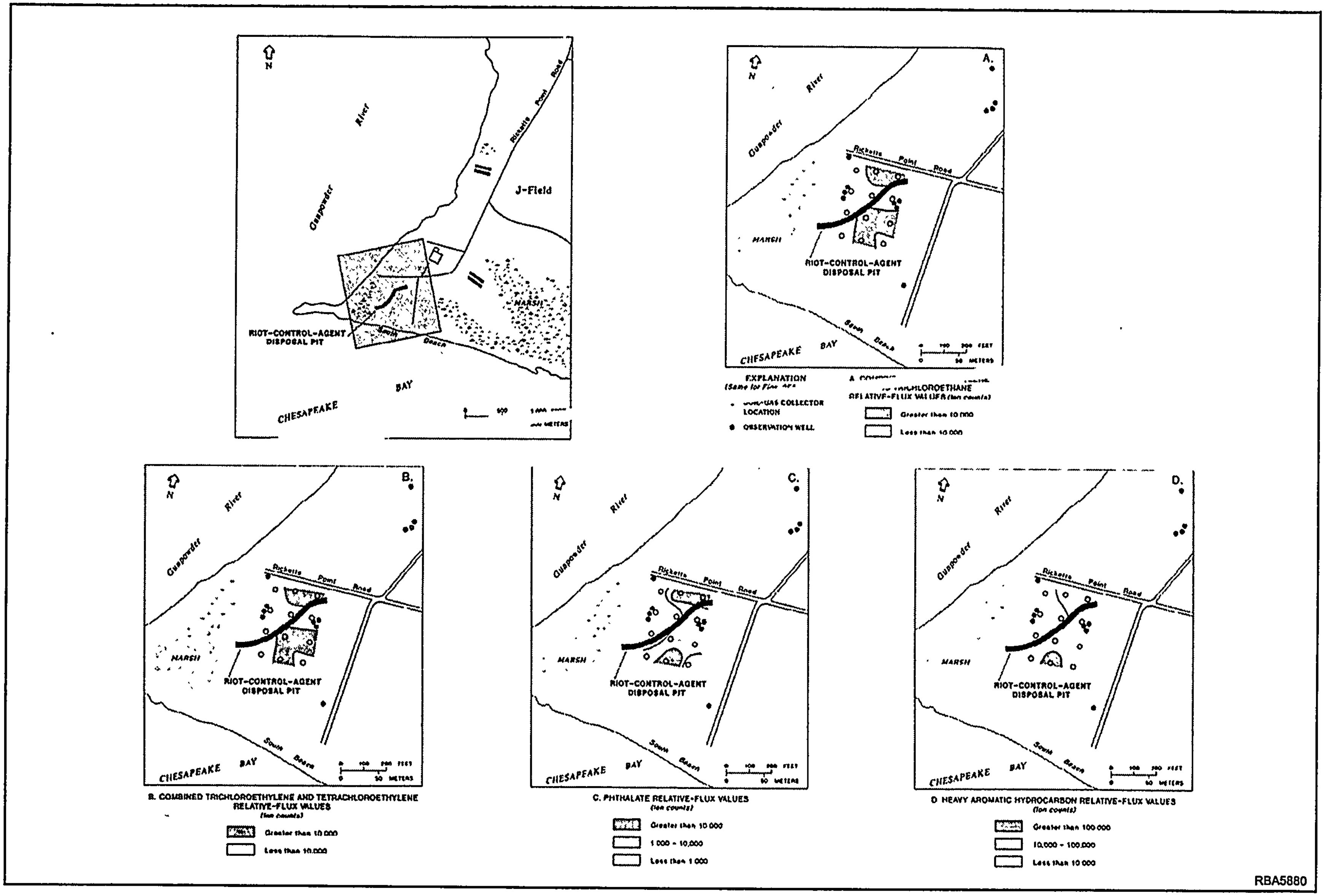

FIGURE A.3-1 Locations of Soil Gas Samples at the RCP AOC: 1993 (Source: Hughes 1993)

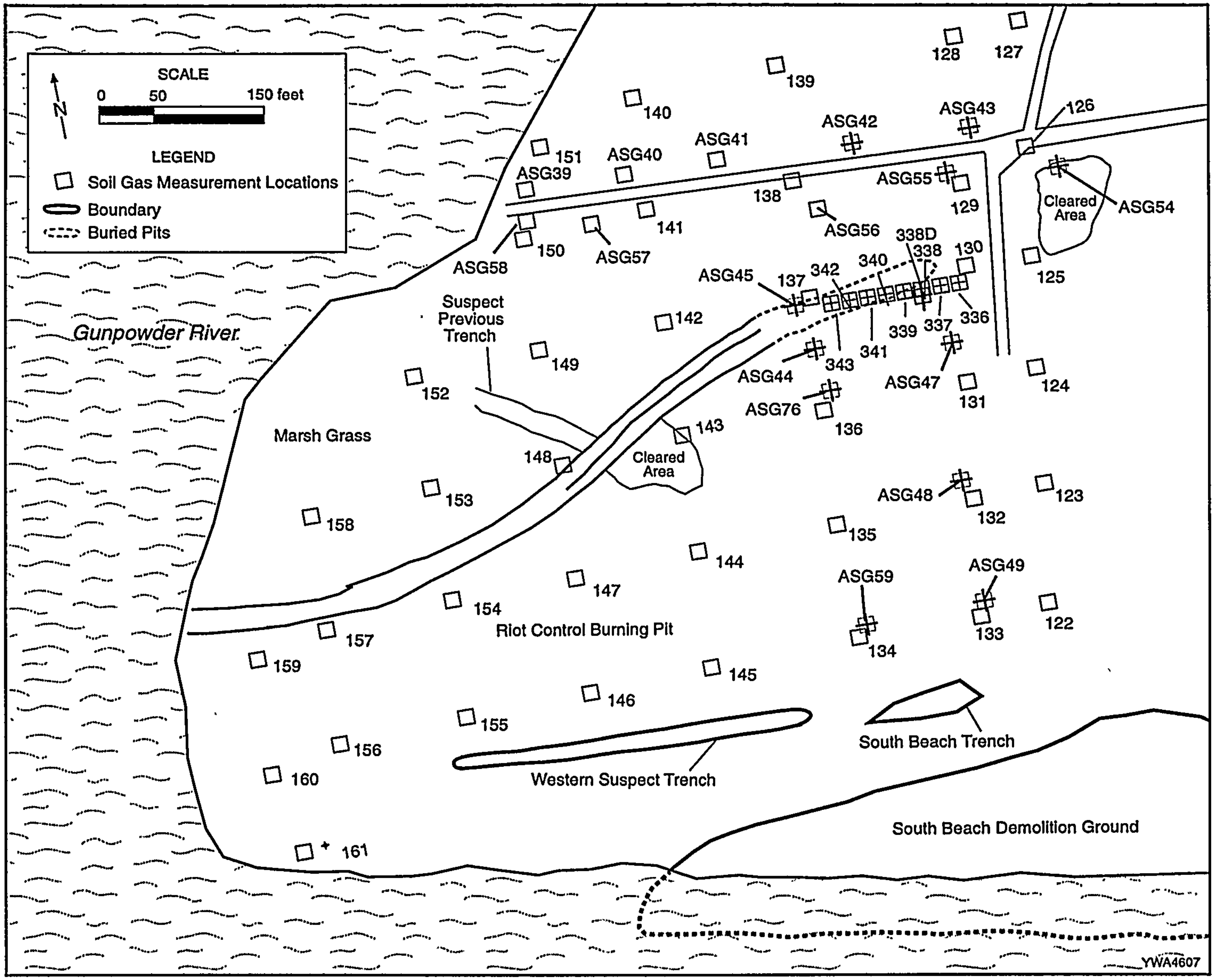

FIGURE A.3-2 Locations of Soil Gas Samples at the RCP AOC: 1994–1995

Active soil gas samples were collected from the southeastern portion and the northeastern corner of the RCP AOC (ASG48 and ASG5, respectively). No significant level of volatile contamination was detected.

In 1995, nine EMFLUX soil gas samples were collected at seven locations along a line intersecting the northeastern end of the burning pit (336–338, 338D, 339–343; Figure A.3-2) (Prasad and Martino 1994b). TCLEE emission rates ranging from 0.6 to 3 ng/m^2/min were detected at three locations (338, 339, and 342). In addition, low TRCLE emission rates were detected (0.6–0.9 ng/m^2/min at locations 341, 342, and 343) near the western end of the profile.

A.3.1.2 In Situ X-Ray Fluorescence

Field XRF measurements were conducted at 27 locations along the burning pit (Figure A.3-3). The locations were clustered in four areas: 6 in the northeastern end of the pit (XRRCP24–29), 10 near the center section of the pit (XRRCP1–10), 6 near the southwestern end of the pit (XRRCP11–16), and 5 in an area between the major pit and the suspect branch of the pit (XRRCP19–23).

Relatively high levels of copper were detected at four locations: XRRCP24 and XRRCP29 in the northeastern end and XRRCP3 and XRRCP4 in the middle section of the pit. Anomalous zinc concentrations were detected in the middle section and the southwestern portions of the burning pit (XRRCP11–16). High levels of zinc were detected in the center of the burning pit (in XRRCP3, XRRCP4, and XRRCP6) and the southwestern end of the pit (in XRRCP11, XRRCP15, and XRRCP16). The middle section of the burning pit also contained anomalous levels of lead, which were detected in samples XRRCP1, XRRCP4, XRRCP7, XRRCP9, and XRRCP11. Low levels of strontium were detected in XRRCP19, XRRCP22, and XRRCP27.

A.3.1.3 Geophysical Surveys

In 1995, a focused geophysical survey was conducted at the RCP AOC to delineate the filled section in the northeastern part of the burning pit, by using electromagnetic conductivity, electromagnetic induction, magnetometer, and GPR methods (Davies et al. 1995). The filled pit was characterized with anomalies of electromagnetic, magnetic, and GPR data (Davies et al. 1995); its location is shown in Figure A.3-3 by a dotted line. Also, the filled pit can be traced and connected to the exposed section of the burning pit.

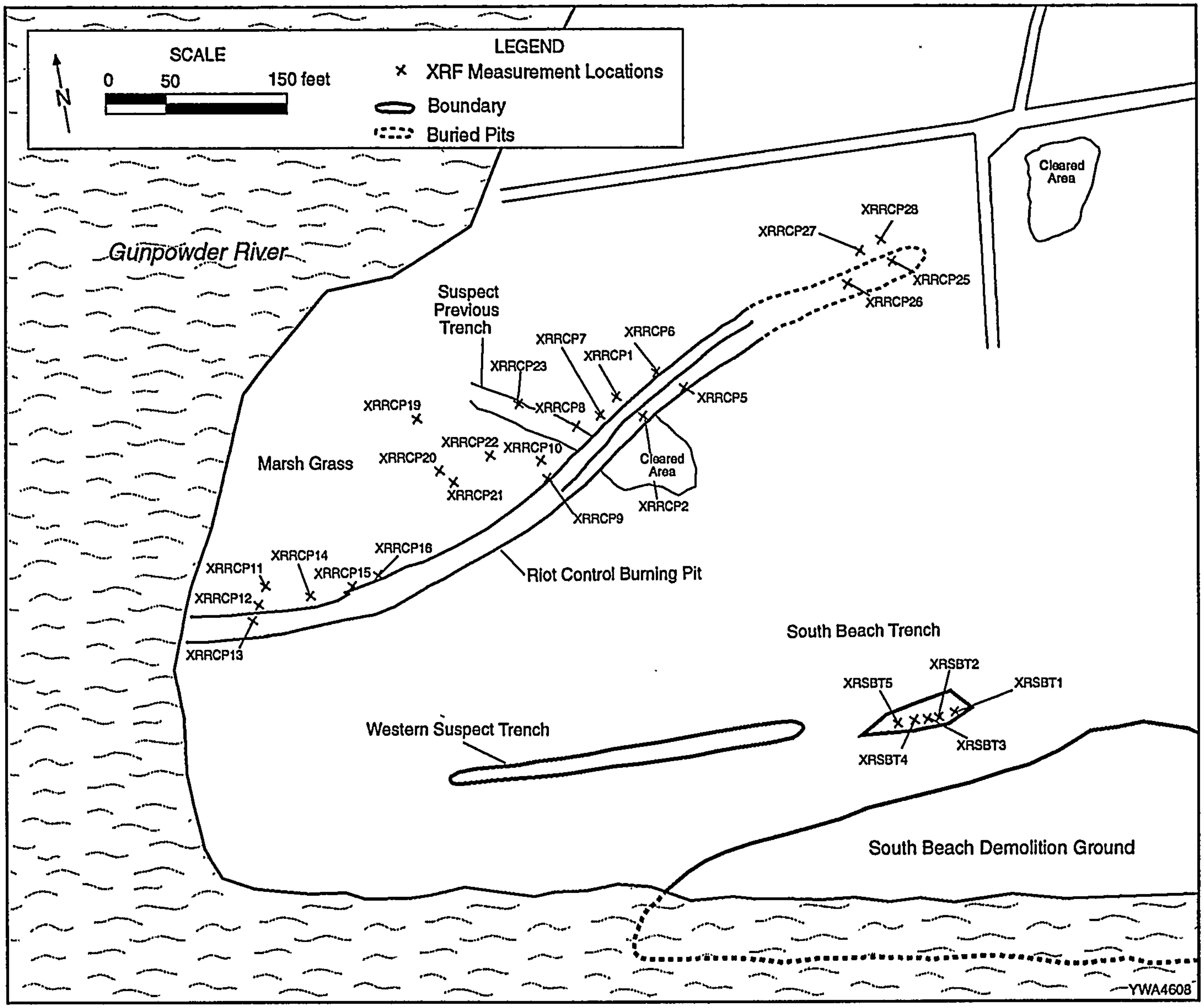

FIGURE A.3-3 Locations of X-Ray Fluorescence Measurements at the RCP AOC

A.3.2 Soil Analysis

A.3.2.1 Surface Soil

A soil sample was collected northeast of the disposal trench during the 1986 RFA (Nemeth 1989). That sample contained a significant amount of ash and other residue from burning operations; analysis showed slightly elevated levels of cadmium, chromium, lead, and silver. Low levels of PAHs were also detected.

In 1991, the USGS collected soil samples from five locations estimated to be within the RCP (locations 16–20 in Figure A.3-3). The samples were collected at 1-ft depths and were analyzed for indicator parameters, VOCs, SVOCs, metals, and explosives-related compounds (Hughes 1992). Table A.3-1 summarizes the analytical results. Trace amounts of acetone were detected in all five samples. No other VOCs were detected. Low levels of butylbenzyl phthalate and benzoic acid, both SVOCs, were detected in some samples (Table A.3-1). Elevated metals concentrations were detected only in samples collected from location 16, near the northeastern part of the burning pit (68 mg/kg of lead and 158 mg/kg of zinc). No explosives-related compounds were detected.

In 1993, Weston collected surface and subsurface soil samples from nine locations in the RCP AOC (Mazelon 1993) (Figure A.3-4). The samples were collected at 3-in., 2-ft, and 4-ft depths in the pit and at 3-in. and 1-ft depths in the marshes and Pushout Areas. They were analyzed for VOCs, SVOCs, metals, PCBs, and pesticides. Tables A.3-2 and A.3-3 summarize the results for surface soil. The deeper soil sample results are discussed in Section A.3.2.2.

Low levels of VOCs were detected in all samples from the RCP AOC. Only acetone and methylene chloride, common laboratory contaminants, were detected in the samples collected from inside the middle section and northern branch of the RCP (JBT1-E, JBT1-C, and JBT1-W). These contaminants were present in other samples, along with low levels of benzene, styrene, toluene, and xylenes (Table A.3-2).

The highest concentrations of SVOCs, particularly benzoic acid and bis(2-chloromethyl)ether, were found in samples JBTM-A and JBTM-B located to the north and south (respectively) of the middle section of the pit. They were found in the upper 3 in. of the soil. PCBs were not detected in any of the samples. The few pesticides detected (DDE, DDD, DDT, and eldrin aldehyde) were also highest in the upper 3 in. of the soil (Table A.3-2).

Table A.3-3 summarizes the metals data. Several metals, including arsenic, cadmium, chromium, copper, nickel, and zinc, were detected at levels exceeding calculated background. The highest levels of metals tended to occur in the upper 3 in. of soil and showed a wide distribution

TABLE A.3-1 Analytical Results for Soil Samples Collected from the RCP AOC: 1991[a]

	Concentration by Sample Location					
Parameter	16	17	18	19	20	Background[b]
Metals (mg/kg)						
Arsenic	4.4	3.8	3.4	2.9	3.7	5.0
Lead	***68***	41	34	2.1	41	61
Zinc	***158***	ND	ND	ND	ND	118
VOCs (μg/kg)						
Acetone	7.3	30	9.0	6.5	10	NA
SVOCs (μg/kg)						
Benzoic acid	3,400	12,000	ND	1,800	949	NA
Butylbenzylphthalate	ND	ND	528	ND	ND	NA

[a] Notation: NA = not available; ND = not detected, detection limits unavailable. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

along the RCP. For example, the highest levels of cadmium, chromium, and copper were found in sample JBT1-E along the northern branch of the pit; lead and zinc were highest in JBT1-C located in the middle section of the pit; and arsenic was highest in sample JBTP-B located at the southern end of the pit.

In 1993, surface soil samples were collected from six locations (ORCP1–6) within the RCP AOC (Figure A.3-5). Soils were collected from a 0–6 in. depth interval (A samples) and 6–12 in. depth interval (B samples). The samples were analyzed for VOCs, SVOCs, and metals. Table A.3-4 summarizes the results. The only VOC detected was methylene chloride, a common laboratory contaminant. No SVOCs were detected. The only metals found at levels exceeding the calculated background were copper in ORCP1A (27 mg/kg) and ORCP6A (22 mg/kg), both in the upper 3 in. of the soil.

In 1995, surface soil samples were collected from 14 locations within the RCP AOC (Figure A.3-5). Six samples (RCPS1, RCPS2, RCPS10, and RCPS12–14) were collected from inside the pit, from the northeastern end of the pit to the Pushout Area near the Gunpowder River. Four samples (RCPS3–6) were collected in an open area near the middle section of the pit. Two samples

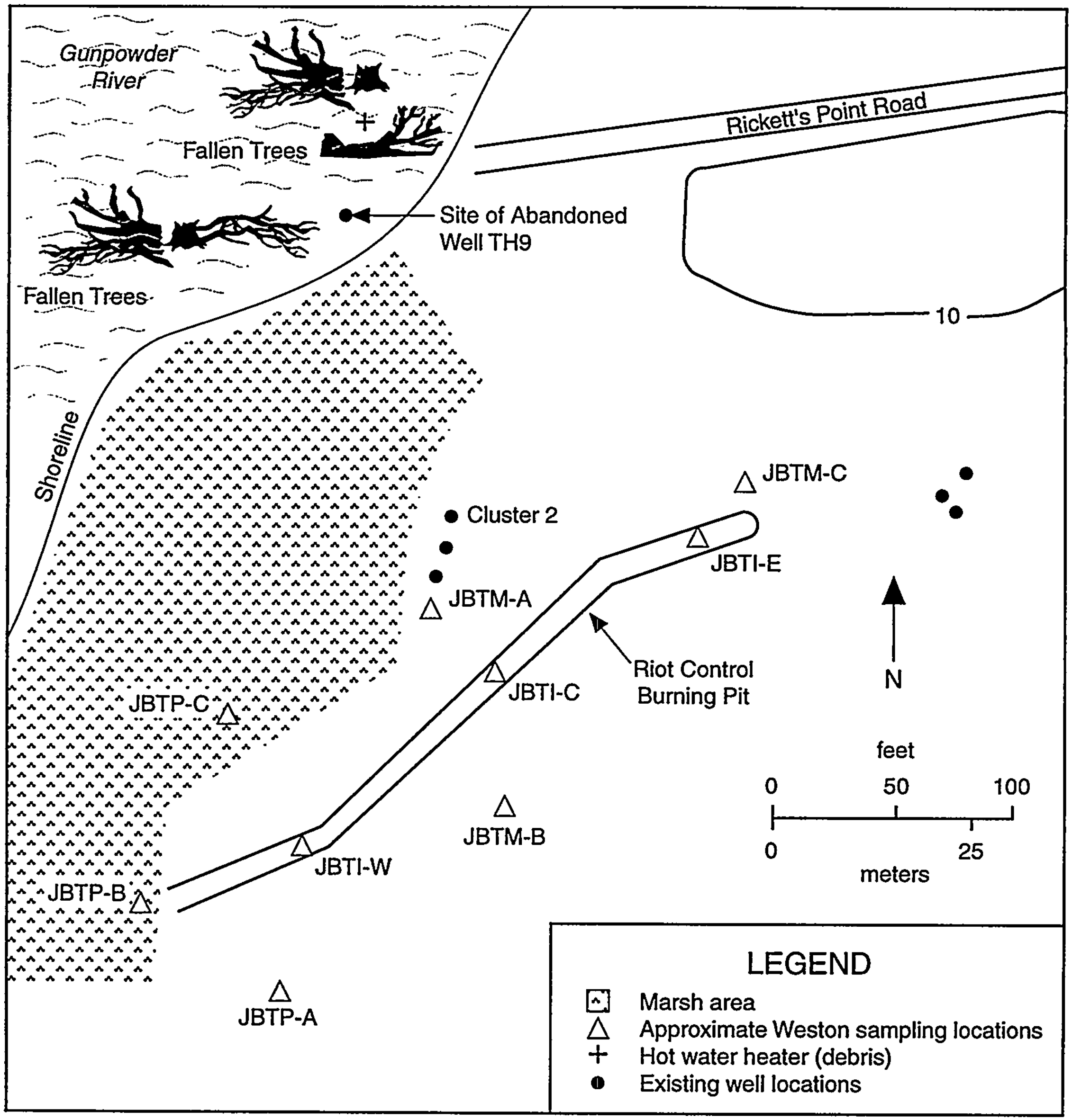

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FIGURE A.3-4 Locations of Soil Samples Collected by Weston from the RCP AOC: 1993 (Source: Adapted from Mazelon 1993)

TABLE A.3-2 Analytical Results for Various Parameters in Surface Soil Samples Collected from the RCP AOC by Weston: 1993[a]

	Concentration (μg/kg) by Sample Location[b]							
Parameter	JBT1-E (3 in.)	JBT1-C (3 in.)	JBP1-W (3 in.)	JBTM-A (3 in.)	JBTM-A (1 ft)	JBTM-B (3 in.)	JBTM-B (1 ft)	JBTM-C (3 in.)
VOCs								
Acetone	62	261	236	171	55	37	94	169
Benzene	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	12	2.7	ND	ND	ND
Methylene chloride	10	21	13	10	5.7	14	5.5	5.9
Styrene	ND	ND	ND	8.6	ND	2.4	ND	ND
Toluene	ND	ND	ND	42	16	3.5	3.4	7.9
Xylenes	ND	ND	ND	159	77	11	ND	ND
SVOCs								
Benzoic acid	ND	5,270	183	4,380	100	1,900	ND	ND
Bis(2-chloromethyl)ether	ND	54	ND	438	ND	276	ND	ND
Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	64	217	126	54	86	ND	ND
Fluoranthene	ND	83	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	205	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	52	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	53	ND	ND	ND	ND	ND	ND
Pyrene	ND	109	ND	ND	ND	ND	ND	ND
Pesticides								
4,4′-DDD	ND	ND	ND	ND	ND	ND	ND	ND
4,4′-DDE	2.2	4.7	11	33	ND	22	ND	ND
4,4′-DDT	ND	38	ND	8.3	ND	*307*	ND	ND
Eldrin aldehyde	ND	12	ND	ND	ND	ND	ND	ND

TABLE A.3-2 (Cont.)

	Concentration (µg/kg) by Sample Location[b]							
Parameter	JBTM-C (1 ft)	JBTP-A (3 in.)	JBTP-A (1 ft.)	JBTP-B (3 in.)	JBTP-B (1 ft)	JBTP-C (3 in.)	JBTP-C (1 ft)	Background[b]
VOCs								
Acetone	91	70	74	ND	22	ND	ND	NA
Benzene	2.5	ND	ND	ND	ND	ND	ND	NA
Carbon disulfide	ND	4.9	ND	ND	5.6	ND	ND	NA
Chloroform	ND	ND	ND	ND	ND	20	ND	NA
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
Methylene chloride	9.8	12	5.7	4.2	3.7	5.7	3.3	NA
Styrene	ND	ND	18	ND	ND	ND	ND	NA
Toluene	1.8	ND	1.4	ND	ND	ND	ND	NA
Xylenes	ND	ND	ND	ND	ND	ND	ND	NA
SVOCs								
Benzoic acid	64	840	336	290	426	ND	106	NA
Bis(2-chloromethyl)ether	ND	65	ND	ND	ND	54	ND	NA
Bis(2-ethylhexyl)phthalate	ND	ND	42	ND	ND	ND	ND	NA
Di-n-butylphthalate	ND	ND	ND	205	62	ND	188	NA
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	173
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	NA
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	74
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	105
Pyrene	ND	ND	ND	ND	ND	ND	ND	290
Pesticides								
4,4´-DDD	ND	ND	ND	ND	7.8	ND	ND	3.7
4,4´-DDE	1.8	10	ND	ND	11	4.7	ND	162
4,4´-DDT	ND	ND	ND	ND	5.1	ND	ND	61
Eldrin aldehyde	ND	ND	ND	ND	ND	ND	ND	NA

[a] Notation: NA = not available; ND = not detected, detection limit unavailable. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

Source: Mazelon (1993).

TABLE A.3-3 Analytical Results for Selected Metals in Surface Soil Samples Collected from the RCP AOC: 1992[a]

	Concentration (mg/kg) by Sample Location					
Parameter	JBT1-E (3 in.)	JBT1-C (3 in.)	JBT1-W (3 in.)	JBTM-A (3 in.)	JBTM-A (1 ft)	JBTM-B (3 in.)
Antimony	ND	***7.5***	ND	ND	ND	ND
Arsenic	***5.0***	3.3	ND	2.8	ND	1.9
Cadmium	***5.2***	***1.9***	***0.91***	***0.99***	0.59	***0.90***
Chromium	***106***	15	11	14	8.1	12
Copper	***742***	***181***	***23***	12	ND	9.0
Lead	1.1	***339***	***61***	57	6.0	52
Nickel	***40***	10	ND	13	ND	8.3
Zinc	***281***	***742***	***119***	47	5.0	59

	Concentration (mg/kg) by Sample Location					
Parameter	JBTM-B (1 ft)	JBTM-C (3 in.)	JBTM-C (1 ft)	JBTP-A (3 in.)	JBTP-A (1 ft)	JBTP-B (3 in.)
Antimony	ND	ND	ND	ND	ND	ND
Arsenic	1.7	1.9	1.7	ND	2.2	1.5
Cadmium	***0.70***	***0.90***	***0.70***	***1.7***	0.60	ND
Chromium	11	12	11	13	14	11
Copper	ND	9.0	ND	9.0	ND	***48***
Lead	7.6	31	35	33	7.2	***90***
Nickel	7.2	8.3	7.2	18	ND	9.9
Zinc	6.8	59	6.8	22	11	***122***

TABLE A.3-3 (Cont.)

	Concentration (mg/kg) by Sample Location			
Parameter	JBTP-B (1 ft)	JBTP-C (3 in.)	JBTP-C (1 ft)	Background (mg/kg)[b]
Antimony	ND	ND	ND	3.8
Arsenic	***5.8***	2.3	1.8	5.0
Cadmium	***1.1***	ND	ND	0.70
Chromium	13	14	24	41
Copper	***49***	11	9.4	20
Lead	***127***	42	9.1	61
Nickel	11	ND	11	20
Zinc	***473***	39	36	118

[a] Notation: ND = not detected; detection limits are unavailable. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

Source: Mazelon (1993).

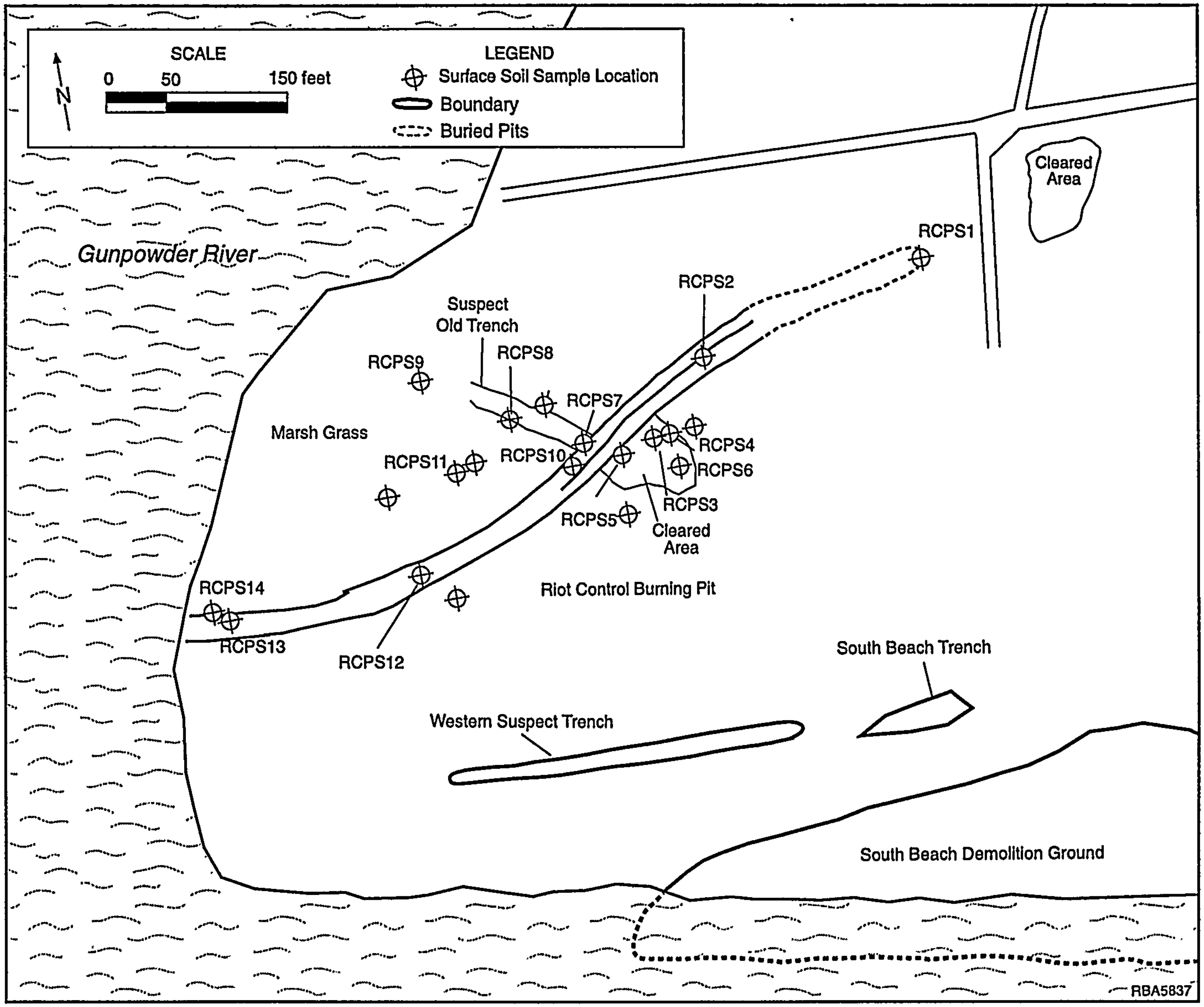

FIGURE A.3-5 Locations of Surface Soil Samples at the RCP AOC: 1993–1995

TABLE A.3-4 Analytical Results for Various Parameters in Surface Soil Samples Collected from the RCP AOC by Argonne: 1993[a,b]

	Concentration (mg/kg) by Sample Location					
Parameter	ORCP1A (0–6 in.)	ORCP1B (6–12 in.)	ORCP2A (0–6 in.)	ORCP2B (6–12 in.)	ORCP3A (0–6 in.)	ORCP3B (6–12 in.)
Arsenic	***11***	<10	<10	NT	<10	<10
Cadmium	<10	<10	<10	NT	<10	<10
Calcium	NT	NT	NT	NT	NT	NT
Chromium	29	21	24	NT	23	18
Copper	***27***	14	14	NT	16	10
Iron	NT	NT	NT	NT	NT	NT
Lead	30	26	26	NT	29	25
Magnesium	NT	NT	NT	NT	NT	NT
Mercury	<10	<10	<10	NT	<10	<10
Zinc	98	59	93	NT	66	53

	Concentration (mg/kg) by Sample Location					
Parameter	ORCP4A (0–6 in.)	ORCP4B (6–12 in.)	ORCP5A (0–6 in.)	ORCP5B (6–12 in.)	ORCP6A (0–6 in.)	Background (mg/kg)[c]
Arsenic	<10	<10	<10	NT	<10	5.0
Cadmium	<10	<10	<10	NT	<10	0.70
Calcium	NT	NT	NT	NT	NT	NA
Chromium	15	20	18	NT	19	41
Copper	16	<10	13	NT	***22***	20
Iron	NT	NT	NT	NT	NT	23,400
Lead	24	21	27	NT	32	61
Magnesium	NT	NT	NT	NT	NT	NA
Mercury	<10	<10	<10	NT	<10	0.10
Zinc	49	33	48	NT	57	118

[a] Notation: NA = not available; ND = not detected, detection limits unavailable; NT = not tested. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Metals analyzed by laboratory x-ray fluorescence.

[c] Background values were derived from soil data in ICF Kaiser Engineers (1995).

Source: Mazelon (1993).

(RCPS7 and RCPS8) were collected near the Suspect Old Trench, and two (RCPS9 and RCPS11) were collected in the marsh west of the pit. Soils were collected from 0-6 in. and analyzed for metals. Table A.3-5 summarizes the results.

Several metals were found at levels exceeding the calculated background. Levels were highest in samples collected from within the pit (RCPS1, RCPS2, RCPS10, and RCPS12). These samples represent metals concentrations in soils along the entire length of the pit (Figure A.3-5). Of particular note are the high concentrations of chromium (up to 191 mg/kg), copper (up to 1,770 mg/kg), lead (up to 1,070 mg/kg), and zinc (up to 385 mg/kg). Samples from the Suspect Old Trench had metals concentrations only slightly higher than the calculated background. These results suggest that the Suspect Old Trench may actually be an access road and not a former disposal pit.

A.3.2.2 Subsurface Soil

In 1993, subsurface soil samples were collected from six locations in the RCP AOC (Mazelon 1993) (Figure A.3-4). The samples were collected at depths of 2 ft and 4 ft and analyzed for VOCs, SVOCs, metals, PCBs, and pesticides. Tables A.3-6 and A.3-7 summarize the results. Surface soil samples were also collected; the results for these samples are discussed in Section A.3.2.1.

Low levels of VOCs were detected in all subsurface samples from the RCP AOC. Only acetone and methylene chloride, common laboratory contaminants, were detected in the samples collected from inside northern and southern branches of the RCP (JBT1-E and JBT1-W). These contaminants were present in other samples along with low levels of styrene (Table A.3-6).

The highest concentrations of SVOCs, particularly benzoic acid and bis(2-chloromethyl)ether, were found in JBT1-C located in the middle section of the pit. The highest SVOC concentrations were found in the sample from 2 ft depth. PCBs were not detected in any of the samples. Only one pesticide (DDE) was detected; it was found in the sample from the middle section of the pit at a depth of 2 ft (Table A.3-6).

Table A.3-7 summarizes the metals data. Several metals, including cadmium, copper, nickel, and zinc, were detected at levels exceeding the calculated background. The highest levels of metals tended to occur in the sample from the middle section of the pit at a depth of 2 ft. The metals concentrations tended to decrease with depth in this area.

In 1994, soil borings were drilled at three locations in the RCP AOC (RCPBOR1, RCPBOR2, and RCPBOR4 (Figure A.3-6). Samples were collected at 2-ft depth intervals from the surface down to 10 ft. They were analyzed for VOCs, SVOCs, and metals. Three additional soil

TABLE A.3-5 Analytical Results for Selected Metals in Surface Soil Samples Collected from the RCP AOC: 1995[a]

	Concentration (mg/kg) by Sample Location						
Parameter	RCPS1 (0–6 in.)	RCPS2 (0–6 in.)	RCPS3 (0–6 in.)	RCPS4 (0–6 in.)	RCPS5 (0–6 in.)	RCPS6 (0–6 in.)	RCPS7 (0–6 in.)
Arsenic	4.0	4.4	2.2	2.6	3.0	2.0	2.0
Cadmium	***6.8***	***4.2***	***0.99***	0.58	0.44	***0.74***	***0.70***
Chromium	***191***	***46***	12	7.8	11	9.5	9.5
Copper	***1,770***	***518***	13	7.6	11	8.8	***31***
Lead	46	46	34	23	27	30	***77***
Mercury	0.055	***0.11***	***0.082***	0.070	0.067	***0.095***	0.055
Nickel	15	***20***	5.3	<2.5	5.1	5.9	4.1
Selenium	***0.61***	0.33	0.34	***0.50***	***0.62***	***0.85***	0.24
Silver	***9.0***	***0.90***	<0.086	<0.083	<0.081	<0.088	<0.082
Zinc	***192***	***182***	58	39	55	52	92

TABLE A.3-5 (Cont.)

	Concentration (mg/kg) by Sample Location							
Parameter	RCPS8 (0–6 in.)	RCPS9 (0–6 in.)	RCPS10 (0–6 in.)	RCPS11 (0–6 in.)	RCPS12 (0–6 in.)	RCPS13 (0–6 in.)	RCPS14 (0–6 in.)	Background (mg/kg)[b]
Arsenic	2.0	1.2	3.4	2.9	3.6	2.7	2.6	5.0
Cadmium	***0.76***	<0.39	***1.6***	***0.79***	***0.77***	0.67	***0.82***	0.70
Chromium	8.2	6.4	13	9.5	10	9.2	9.3	41
Copper	11	5.4	***49***	15	***87***	15	***27***	20
Lead	44	21	***1,070***	35	***175***	41	***61***	61
Mercury	***0.089***	0.056	0.063	***0.10***	0.062	0.052	0.060	0.080
Nickel	5.2	<2.8	7.4	4.2	7.1	6.2	5.2	20
Selenium	***0.78***	***0.65***	***0.61***	***0.62***	***0.70***	***0.52***	0.38	0.43
Silver	<0.096	<0.092	<0.084	<0.10	<0.090	<0.084	<0.087	0.39
Zinc	59	28	***218***	48	***385***	***88***	82	118

[a] Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

TABLE A.3-6 Analytical Results for Various Parameters in Subsurface Soil Samples Collected from the RPC AOC: 1993[a]

Parameter	Concentration (µg/kg) by Sample Location					
	JBT1-E (2 ft)	JBT1-E (4 ft)	JBT1-C (2 ft)	JBT1-C (4 ft)	JBT1-W (2 ft)	JBT1-W (4 ft)
VOCs						
Acetone	46	191	109	141	82	19
Benzene	ND	ND	ND	ND	ND	ND
Carbon disulfide	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND
Methylene chloride	7.7	5.2	7.6	14	18	6.8
Styrene	ND	ND	ND	8.4	ND	ND
Toluene	ND	ND	ND	ND	ND	ND
Xylenes	ND	ND	ND	ND	ND	ND
SVOCs						
Benzoic acid	ND	ND	441	136	79	48
Bis(2-chloromethyl)ether	ND	ND	54	ND	ND	ND
Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	ND	165	ND	111	54
Fluoranthene	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND
Pesticides						
4,4′-DDD	ND	ND	ND	ND	ND	ND
4,4′-DDE	ND	ND	4.0	ND	ND	ND
4,4′-DDT	ND	ND	ND	ND	ND	ND
Eldrin aldehyde	ND	ND	ND	ND	ND	ND

[a] Notation: NA = not available; ND = not detected, detection limit unavailable.

Source: Mazelon (1993).

TABLE A.3-7 Analytical Results for Various Parameters in Subsurface Soil Samples Collected from the RCP AOC: 1993[a]

	Concentration (mg/kg) by Sample Location					
Parameter	JBT1-E (2 ft)	JBT1-E (4 ft)	JBT1-C (2 ft)	JBT1-C (4 ft)	JBT1-W (2 ft)	JBT1-W (4 ft)
Antimony	5.3	ND	6.1	ND	ND	ND
Arsenic	4.3	ND	ND	2.0	2.9	1.8
Cadmium	2.7	ND	ND	ND	0.69	ND
Chromium	40	12	7.8	7.9	17	17
Copper	262	116	8.8	7.2	ND	9.8
Lead	49	11	21	22	9.0	8.9
Nickel	23	9.9	ND	ND	9.1	8.0
Zinc	139	46	16	12	17	15

a Notation: NA = not available; ND = not detected, detection limit unavailable.

Source: Mazelon (1993).

borings (RCPBOR5–7) were drilled and sampled in 1995. These were analyzed for VOCs, SVOCs, metals, cyanide, PCBs, pesticides, dioxins, CSM/CSM degradation products, and explosives-related compounds (not all analyses were performed all on samples). Table A.3-8 provides an analytical matrix for all the 1994 and 1995 borings. Tables A.3-9 and A.3-10 summarize the results.

Low levels of VOCs were detected in most boring samples; however, except for acetone and carbon disulfide, none were at levels above the detection limit. Several SVOCs were also detected at very low levels. Higher levels of acetone (ranging from 94 to 3,000 μg/kg) were found in samples from borings RCPBOR5–7. Sample RCPBOR6, located in the northern branch of the RCP near the disposal center, had several SVOCs at the 2–4 ft depth interval.

Table A.3-10 summarizes the metals data. Several metals, including arsenic, cadmium, copper, lead, and zinc, were most elevated in borings RCPBOR5 and RCPBOR6, located near the disposal center. The metals concentrations were highest in the 2–4 ft depth interval and tended to decrease with depth in this area.

Low levels of pesticides were found in boring RCPBOR5 (2–4 ft); however, these levels were below the corresponding detection limits. No PCBs were detected. Two samples from boring RCPBOR6 (4–6 and 6–8 ft) were analyzed for dioxins and furans; only low levels of

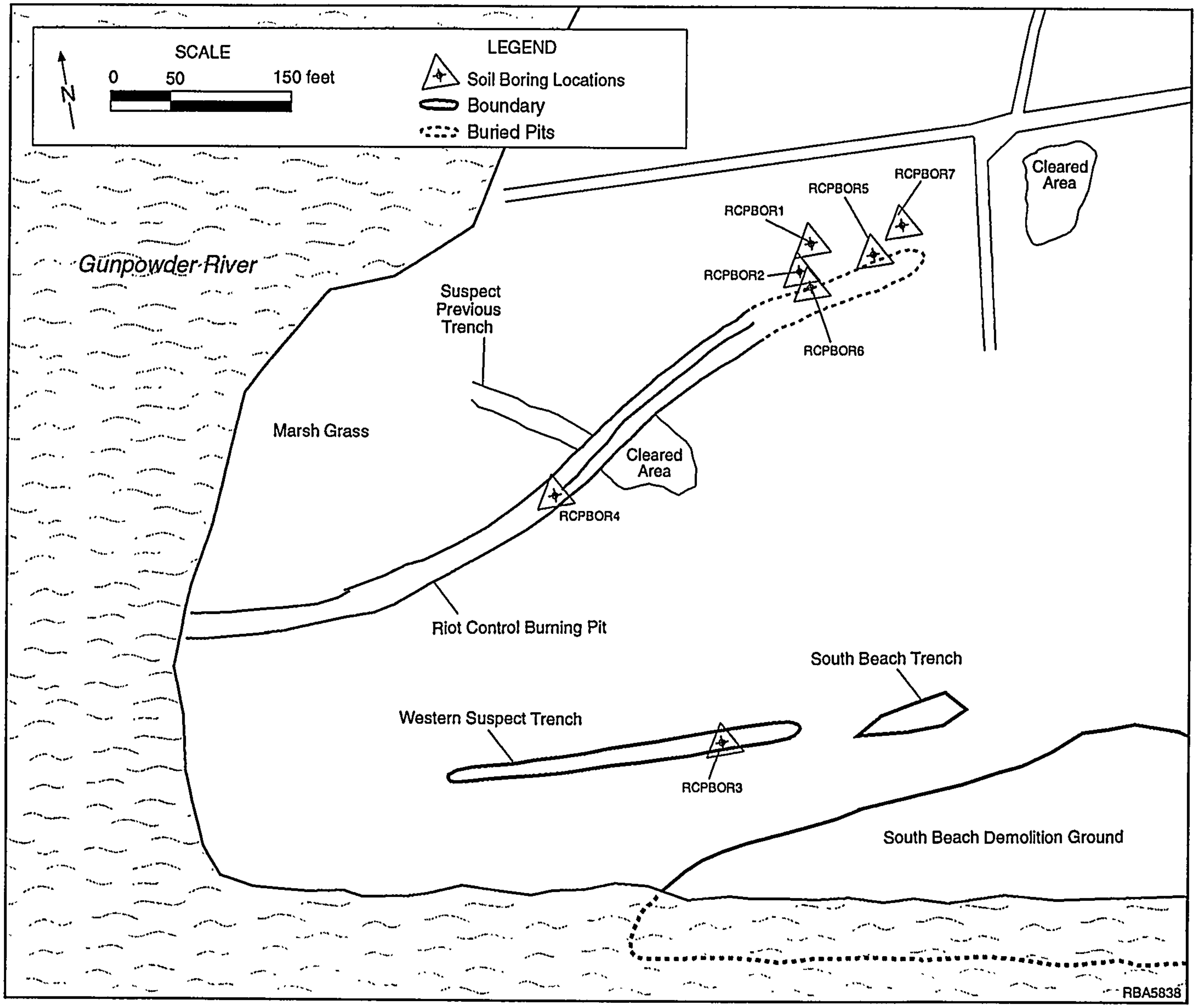

FIGURE A.3-6 Locations of Soil Borings at the RCP AOC: 1994–1995

TABLE A.3-8 Analytical Matrix of Soil Samples from Borings at the RCP AOC: 1994–1995[a]

Sample	VOCs	SVOCs	Metals	Pesticides	PCBs	Dioxins	Others
RCPBOR1							
0–2 ft	X	X	X				
2–4 ft	X	X	X				
4–6 ft	X	X	X				
6–8 ft	X	X	X				
8–10 ft	X	X	X				
RCPBOR2							
0–2ft	X	X	X				
2–4 ft	X	X	X				
4–6 ft	X	X	X				
6–8 ft	X	X	X				
8–10 ft	X	X	X				
RCPBOR4							
0–2ft	X	X	X				
2–4 ft	X	X	X				
4–6 ft	X	X	X				
6–8 ft	X	X	X				
RCPBOR5							
0–2 ft	X	X	X	X	X		
2–4 ft	X	X	X	X	X		
4–6 ft	X	X	X				Explosives, CSM
6–8 ft	X		X				
8–10 ft	X						
10–12 ft							
12–14 ft							
14–16 ft	X						

TABLE A.3-8 (Cont.)

Sample	VOCs	SVOCs	Metals	Pesticides	PCBs	Dioxins	Others
RCPBOR6							
0–2 ft	X		X	X	X		
2–4 ft	X	X	X	X	X		CSM
4–6 ft	X	X	X	X	X	X	Explosives, CSM
6–8 ft	X	X	X	X	X	X	CSM, TPH, cyanide
8–10 ft	X	X	X				CSM, TPH, cyanide
10–12 ft							
12–14 ft							CSM, TPH
14–16 ft	X						
RCPBOR7							
0–2 ft			X				Cyanide
2–4 ft	X		X				Cyanide
4–6 ft			X				Cyanide
6–8 ft	X		X				Cyanide
8–10 ft							
10–12 ft	X		X				Cyanide
12–14 ft	X		X				Cyanide

a CSM = chemical surety material/CSM degradation products; explosives = explosives-related compounds; TPH = total petroleum hydrocarbons.

octachlorodibenzo-p-dioxin were detected (at 0.10 and 0.13 µg/kg, respectively). Samples from RCPBOR5 were analyzed for CSM/CSM degradation products (including organic phosphorus, organic sulfur, and thiodiglycol); none were detected. Cyanide and explosives-related compounds also were not detected.

A.3.3 Groundwater

The USGS installed a total of six wells in two monitoring well nests (JF11, JF12, JF13, JF21, JF22, and JF23 in Figure A.3-7) near the RCP in late 1988 and 1989 (Sonntag 1991; Hughes 1993). At each site, the wells were screened in the confined aquifer (wells JF11 and JF21), the leaky confining unit (wells JF12 and JF22), and the surficial aquifer of the Talbot Formation (wells JF13 and JF23). One additional monitoring well (JF143) was completed in the surficial aquifer (Unit C) south of the RCP AOC in 1992. Table A.3-11 provides the dates of installation and construction details for all wells at the RCP AOC.

TABLE A.3-9 Analytical Results for Various Parameters in Soil Samples Collected from the RCP AOC: 1994–1995[a]

Parameter	Concentration (µg/kg) by Sample Location RCPBOR1 (0–2 ft)	RCPBOR1 (2–4 ft)	RCPBOR1 (4–6 ft)	RCPBOR1 (6–8 ft)	RCPBOR1 (8–10 ft)
VOCs					
Acetone	<12	<12	<12	<12	<12
Benzene	<12	<12	<12	<12	<12
Carbon disulfide	<12	44	<12	81	<12
Chlorobenzene	<12	<12	<12	<12	<12
1,2-Dichloroethene (total)	<12	<12	<12	<12	<12
Methylene chloride	<12	<12	<12	<12	<12
Styrene	<12	<12	<12	<12	<12
Xylenes	<12	<12	<12	<12	<12
SVOCs					
Benzo(a)anthracene	<390	<380	<390	<400	<400
Benzo(k)fluoranthene	<390	<380	<390	<400	<400
Benzo(g,h,i)perylene	<390	<380	<390	<400	<400
Bis(2-ethylhexyl)phthalate	<390	<380	<390	<400	<400
Di-n-butylphthalate	180 BJ	280 BJ	270 BJ	280 BJ	280 BJ
Hexachloroethane	<390	<380	<390	<400	<400
Ideno(1,2,3-c,d)pyrene	<390	<380	<390	<400	<400
2-Methynaphthalene	<390	<380	<390	<400	<400
Phenanthrene	<390	<380	<390	<400	<400
Phenol	<390	<380	<390	<400	<400
Pyrene	<390	<380	<390	<400	<400

Parameter	Concentration (µg/kg) by Sample Location RCPBOR2 (0–2 ft)	RCPBOR2 (2–4 ft)	RCPBOR2 (4–6 ft)	RCPBOR2 (6–8 ft)	RCPBOR2 (8–10 ft)
VOCs					
Acetone	<12	<12	<12	<12	<12
Benzene	<12	<12	<12	<12	<12
Carbon disulfide	<12	<12	<12	<12	<12
Chlorobenzene	<12	<12	<12	<12	<12
1,2-Dichloroethene (total)	<12	<12	<12	<12	<12
Methylene chloride	<12	<12	<12	<12	<12
Styrene	<12	<12	<12	<12	<12
Xylenes	<12	<12	<12	<12	<12

TABLE A.3-9 (Cont.)

Parameter	RCPBOR2 (0–2 ft)	RCPBOR2 (2–4 ft)	RCPBOR2 (4–6 ft)	RCPBOR2 (6–8 ft)	RCPBOR2 (8–10 ft)
	Concentration (µg/kg) by Sample Location				
SVOCs					
Benzo(a)anthracene	<390	<370	<400	<400	<400
Benzo(k)fluoranthene	<390	<370	<400	<400	<400
Benzo(g,h,i)perylene	<390	<370	<400	<400	<400
Bis(2-ethylhexyl)phthalate	<390	<370	<400	<400	98 J
Di-n-butylphthalate	280 BJ	250 BJ	230 BJ	220 BJ	240 BJ
Hexachloroethane	<390	<370	<400	<400	<400
Ideno(1,2,3-c,d)pyrene	<390	<370	<400	<400	<400
2-Methynaphthalene	<390	<370	<400	<400	<400
Phenanthrene	<390	<370	<400	<400	<400
Phenol	<390	<370	110 J	<400	98 J
Pyrene	<390	<370	<400	<400	98 J

Parameter	RCPBOR3 (0–2 ft)	RCPBOR3 (2–4 ft)	RCPBOR3 (4–6 ft)	RCPBOR3 (6–8 ft)	RCPBOR4 (0–2 ft)
	Concentration (µg/kg) by Sample Location				
VOCs					
Acetone	<13	<12	<12	14 B	<12
Benzene	<13	<12	<12	<12	<12
Carbon disulfide	<13	<12	<12	<12	<12
Chlorobenzene	<13	<12	<12	<12	<12
1,2-Dichloroethene (total)	<13	<12	<12	<12	<12
Methylene chloride	<13	<12	<12	<12	<12
Styrene	<13	<12	<12	<12	<12
Xylenes	<13	<12	<12	<12	<12
SVOCs					
Benzo(a)anthracene	<400	<420	<390	<410	<390
Benzo(k)fluoranthene	<400	<420	<390	<410	<390
Benzo(g,h,i)perylene	<400	<420	<390	<410	<390
Bis(2-ethylhexyl)phthalate	<400	<420	<390	<410	<390
Di-n-butylphthalate	210 BJ	250 BJ	230 BJ	230 BJ	240 BJ
Hexachloroethane	<400	<420	<390	<410	<390
Ideno(1,2,3-c,d)pyrene	<400	<420	<390	<410	<390
2-Methynaphthalene	<400	<420	<390	<410	<390
Phenanthrene	<400	<420	<390	<410	<390
Phenol	<400	<420	<390	<410	<390
Pyrene	<400	<420	<390	<410	<390

TABLE A.3-9 (Cont.)

	Concentration (µg/kg) by Sample Location				
Parameter	RCPBOR4 (2–ft)	RCPBOR4 (4–6 ft)	RCPBOR4 (6–8 ft)	RCPBOR4 (8–10 ft)	RCPBOR5 (0–2 ft)
VOCs					
Acetone	<12	<12	<12	NT	<12
Benzene	<12	<12	<12	NT	<12
Carbon disulfide	<12	<12	<12	NT	<12
Chlorobenzene	<12	<12	<12	NT	<12
1,2-Dichloroethene (total)	<12	<12	<12	NT	<12
Methylene chloride	<12	<12	<12	NT	5.0 J
Styrene	<12	<12	<12	NT	<12
Xylenes	<12	<12	<12	NT	<12
SVOCs					
Benzo(a)anthracene	<390	<400	<400	NT	<384
Benzo(k)fluoranthene	<390	<400	<400	NT	<384
Benzo(g,h,i)perylene	<390	<400	<400	NT	<384
Bis(2-ethylhexyl)phthalate	<400	<400	<400	NT	<384
Di-n-butylphthalate	230 BJ	230 BJ	230 BJ	NT	<384
Hexachloroethane	<390	<400	<400	NT	<384
Ideno(1,2,3-c,d)pyrene	<390	<400	<400	NT	<384
2-Methynaphthalene	<390	<400	<400	NT	<384
Phenanthrene	<400	<400	<400	NT	<384
Phenol	<400	<400	<400	NT	<384
Pyrene	<400	<400	<400	NT	<384

	Concentration (µg/kg) by Sample Location				
Parameter	RCPBOR5 (2–4 ft)	RCPBOR5 (4–6 ft)	RCPBOR5 (6–8 ft)	RCPBOR5 (8–10 ft)	RCPBOR5 (14–16 ft)
VOCs					
Acetone	49	106	3,000 BD	1,020	<13
Benzene	<12	<12	<12	<12	<13
Carbon disulfide	2.0 J	<12	<12	<12	<13
Chlorobenzene	<12	<12	<12	<12	<13
1,2-Dichloroethene (total)	<12	<12	2.0 J	3.0 J	3.0 J
Methylene chloride	7.0 BJ	6.0 J	5.0 J	6.0 J	5.0 J
Styrene	<12	<12	<12	<12	<13
Xylenes	<12	<12	<12	<12	<13

TABLE A.3-9 (Cont.)

	Concentration (µg/kg) by Sample Location				
Parameter	RCPBOR5 (2–4 ft)	RCPBOR5 (4–6 ft)	RCPBOR5 (6–8 ft)	RCPBOR5 (8–10 ft)	RCPBOR5 (14–16 ft)
SVOCs					
Benzo(a)anthracene	<402	<393	NT	NT	NT
Benzo(k)fluoranthene	<402	<393	NT	NT	NT
Benzo(g,h,i)perylene	<402	<393	NT	NT	NT
Bis(2-ethylhexyl)phthalate	58 J	<393	NT	NT	NT
Di-n-butylphthalate	<402	<393	NT	NT	NT
Hexachloroethane	<402	<393	NT	NT	NT
Ideno(1,2,3-c,d)pyrene	<402	<393	NT	NT	NT
2-Methynaphthalene	<402	<393	NT	NT	NT
Phenanthrene	130 J	<393	NT	NT	NT
Phenol	<402	<393	NT	NT	NT
Pyrene	44 J	<393	NT	NT	NT

	Concentration (µg/kg) by Sample Location				
Parameter	RCPBOR6 (0–2 ft)	RCPBOR6 (2–4 ft)	RCPBOR6 (4–6 ft)	RCPBOR6 (6–8 ft)	RCPBOR6 (8–10 ft)
VOCs					
Acetone	11 J	49 B	73	96	94
Benzene	<12	<12	<12	<63	<12
Carbon disulfide	<12	<12	<12	<63	<12
Chlorobenzene	<12	2.0 J	<12	13 J	<12
1,2-Dichloroethene (total)	<12	<12	<12	<63	<12
Methylene chloride	5.0 J	8.0 BJ	7.0 BJ	13 BJ	60 BJ
Styrene	<12	<12	<12	<63	<12
Xylenes	<12	<12	3.0 J	<63	<12
SVOCs					
Benzo(a)anthracene	NT	41 J	<393	<412	<412
Benzo(k)fluoranthene	NT	48 J	<393	<412	<412
Benzo(g,h,i)perylene	NT	79 J	<393	<412	<412
Bis(2-ethylhexyl)phthalate	NT	<384	<393	43 J	<412
Di-n-butylphthalate	NT	<384	<393	<412	<412
Hexachloroethane	NT	41 J	<393	<412	<412
Ideno(1,2,3-c,d)pyrene	NT	72 J	<393	<412	<412
2-Methynaphthalene	NT	<384	<393	320 J	<412
Phenanthrene	NT	<384	<393	340 J	<412
Phenol	NT	<384	<393	<412	<412
Pyrene	NT	<384	<393	<412	<412

TABLE A.3-9 (Cont.)

Parameter	Concentration (μg/kg) by Sample Location RCPBOR6 (14–16 ft)	RCPBOR7 (0–2 ft)	RCPBOR7 (2–4 ft)	RCPBOR7 (4–6 ft)	RCPBOR7 (6–8 ft)
VOCs					
Acetone	52	NT	20	NT	33
Benzene	2.0 J	NT	<12	NT	<12
Carbon disulfide	<13	NT	<12	NT	<12
Chlorobenzene	<13	NT	<12	NT	<12
1,2-Dichloroethene (total)	<13	NT	<12	NT	<12
Methylene chloride	3.0 BJ	NT	4.0 BJ	NT	13 B
Styrene	<13	NT	<12	NT	<12
Xylenes	<13	NT	<12	NT	<12
SVOCs					
Benzo(a)anthracene	NT	NT	NT	NT	NT
Benzo(k)fluoranthene	NT	NT	NT	NT	NT
Benzo(g,h,i)perylene	NT	NT	NT	NT	NT
Bis(2-ethylhexyl)phthalate	NT	NT	NT	NT	NT
Di-n-butylphthalate	NT	NT	NT	NT	NT
Hexachloroethane	NT	NT	NT	NT	NT
Ideno(1,2,3-c,d)pyrene	NT	NT	NT	NT	NT
2-Methynaphthalene	NT	NT	NT	NT	NT
Phenanthrene	NT	NT	NT	NT	NT
Phenol	NT	NT	NT	NT	NT
Pyrene	NT	NT	NT	NT	NT

Parameter	Concentration (μg/kg) by Sample Location RCPBOR7 (8–10 ft)	RCPBOR7 (10–12 ft)	RCPBOR7 (12–14 ft)
VOCs			
Acetone	NT	1,700 D	104
Benzene	NT	<12	<12
Carbon disulfide	NT	<12	<12
Chlorobenzene	NT	<12	<12
1,2-Dichloroethene (total)	NT	<12	<12
Methylene chloride	NT	10 BJ	10 BJ
Styrene	NT	<12	<12
Xylenes	NT	<12	<12

TABLE A.3-9 (Cont.)

Parameter	RCPBOR7 (8–10 ft)	RCPBOR7 (10–12 ft)	RCPBOR7 (12–14 ft)
	Concentration (μg/kg) by Sample Location		
SVOCs			
Benzo(a)anthracene	NT	NT	NT
Benzo(k)fluoranthene	NT	NT	NT
Benzo(g,h,i)perylene	NT	NT	NT
Bis(2-ethylhexyl)phthalate	NT	NT	NT
Di-n-butylphthalate	NT	NT	NT
Hexachloroethane	NT	NT	NT
Ideno(1,2,3-c,d)pyrene	NT	NT	NT
2-Methynaphthalene	NT	NT	NT
Phenanthrene	NT	NT	NT
Phenol	NT	NT	NT
Pyrene	NT	NT	NT

[a] Notation: B = analyte also found in the associated blank; D = sample was diluted for analysis; J = estimated value; NT = not tested.

TABLE A.3-10 Analytical Results for Selected Metals in Soil Samples Collected from the RCP AOC: 1994–1995[a]

	Concentration (µg/kg) by Sample Location				
Parameter	RCPBOR1 (0–2 ft)	RCPBOR1 (2–4 ft)	RCPBOR1 (4–6 ft)	RCPBOR1 (6–8 ft)	RCPBOR1 (8–10 ft)
Antimony	<2.8	<2.7	<2.8	<2.7	<2.9
Arsenic	4.6	2.3	4.7	3.2	1.4
Cadmium	<0.50	<0.48	<0.49	<0.49	<0.51
Chromium	20	11	10	13	8.1
Copper	8.6	4.6	4.1	6.6	4.0
Lead	9.8	6.6	6.0	6.3	3.4
Nickel	10	5.8	5.8	5.8	5.1
Zinc	28	17	15	18	15

	Concentration (µg/kg) by Sample Location				
Parameter	RCPBOR2 (0–2 ft)	RCPBOR2 (2–4 ft)	RCPBOR2 (4–6 ft)	RCPBOR2 (6–8 ft)	RCPBOR2 (8–10 ft)
Antimony	NT	<2.6	<2.8	<2.8	<2.8
Arsenic	NT	*5.9*	1.3	1.8	1.7
Cadmium	NT	<0.47	<0.50	<0.50	<0.50
Chromium	NT	16	8.9	7.1	7.8
Copper	NT	6.4	5.0	3.9	5.1
Lead	NT	9.6	5.0	4.3	4.1
Nickel	NT	8.3	6.4	4.7	5.4
Zinc	NT	24	19	26	25

	Concentration (µg/kg) by Sample Location				
Parameter	RCPBOR3 (0–2 ft)	RCPBOR3 (2–4 ft)	RCPBOR3 (4–6 ft)	RCPBOR3 (6–8 ft)	RCPBOR4 (0–2 ft)
Antimony	<2.7	<3.0	<2.9	<2.8	<2.7
Arsenic	4.2	2.1	3.0	3.7	2.5
Cadmium	<0.48	<0.53	<0.51	<0.50	<0.48
Chromium	14	8.1	8.6	11	12
Copper	5.0	5.1	5.1	6.0	7.6
Lead	9.4	4.9	4.0	4.8	12
Nickel	5.8	5.0	4.9	6.8	8.8
Zinc	18	16	15	22	32

TABLE A.3-10 (Cont.)

	Concentration (µg/kg) by Sample Location				
Parameter	RCPBOR4 (2–4 ft)	RCPBOR4 (4–6 ft)	RCPBOR4 (6–8 ft)	RCPBOR4 (8–10 ft)	RCPBOR5 (0–2 ft)
Antimony	<2.7	<2.8	<2.7	NT	<0.20
Arsenic	3.3	1.2	2.9	NT	3.6
Cadmium	<0.48	<0.50	<0.48	NT	***0.97***
Chromium	14	7.0	6.9	NT	23
Copper	9.9	4.9	5.2	NT	***89***
Lead	11	4.8	6.0	NT	25
Nickel	8.6	6.3	5.4	NT	5.7
Zinc	30	20	18	NT	43

	Concentration (µg/kg) by Sample Location				
Parameter	RCPBOR5 (2–4 ft)	RCPBOR5 (4–6 ft)	RCPBOR5 (6–8 ft)	RCPBOR5 (8–10 ft)	RCPBOR5 (14–16 ft)
Antimony	<0.21	<0.20	<0.21	NT	NT
Arsenic	2.6	3.1	***5.2***	NT	NT
Cadmium	0.56	<0.48	<0.49	NT	NT
Chromium	36	18	4.1	NT	NT
Copper	***125***	6.5	1.8	NT	NT
Lead	21	4.1	2.6	NT	NT
Nickel	7.3	8.7	4.2	NT	NT
Zinc	52	26	13	NT	NT

	Concentration (µg/kg) by Sample Location				
Parameter	RCPBOR6 (0–2 ft)	RCPBOR6 (2–4 ft)	RCPBOR6 (4–6 ft)	RCPBOR6 (6–8 ft)	RCPBOR6 (8–10 ft)
Antimony	0.63	1.6	<0.20	<0.21	<0.21
Arsenic	3.5	4.0	0.58	1.2	0.95
Cadmium	<0.46	0.56	<0.36	4.9	<0.50
Chromium	13	13	3.0	2.8	4.2
Copper	***22***	***26***	8.7	***32***	3.5
Lead	***64***	***185***	25	6.5	2.9
Nickel	6.6	19	2.5	***24***	3.1
Zinc	97	***121***	20	55	35

TABLE A.3-10 (Cont.)

Parameter	RCPBOR6 (14–16 ft)	RCPBOR7 (0–2 ft)	RCPBOR7 (2–4 ft)	RCPBOR7 (4–6 ft)	RCPBOR7 (6–8 ft)
	Concentration (µg/kg) by Sample Location				
Antimony	NT	<0.20	<0.21	<0.20	<0.21
Arsenic	NT	4.8	***5.2***	***7.6***	3.5
Cadmium	NT	<0.48	<0.48	<0.48	<0.49
Chromium	NT	14	20	9.9	11
Copper	NT	14	11	8.2	3.7
Lead	NT	17	10	5.0	4.0
Nickel	NT	8.5	11	7.9	3.4
Zinc	NT	23	35	23	36

Parameter	RCPBOR7 (8–10 ft)	RCPBOR7 (10–12 ft)	RCPBOR7 (12–14 ft)	Background (µg/kg)[b]
	Concentration (µg/kg) by Sample Location			
Antimony	NT	<0.21	<0.20	3.8
Arsenic	NT	0.47	1.7	5.0
Cadmium	NT	<0.48	<0.47	0.70
Chromium	NT	3.4	4.9	41
Copper	NT	2.1	4.6	20
Lead	NT	2.7	4.1	61
Nickel	NT	3.3	5.3	20
Zinc	NT	16	17	118

[a] Notation: NT = not tested. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values derived from soil data in ICF Kaiser Engineers (1995).

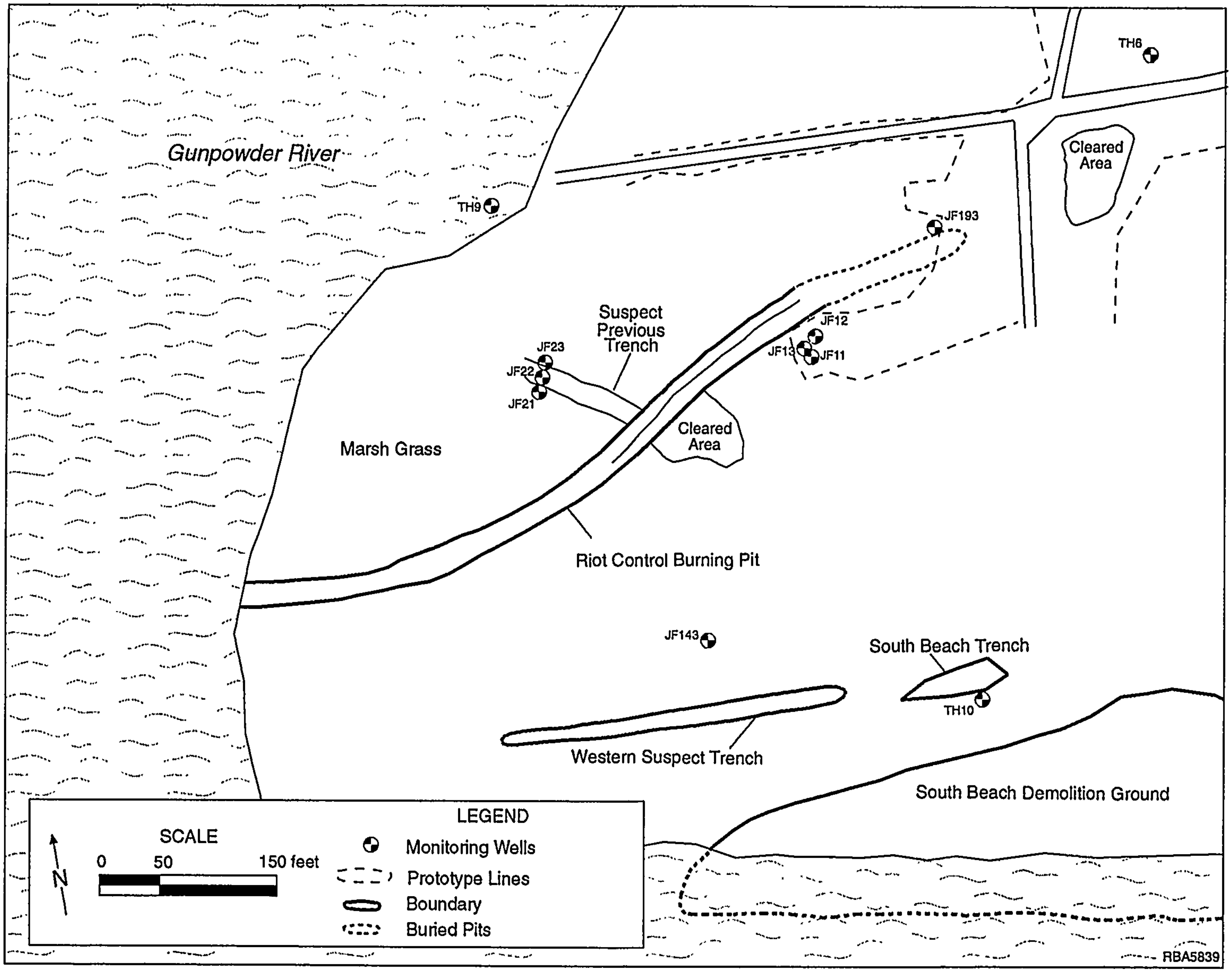

FIGURE A.3-7 Locations of Monitoring Wells at the RCP AOC

TABLE A.3-11 Well Construction Data for Monitoring Wells at the RCP AOC

Well Number	Elevation of Land Surface (ft MSL)	Depth of Boring (ft)	Screened Inverval (ft below surface)	Date Installed (investigator)
JF11	7.4	90	85–90	1988–1989 (USGS)
JF12	7.3	55	50–55	1988–1989 (USGS)
JF13	7.2	25.5	20.5–25.5	1988–1989 (USGS)
JF21	3.0	71	68–71	1988–1989 (USGS)
JF22	3.0	52.5	47.5–52.5	1988–1989 (USGS)
JF23	3.1	19	16–19	1988–1989 (USGS)
JF143	NA[a]	10	5–10	1992 (USGS)
JF193	NA	24	13–23	1996 (ANL)

[a] NA = not available.

Groundwater samples were analyzed for metals, VOCs, and SVOCs in 1990. Samples from wells JF22 and JF23 were also analyzed for organosulfur and explosives-related compounds. None of these compounds were detected, but the results showed some fluoride contamination in both wells. Cyanide was found in well JF22 (66 µg/L). The VOC measurements for well JF13 showed benzene (1,500 µg/L) and methylisobutylketone (640 µg/L). Benzene (800 µg/L) was also detected in well JF13 in 1992. No VOCs were detected in the newly installed well (JF143) (Hughes 1992).

Groundwater from wells JF12, JF13, JF22, JF23, and JF143 was sampled in summer 1994. Samples from wells completed in the leaky confining unit (JF12 and JF22) were analyzed for general chemistry and VOCs. No VOCs above the detection limits were found in these two wells. No fluoride or cyanide was detected.

Groundwater samples were collected from three wells (JF13, JF23, and JF143) completed in the surficial aquifer. Samples from JF13 were analyzed for general chemistry, PCBs, pesticides, SVOCs, VOCs, and total and dissolved metals. No PCBs or pesticides were detected in this well, and only two SVOCs, bis(2-ethylhexyl)phthalate (12 µg/L) and phenol (59 µg/L), were detected. Both parameters were outside the laboratory control limits, and a high degree of uncertainty is associated with them. Benzene (300 µg/L) was the only VOC detected in well JF13. This contaminant exceeded the instrument's calibration range and was subsequently diluted. There is no AWQC for benzene; however, the MCL is 5 µg/L.

Samples from well JF13 were also analyzed for total and dissolved metals. Hardness was calculated as 449 mg/L (dissolved) and 430 mg/L (total). Iron was the only metal that exceeded the AWQC of 1,000 µg/L (the MCL is 300 µg/L); however, iron is not considered a problem in this environment. Dissolved iron was detected at 3,060 µg/L, and total iron was detected at 5,350 µg/L. Lead was detected at 5.0 µg/L. The AWQC lead value is hardness dependent and must be adjusted accordingly. This adjustment provides a lead AWQC of 20 µg/L. The MCL for lead is 50 µg/L.

Samples collected from well JF143 were analyzed for general chemistry, VOCs, and total and dissolved metals. No VOCs were detected. Iron and lead were the only metals found at levels exceeding the AWQC. Hardness was calculated at 84 mg/L (dissolved) and 80 mg/L (total). Total iron was detected at 2,270 µg/L, and dissolved iron was detected at 64 µg/L. The MCL for iron is 300 µg/L, and the AWQC is 1,000 µg/L; however, iron is not considered to be a problem in this environment. Lead was detected at 3.3 µg/L. The AWQC lead value is hardness dependent and must be adjusted accordingly. This adjustment provides a lead criteria level of 2.4 µg/L; the detected value exceeds the adjusted AWQC value.

Samples from JF23 were analyzed for general chemistry, pesticides, and total and dissolved metals. No PCBs or pesticides were detected in these samples. Iron and lead were the only metals that exceeded the AWQC. Hardness was calculated at 526 mg/L (dissolved) and 499 mg/L (total). Dissolved iron was detected at 1,750 µg/L, and total iron was detected at 2,450 µg/L. The AWQC for iron is 1,000 µg/L, and the MCL is 300 µg/L; however, iron is not considered a problem in this environment. Lead was detected at 3.4 µg/L. The AWQC value for lead is hardness dependent and must be adjusted accordingly. This adjustment provides a lead criteria level of 25 µg/L; the detected value is below the AWQC and the MCL.

A groundwater sample was collected from well JF193 in June 1996. The sample was analyzed for VOCs because they were considered the most common contaminants reported at J-Field. Methylene chloride and acetone were detected in the sample at 4 µg/L and 55 µg/L, respectively. The same analytes were also detected in the trip blank sample at similar concentrations (4 µg/L and 12 µg/L, respectively). No other VOCs were detected above the method detection limits of 10 µg/L. The presence of methylene chloride and acetone in the groundwater sample is probably the result of laboratory contamination.

When judged by groundwater level, well JF193 is located hydrologically upgradient of the buried pit. The June 1996 groundwater quality results support this conclusion. Well JF13, previously considered an upgradient well, is therefore actually a downgradient well. The detection of benzene in groundwater from well JF13 is likely from past burning operations at the pit.

A.3.4 Surface Water and Sediments

Seven surface water and one sediment sample were collected from locations at or near the RCP AOC. Three water samples were collected in near-offshore areas immediately west of the RCP in the Gunpowder River. Samples JFSW8 and JFSW9 were collected in August 1988 by the USGS (Figure A.1-9) and were analyzed for metals, general chemistry, acetone, phenol, toluene, TOC, and TOX.

The EPA collected a surface water sample and a sediment sample at location 11 (Figure A.1-10) offshore of the RCP AOC in August 1992. The USGS collected sample JFSW5 in April 1993 from a ponded water area near the southwest terminus of the RCP (Figure A.1-9). Argonne collected samples RCPSW1 and RCPSW3 in June 1995 near the shore west of the site and sample RCPSW2 inside the pit (Figure A.3-8). These sediment and surface water samples were analyzed for VOCs, SVOCs, metals, pesticides, explosives-related compounds, and CSM/CSM degradation products. Table A.3-12 provides selected chemical data for the surface water samples.

Four of the seven surface water samples from the RCP had contaminant concentrations above the calculated background levels. The highest concentrations were found onshore, in sample JFSW5, located at the southwestern tip of the burning pit: copper (30 µg/L), iron (10,000 µg/L), lead (26 µg/L), and zinc (160 µg/L). Offshore samples from EPA-11 had slightly elevated levels of chromium and nickel. The zinc concentration was slightly elevated in RCPSW3.

VOCs, SVOCs, pesticides, CSM/CSM degradation products, and explosives-related compounds were not detected in any of the surface water samples. The basic water quality parameters (e.g., pH, chloride, sodium, calcium) were all within normal ranges for local estuarine/river waters. No elevated levels of analytes were found in the sediment samples.

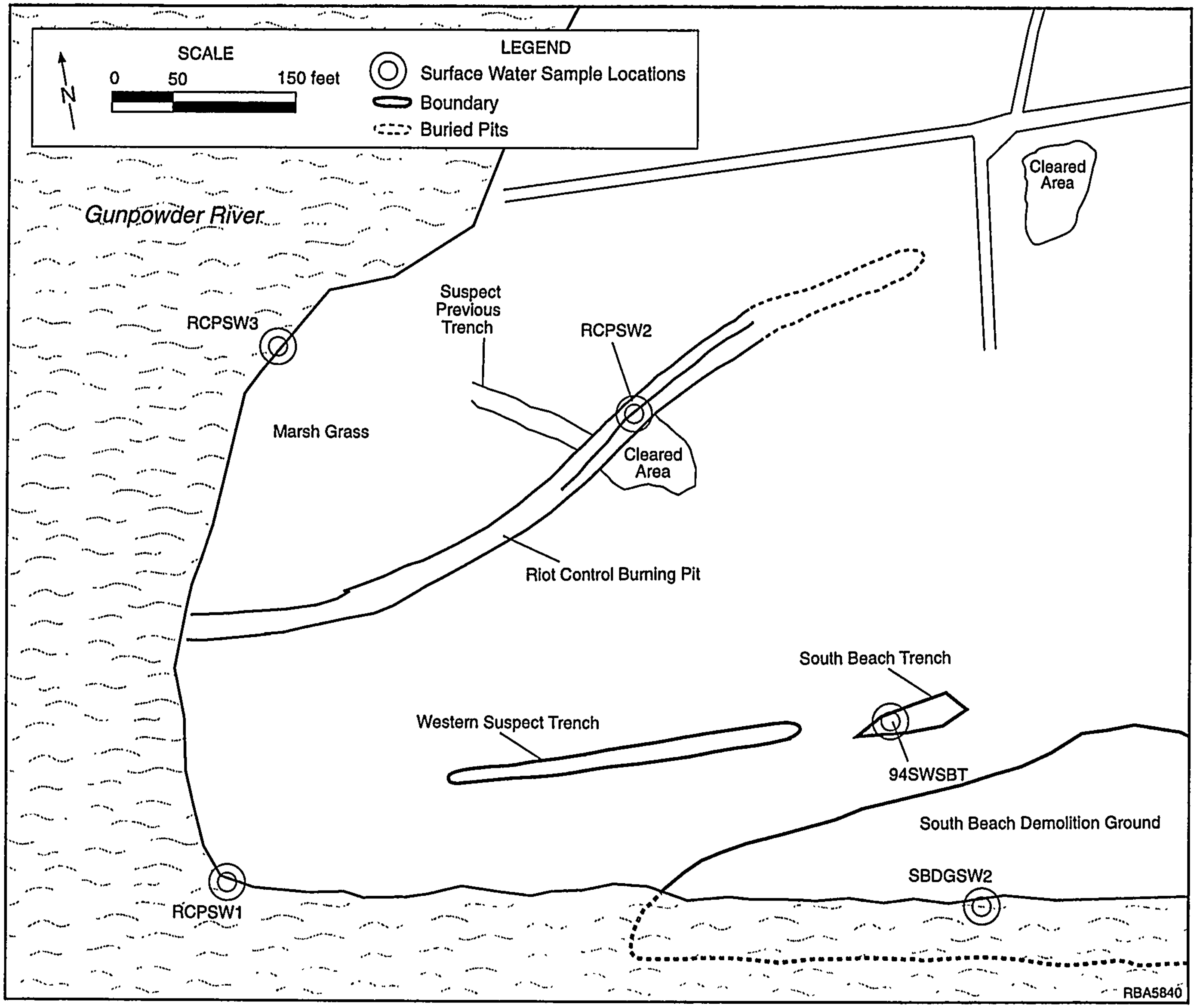

FIGURE A.3-8 Locations of Surface Water Samples at the RCP AOC

TABLE A.3-12 Analytical Results for Selected Metals in Surface Water Samples Collected from the RCP AOC[a]

	Concentration (µg/L) by Sample Location						
Contaminant	EPA11[b] (Offshore)	RCPSW1[c] (Offshore)	RCPSW3[c] (Offshore)	Estuarine River Background[d]	RCPSW2[c] (Onshore)	JFSW5[e] (Onshore)	Freshwater Pond Background[f]
Arsenic	–	<1.8	<1.8	NA[f]	<1.8	5	NA
Chromium	12	<8.0	<8.0	NA	<8.0	9	NA
Copper	–	<23	<23	5	25	30	NA
Iron	–	85	719	2,140	1,540	***10,000***	5,750
Lead	–	<0.90	<0.90	3	1.3	***26***	6
Vanadium	–	<29	<29	***16***	<29	***17***	9
Nickel	28	<21	<21	NA	<21	23	NA
Zinc	–	12	34	15	32	***160***	76

[a] Notation: NA = data not reported for media in ICF Kaiser Engineers (1995); a hyphen indicates contaminant not present above method detection limit, detection limit unavailable. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Source: EPA (1992).

[c] Source: ANL (1995).

[d] Background values derived from estuarine river data in ICF Kaiser Engineers (1995). Estuarine river calculated background values were used as comparison criteria for offshore samples EPA11, RCPSW1, and RCPSW3.

[e] Source: Hughes (1993).

[f] Background values derived from freshwater pond data in ICF Kaiser Engineers (1995). Freshwater pond calculated background values were used as comparison criteria for onshore samples RCPSW2 and JFSW5.

A.4 PROTOTYPE BUILDING AREA OF CONCERN

A.4.1 Screening Investigations

A.4.1.1 Soil Gas

In May 1993, an EMFLUX soil gas survey was conducted at 42 locations east of the PB AOC (Figure A.4-1) (Prasad 1993). Low emissions of TCLEE (0.8–11.5 ng/m^2/min) were detected at three locations northeast of the building (Q23, Q36, and Q37). The same general areas also indicated low emissions of acetone (0.2–7.0 ng/m^2/min).

In January 1995, another EMFLUX survey was conducted at 22 locations, mainly in areas west and south of the building (Quadrel 1995) (Figure A.4-2). Low levels of acetone (3.5–24.5 ng/m^2/min) were present in those areas. Two soil gas samples taken from an area immediately north of the Southwestern Suspect Burning Area (sample locations 369, 370) also had a low level of acetone (up to 11.8 ng/m^2/min). Low levels of benzene (0.8 and 1.0 ng/m^2/min at 358 and 367, respectively), xylene (0.4 and 1.1 ng/m^2/min at 359 and 370, respectively), and toluene (2.5 ng/m^2/min at 370) were detected in three widely separated locations.

A.4.1.2 In Situ X-Ray Fluorescence

Field XRF measurements were made at 27 locations in the PB AOC: 6 in the Northeastern Suspect Burning Area (XRPBBP–6); 7 in the Southwestern Suspect Burning Area (XRPBBP7–13); and 14 around the building (XRPTB1–6; 8 samples next to each side and corner of the building) (Figure A.4-3).

Elevated levels of zinc were detected at the north and west sides of the building (XRPTBN and XRPTBW, respectively). Elevated levels of lead were also detected at the north, south, and west sides of the building (XRPTBN, XRPTBS, and XRPTBW, respectively).

A.4.1.3 Geophysical Surveys

In 1993, a geophysical survey was conducted mainly at the west side of the PB (Daudt et al. 1994). The methods used included seismic refraction, seismic reflection, electrical resistivity soundings, electromagnetic conductivity, magnetometer, and GPR. No GPR geophysical anomalies were found in the area west of the building. The magnetic anomalies found could be attributed to the

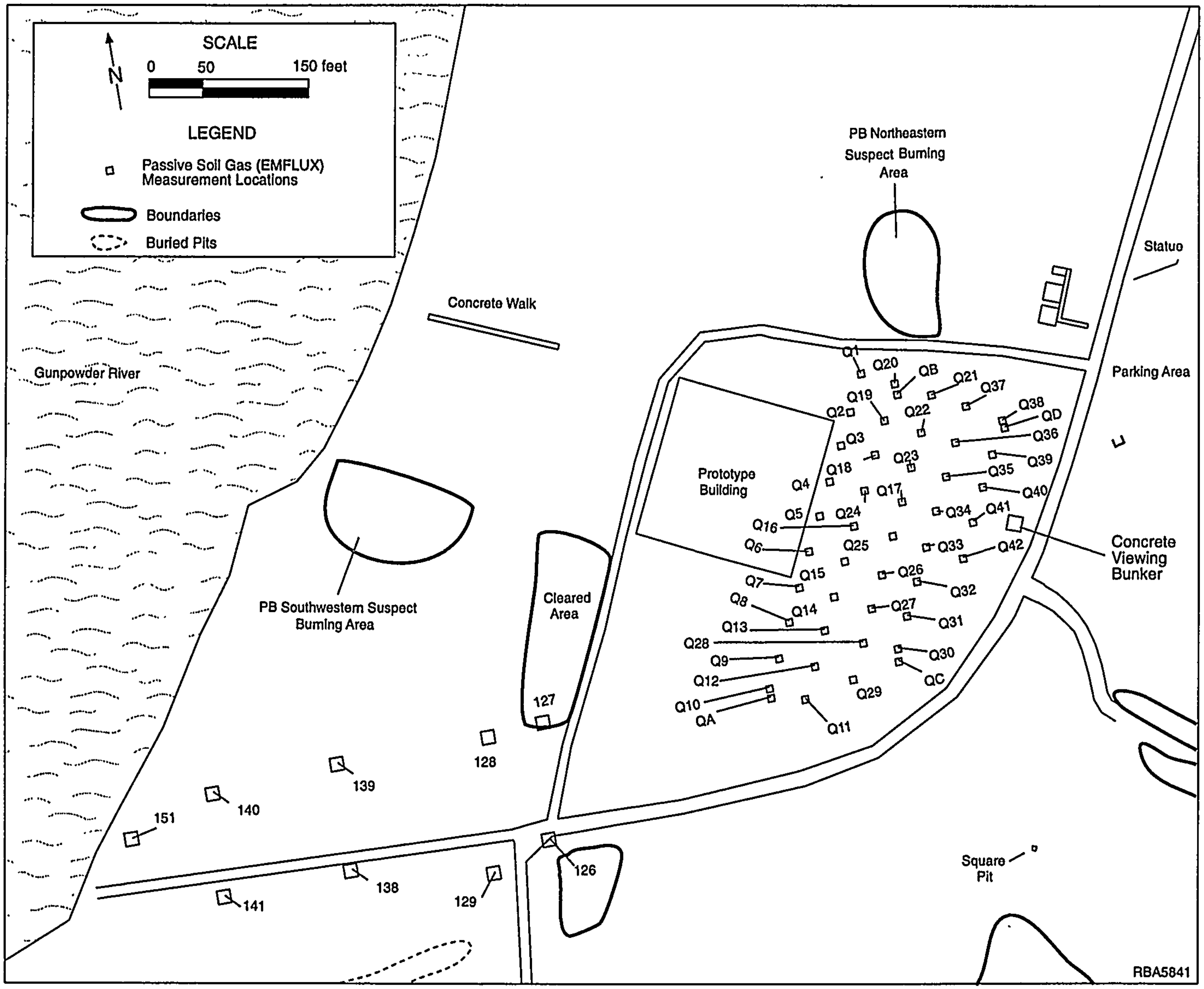

FIGURE A.4-1 Locations of EMFLUX Soil Gas Samples at the PB AOC: 1993

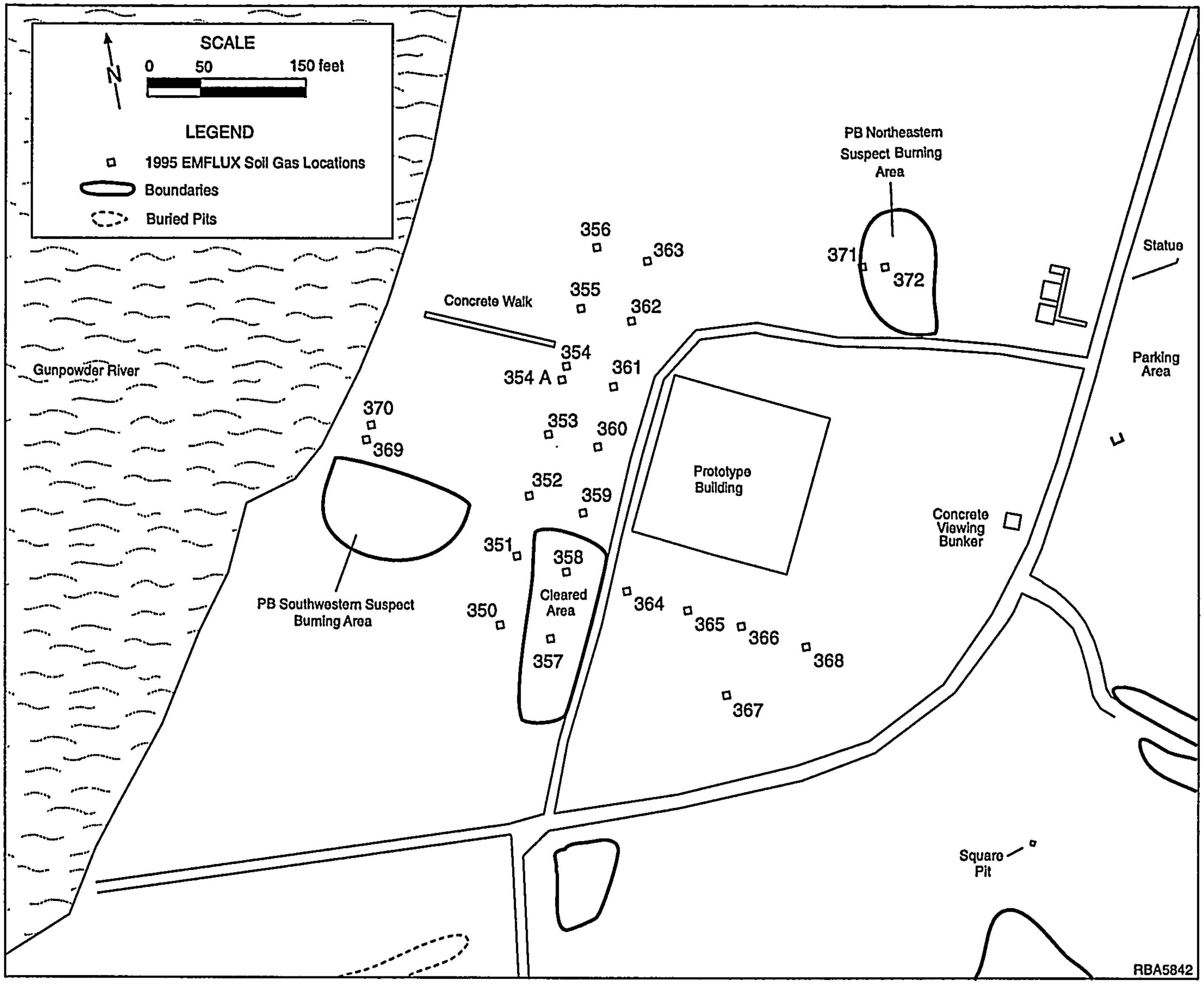

FIGURE A.4-2 Locations of EMFLUX Soil Gas Samples at the PB AOC: 1995

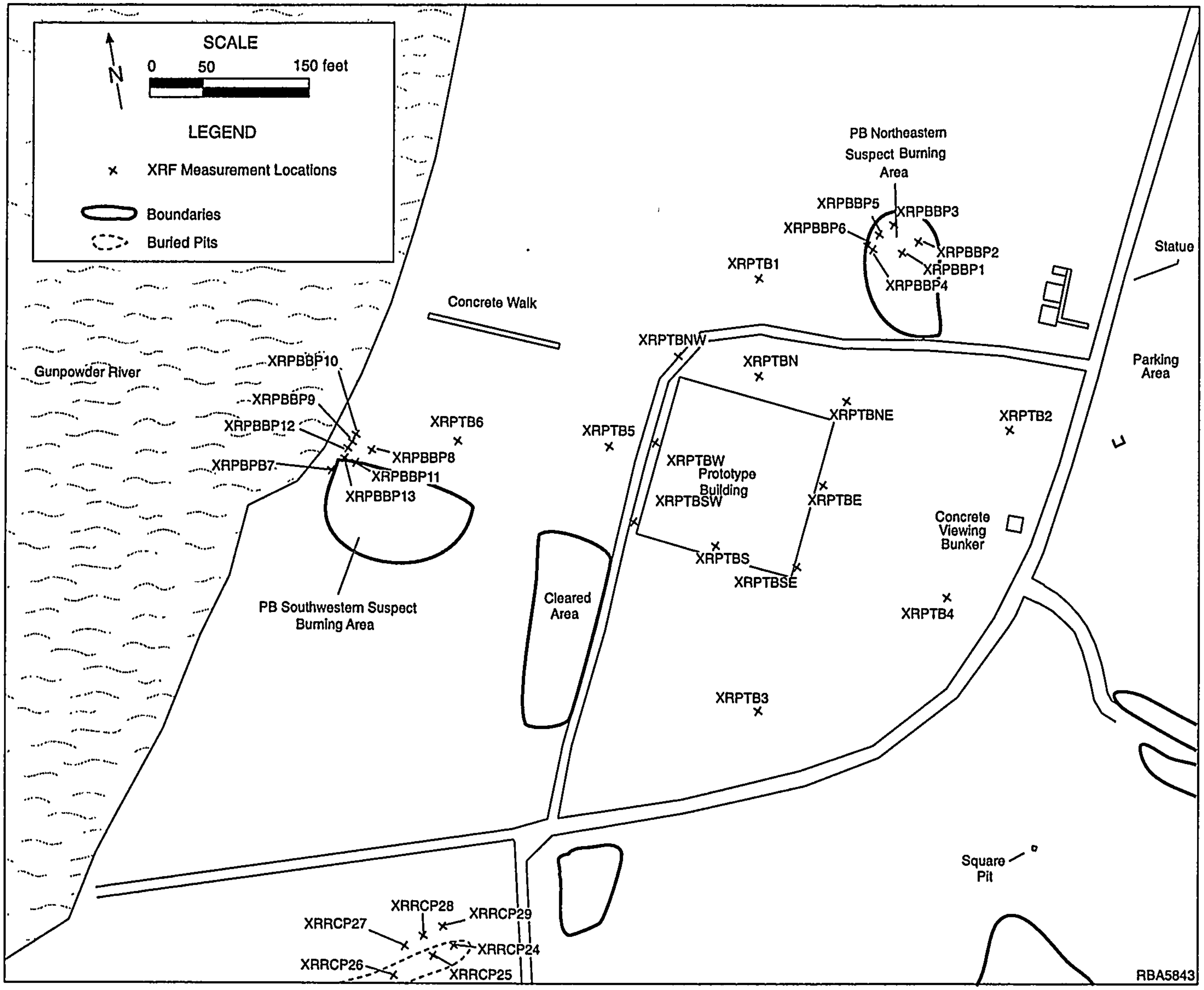

FIGURE A.4-3 Locations of X-Ray Fluorescence Measurements at the PB AOC building itself, the concrete walk, and groundwater well cluster 3 (including wells JF31, JF32, and JF33). Two positive conductivity anomalies were found. One extended northwest from the building, and the other extended west from well cluster 3 (Daudt et al. 1994). The origin of the anomalies is unknown. No additional surveys were conducted.

A.4.2 Soil Analysis

A.4.2.1 Surface Soil

Two surface soil samples, one from the north side and the other from the south side of the building, were collected as part of the 1986 RFA (Nemeth 1989). These samples were analyzed for metals, extractable metals, and explosives-related compounds. Cadmium (17 mg/kg) and lead (1,622 mg/kg) were detected near the south side of the building. The concentrations of organic compounds found in these samples were below the corresponding detection limits. A composite sample collected near the building contained low concentrations of pesticides: 1.0 mg/kg each of DDD, DDE, and DDT.

In 1991, the USGS collected five surface soil samples from the PB AOC (sample locations 11–15 in Figure A.1-7). These samples were collected at 1-ft depths and analyzed for indicator parameters, VOCs, SVOCs, metals, and explosives-related compounds (Hughes 1992). No significant levels of VOCs or SVOCs were found. Explosives-related compounds also were not detected. Analytical results showed low levels of metals at the site, especially at sample location 15 east of the PB, where lead (93 mg/kg), chromium (19 m/kg), copper (48 mg/kg), and zinc (158 mg/kg) were detected.

In 1994, surface soil samples were collected from six locations (PTB1–6) in the PB AOC (Figure A.4-4). The samples were analyzed for VOCs, SVOCs, metals, cyanide, pesticides, and CSM/CSM degradation products. Table A.4-1 summarizes the results.

For all samples, VOCs and CSM/CSM degradation products were below the corresponding detection limits. Bis(2-ethylhexyl)phthalate, an SVOC, was detected in most of the samples, ranging from 300 µg/kg in sample PTB3 (6–12 in.) to 810 µg/kg in sample PTB6 (0–6 in.). Low levels of other SVOCs were detected in sample PTB4, taken southeast of the PB, but the concentrations were lower than the calculated backgrounds derived from ICF-Kaiser Engineers (1995). Levels of metals (cadmium, copper, mercury, and silver) in most of the PTB samples were slightly higher than the calculated backgrounds. The highest levels of zinc (190 mg/kg) were detected in sample PTB1, collected north of the building. Lead was highest in PTB2, but the concentration (60 mg/kg) was lower than the calculated background (61 mg/kg).

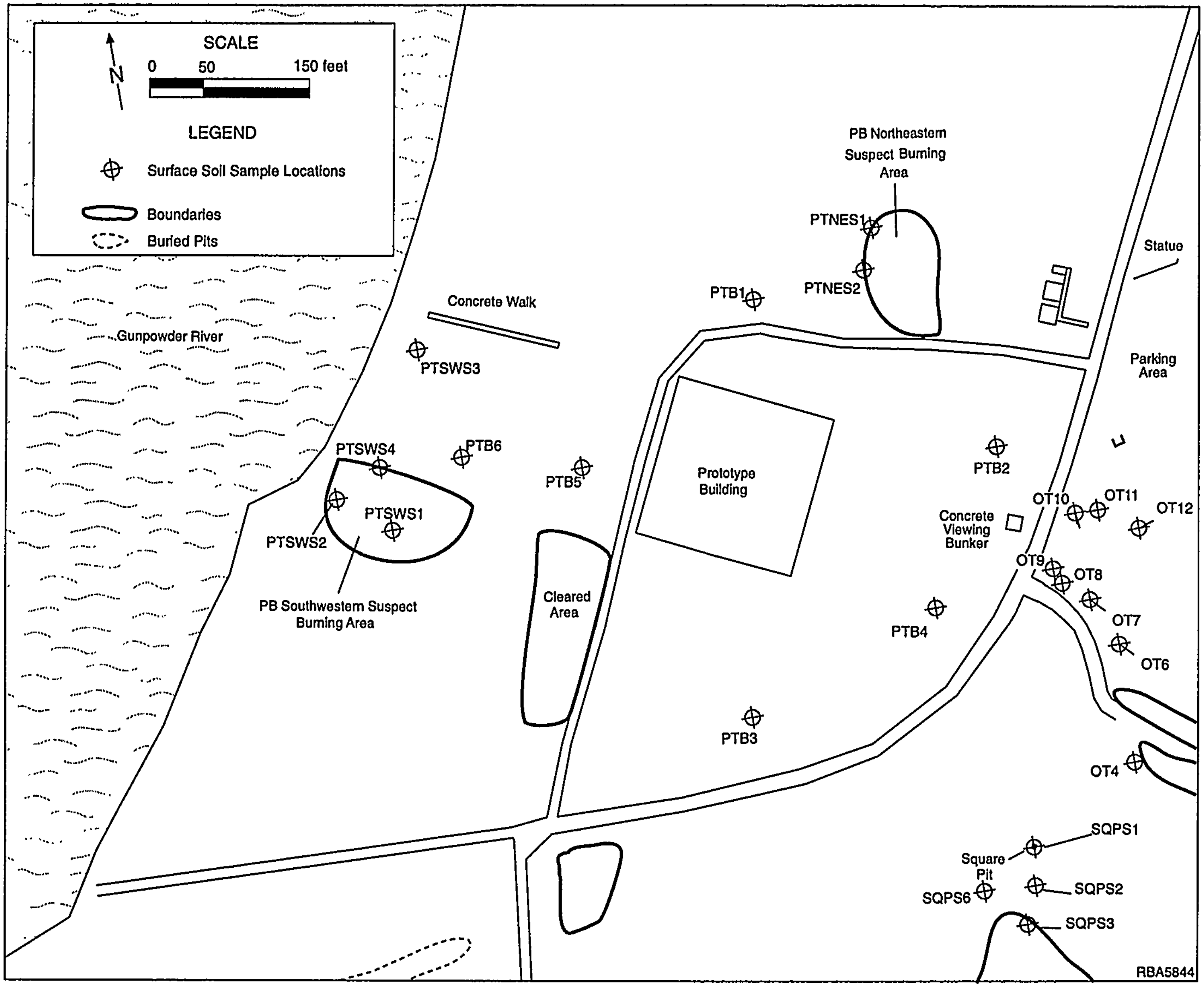

FIGURE A.4-4 Locations of Surface Soil and Surface Water Samples at the PB AOC: 1991–1994

TABLE A.4-1 Analytical Results for Various Parameters in Surface Soil Samples Collected from the PB AOC: 1994[a]

	Concentration by Sample Location										
	PTB1		PTB2		PTB3		PTB4	PTB5	PTB6		
Parameter	(0–6 in.)	(6–12 in.)	(0–6 in.)	(6–12 in.)	(0–6 in.)	(6–12 in.)	(0–6 in.)	(0–6 in.)	(0–6 in.)	(6–12 in.)	Background[b]
SVOCs (μg/kg)[c]											
Benz[a]anthracene	<420	NT	NT	<380	<390	<450	49 J	<400	<410	NT	135
Benzo[b]fluoranthene	<420	NT	NT	<380	<390	<450	78 J	<400	<410	NT	183
Benzo[g,h,i]perylene	<420	NT	NT	<380	<390	<450	43 J	<400	<410	NT	153
Benzo[a]pyrene	<420	NT	NT	<380	<390	<450	59 J	<400	<410	NT	259
Bis(2-ethylhexyl)phthalate	300 BJ	NT	NT	480 B	340 BJ	300 BJ	400 J	580 B	810 B	470 B	NA
Chrysene	<420	NT	NT	<380	<390	<450	54 J	<400	<410	NT	197
Di-n-butylphthalate	75 J	NT	NT	130 J	<390	<450	54 J	<400	<410	NT	NA
Fluoranthene	<420	NT	NT	<380 J	<390	<450	66 J	<400	<410	NT	NA
Indeno[1,2,3-c,d] pyrene	<420	NT	NT	<380	<390	<450	46 J	<400	<410	NT	165
Pyrene	<420	NT	NT	50 J	<390	<450	74 J	<400	<410	NT	290
Metals (mg/kg)											
Arsenic	2.9	NT	3.2	3.6	3.5	3.3	4.2	3.7	2.2	NT	5.0
Cadmium	***2.6***	NT	***3.5***	***3.0***	***1.9***	***2.1***	***2.5***	***2.4***	***1.9***	***2.0***	0.70
Copper	***75***	NT	***65***	***56***	16 E	8.4 E	***30***	***26***	***40***	***41***	20
Lead	36	NT	46	60	34	13	37	18	19	NT	61
Mercury	<0.10	NT	<0.12	***0.13***	***0.13***	<0.11	<0.12	<0.12	<0.12	***0.13***	0.080
Silver	<0.79	NT	<0.89	<0.77	<0.79	<0.94	<0.79	<0.72	***0.74***	***0.78***	0.39
Zinc	***190***	NT	86	103	57	48	76	37	51	103	118
Cyanide (mg/kg)	<0.21	NT	<0.22	0.28	0.36	<0.23	2.6	<0.21	0.35	0.28	NA
Pesticides (μg/kg)[c]											
Aldrin	<2.2	<2.0	ND	ND	2.0	<2.3	<2.1	<2.1	<2.1	NT	NA
4,4'-DDD	***6.2***	<3.8	***4.2***	ND	<3.9	<4.5	<4.1	<4.0	<4.1	NT	3.7
4,4'-DDE	<4.2	30	5.7	30	<6.4	<4.5	<4.1	<4.0	<4.1	NT	162
4,4'-DDT	16 P	4.6 P	7.2	4.6	15	<4.5	14	<4.0	<4.1	NT	61
Endrin aldehyde	7.5 P	<3.8	ND	ND	<3.9	<4.5	<4.1	<4.0	<4.1	NT	NA

[a] Notation: B = analyte also found in the associated blank; E = estimated value (metals); J = estimated value (SVOCs); P = difference for detected concentrations between two GC columns was greater than 25%, and the lower of the two is reported; NA = not available; ND = not detected; NT = not tested. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

[c] Only contaminants detected in at least one sample are reported.

Low levels of pesticides were present in surface soil collected from east, south, and north of the building. For example, sample PTB1 (0–6 in.) contained 6.2 mg/kg of 4,4'-DDD, 16 mg/kg of 4,4'-DDT, and 7.5 mg/kg of endrin aldehyde. Sample PTB2 (0–6 in.) contained 5.7 mg/kg of 4,4'-DDE and 7.2 mg/kg of 4,4'-DDT. Sample PTB2 (6-12 in.) had 30 mg/kg of 4,4'-DDE and 4.6 mg/kg of 4,4'-DDT. Low levels of 4,4'-DDT (7.2–16 µg/kg) were also detected in samples PTB1 to PTB4, which were below the calculated background (61 µg/kg). Low levels of cyanide were detected in samples PTB3 (0.36 mg/kg at 6–12 in.), PTB4 (2.6 mg/kg at 0–6 in.), and PTB6 (0.35 mg/kg at 0–6 in. and 0.28 mg/kg at 6–12 in.).

In 1995, six surface soil samples were collected in the PB AOC: two in the Northeastern Suspect Burning Area (PTNES1 and PTNES2), three in the Southwestern Suspect Burning Area (PTSWS1, PTSWS2, and PTSWS4), and one south of the concrete walk (PTSW3) (Figure A.4-4). All samples were collected at a depth of 0–6 in. The samples were analyzed for VOCs and metals. Sample PTSW4 was also analyzed for SVOCs. Table A.4-2 summarizes the results.

TABLE A.4-2 Analytical Results for Various Parameters in Surface Soil Samples Collected from the PB AOC: 1995[a]

	Concentration by Sample Location						
Parameter	PTNES1	PTNES2	PTSWS1	PTSWS2	PTSWS3	PTSWS4	Background[b]
VOCs (µg/kg)[c]							
Acetone	NT	<12	NT	NT	NT	5.0	NA
Methylene chloride	NT	8.0 BJ	NT	NT	NT	7.0	NA
SVOCs (µg/kg)[c]							
Benzo[k]fluoranthene	NT	NT	NT	NT	NT	59	NA
Metals (mg/kg)							
Arsenic	3.8	2.5	0.84	0.83	2.3	2.5	5.0
Barium	62	85	74	71	***94***	64	94
Cadmium	0.62	0.56	0.45	0.64	***0.74***	***0.84***	0.70
Copper	3.9	12	4.3	13	19	18	20
Lead	5.7	25	10	20	16	20	61
Mercury	<0.056	***0.080***	<0.050	***0.12***	<0.060	<0.061	0.080
Zinc	24	41	21	48	58	46	118

[a] Notation: B = analyte also found in the associated blank; J = estimated value; NA = not available; NT = not tested. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

[c] Only contaminants detected in at least one sample are reported.

No significant contamination was detected in the surface soil samples from the two suspect burning areas or the concrete walk. Low levels of acetone and methylene chloride were detected in samples PTNES2 and PTSWS4. Benzo[k]fluroanthene, an SVOC, was detected at 59 µg/kg in sample PTSWS4 along the northern edge of the Southwestern Suspect Burning Area. Only two metals, barium (in PTSWS3) and mercury (in PTNES2), were detected at the calculated background level. All other metals were either not detected or detected at levels below the calculated background.

A.4.2.2 Subsurface Soil

No borings were drilled at the PB AOC; therefore, no subsurface soil samples were collected.

A.4.3 Groundwater

The major direction of groundwater movement in the surficial and confined aquifers appears to be westward away from the PB AOC to the Gunpowder River. The vertical movement of groundwater appears to be through the surficial aquifer into the confined aquifer; however, offshore there may be upward flow from each of the two aquifers and into the Gunpowder River. Movement in the surface and confined aquifers is affected by the tides (USGS 1991).

In 1977, three monitoring wells were installed in the PB AOC (TH5, TH6, and TH8) (Figure A.4-5). Well TH9, downgradient of the PB AOC, was also installed at this time; it is currently under water from the Gunpowder River. Analysis of a groundwater sample collected from TH5 during an environmental survey (Nemeth 1989) showed only compounds related to well construction. Minor amounts of hydrocarbons were detected in groundwater from well TH8. The compounds 111TCE and dimethyldisulfide were detected in well TH6 (on the southern side of the PB).

In 1987, the USGS installed a monitoring well nest (wells JF31, JF32, and JF33) to the west of the PB (Sonntag 1991; Hughes 1993). The three wells are screened in the confined aquifer, the leaky confined unit, and the surficial aquifer of the Talbot Formation (Figure A.4-5). Table A.4-3 provides the dates of installation and construction details for monitoring wells at the PB AOC. Groundwater samples were analyzed for VOCs, SVOCs, metals, and water quality parameters. In an analysis of samples from well TH8, benzene (6.4 µg/L) and methylisobutyl ketone (120 µg/L) were detected. However, no VOCs were detected in well TH8 or in wells JF31, JF32, and JF33 during a 1992 sampling event (Hughes 1992).

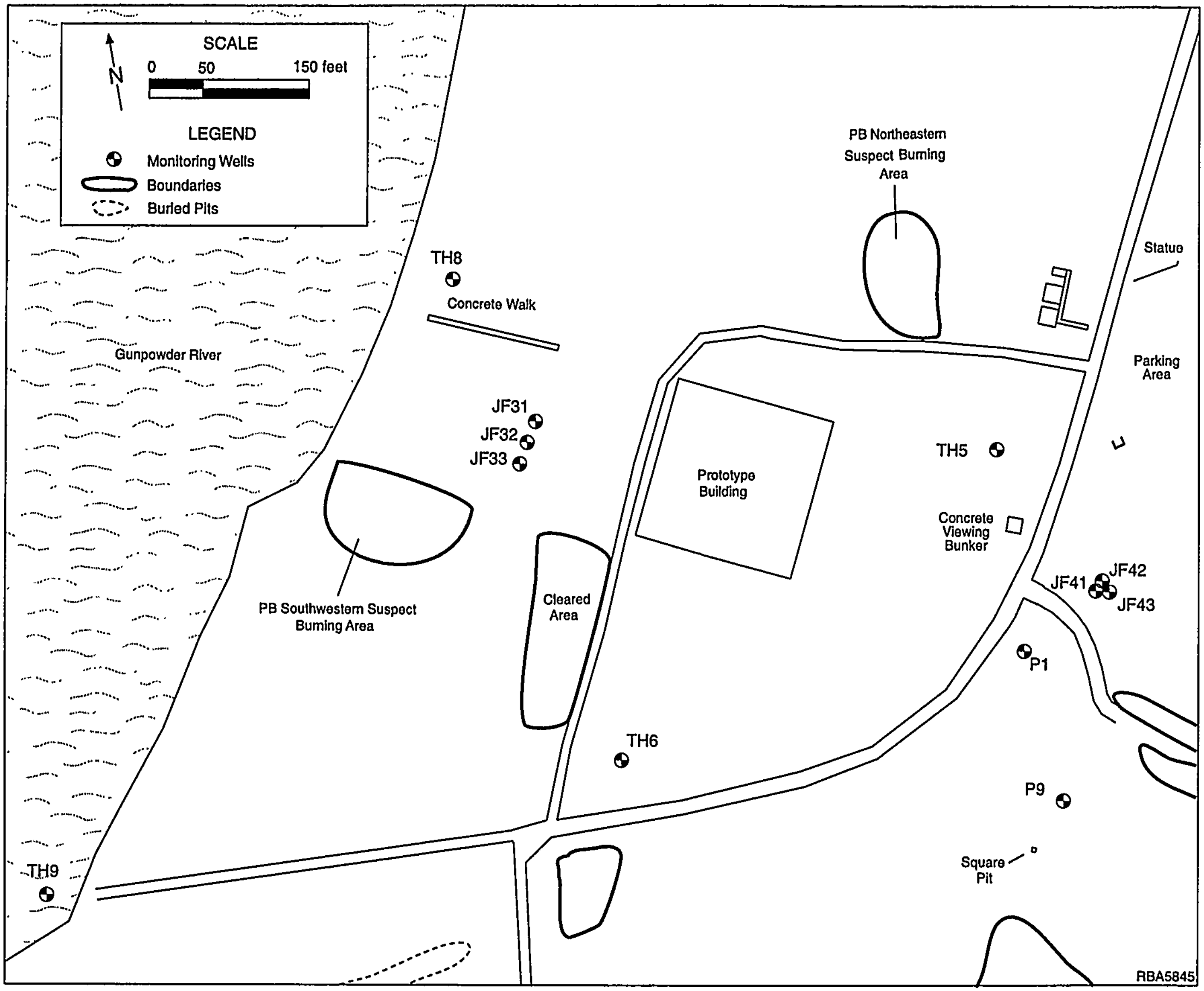

FIGURE A.4-5 Locations of Monitoring Wells at the PB AOC

TABLE A.4-3 Well Construction Data for Monitoring Wells at the PB AOC

Well Number	Elevation of Land Surface (ft MSL)	Depth of Boring (ft)	Screened Interval (ft below surface)	Date Installed (Investigator)
TH5	8.3	20	10–20	1977 (USATHAMA)
TH6	8.8	20	10–29	1977 (USATHAMA)
TH8	5.3	17	7–17	1977 (USATHAMA)
TH9[a]	4.8	18	8–18	1977 (USATHAMA)
JF31	7.7	81.3	73.8–78.8	1987 (USGS)
JF32	7.7	54.4	49.4–54.4	1987 (USGS)
JF33	7.8	20	15–20	1987 (USGS)

[a] Well TH9 is now located offshore because of shoreline erosion. The grout seal is missing. This well was not sampled during the RI.

Groundwater was sampled from wells TH8, JF31, JF32, and JF33 during the summer of 1994. Samples collected from well JF31, which is completed in the confined aquifer, were analyzed for VOCs; none were detected. Samples from wells JF32 and JF33 were analyzed for VOCs and general chemistry parameters; no VOCs were detected.

Samples collected from well TH8, located near the shore and downgradient of the PB, were analyzed for VOCs, total and dissolved metals, general chemistry, and explosives-related compounds. No VOCs or explosives-related compounds were detected. Groundwater from TH8 was also analyzed for TOX, which was found at a very low level (5.4 µg/L).

Total iron (1,510 µg/L), total lead (41 µg/L), and dissolved lead (14 µg/L) were the only metals found in groundwater from TH8 to exceed the AWQC. Lead did not exceed the MCL of 50 µg/L. For TH8, hardness was calculated at 129 mg/L (dissolved) and 94 mg/L (total). After the value was adjusted for hardness, the AWQC for total and dissolved lead were recalculated: 3.0 µg/L and 4.4 µg/L, respectively.

A.4.4 Surface Water and Sediments

No defined surface water or sediment areas exist within the PB AOC; therefore, all sampling for surface water and sediment took place offshore. Nearshore surface water and sediment samples were collected in 1988 by the USGS and in 1992 by the EPA. The data are discussed in detail in Section A.1.4.1.

In 1995, Argonne collected two additional offshore surface water samples (PTSW1 and PTSW2, Figure A.4-6). No sediment samples were collected. The surface water samples were analyzed for metals. The results are summarized in Table A.4-4. No metals were detected at levels exceeding the calculated background levels. Although cadmium was not detected, its detection limit (3.0 mg/kg) was above the calculated background (0.85 mg/kg). As a result, it is unknown whether the cadmium concentrations in these samples were above the calculated background level.

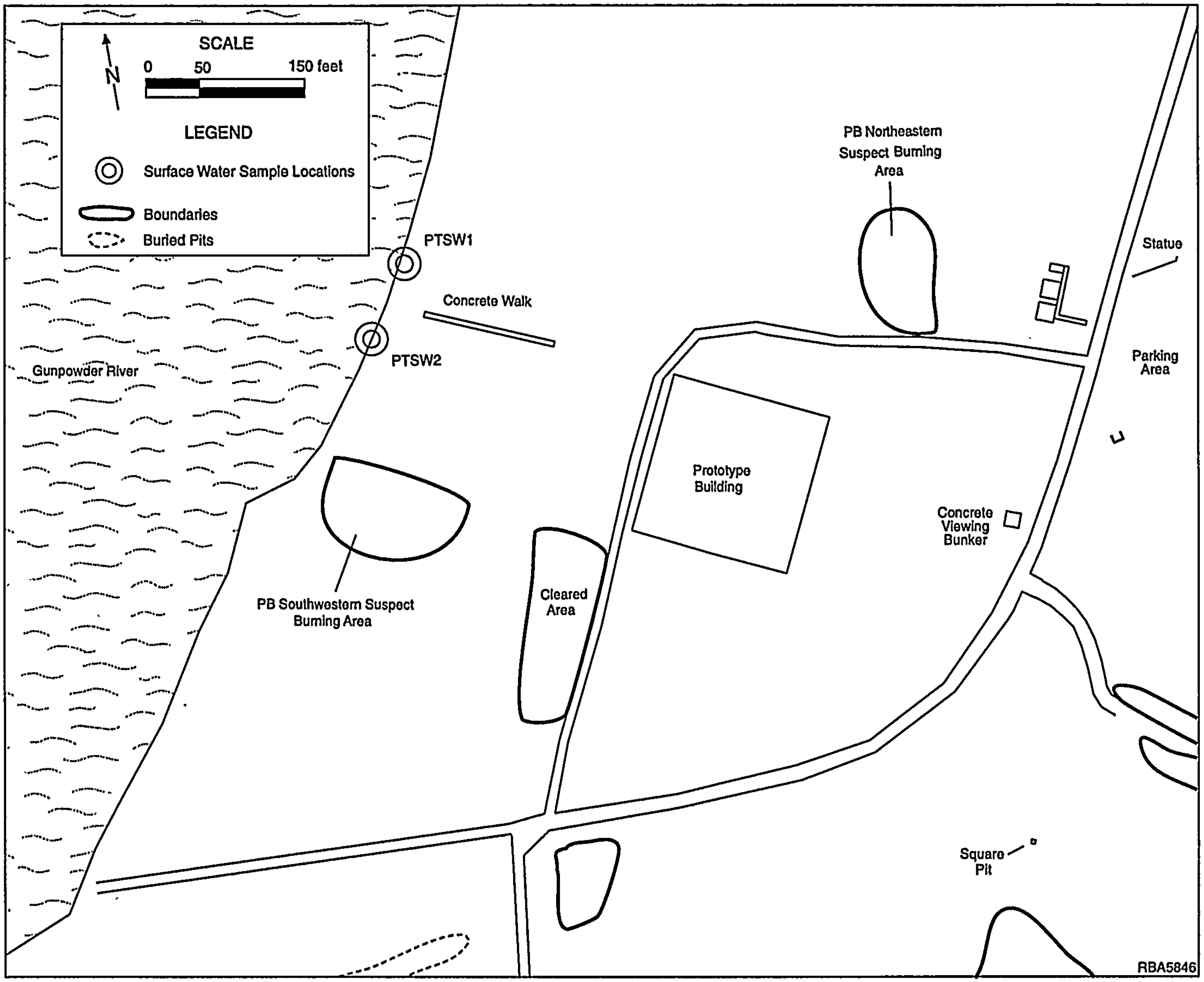

FIGURE A.4-6 Locations of Surface Water Samples at the PB AOC: 1995

TABLE A.4-4 Analytical Results for Selected Metals in Surface Water Samples Collected near the PB AOC: 1995[a]

Parameter	Concentration (µg/L) by Sample Location PTSW1	Concentration (µg/L) by Sample Location PTSW2	Estuarine River Background (µg/L)[b]
Arsenic	<1.8	<1.8	16
Cadmium	<3.0	<3.0	0.85
Calcium	48,600	46,900	NA
Chromium	<8.0	<8.0	123
Copper	<23	<23	48
Iron	2,520	3,010	65,000
Lead	3.2	4.9	70
Magnesium	150,000	130,000	NA
Mercury	<0.10	<0.10	0.21
Zinc	27	25	241

[a] Notation: NA = not available.

[b] Background values derived from estuarine river data in ICF Kaiser Engineers (1995).

A.5 SOUTH BEACH DEMOLITION GROUND AREA OF CONCERN

A.5.1 Screening Investigations

A.5.1.1 Soil Gas

No soil gas surveys were conducted at the SBDG AOC.

A.5.1.2 In Situ X-Ray Fluorescence

No XRF measurements were made at the SBDG AOC.

A.5.1.3 Geophysical Surveys

No geophysical surveys were conducted at the SBDG AOC.

A.5.2 Soil Analyses

No soil samples were collected at the SBDG AOC because the previously active area of the demolition ground is now in Chesapeake Bay (Figure A.5-1).

A.5.3 Groundwater

Groundwater was not sampled because the former demolition ground is now offshore and no wells are present in the area. Groundwater contamination is not expected in this area because of the continual washing effect on surface material by tidal water from the bay.

Well JF133 is northeast and hydrologically upgradient of SBDG (Figure A.5-1). The groundwater near the well is heavily influenced by bay water. Total sodium (794 mg/L), potassium (8.8 mg/L), and chloride (1.6 mg/L) indicate that the groundwater in the surficial aquifer is mixed with bay water.

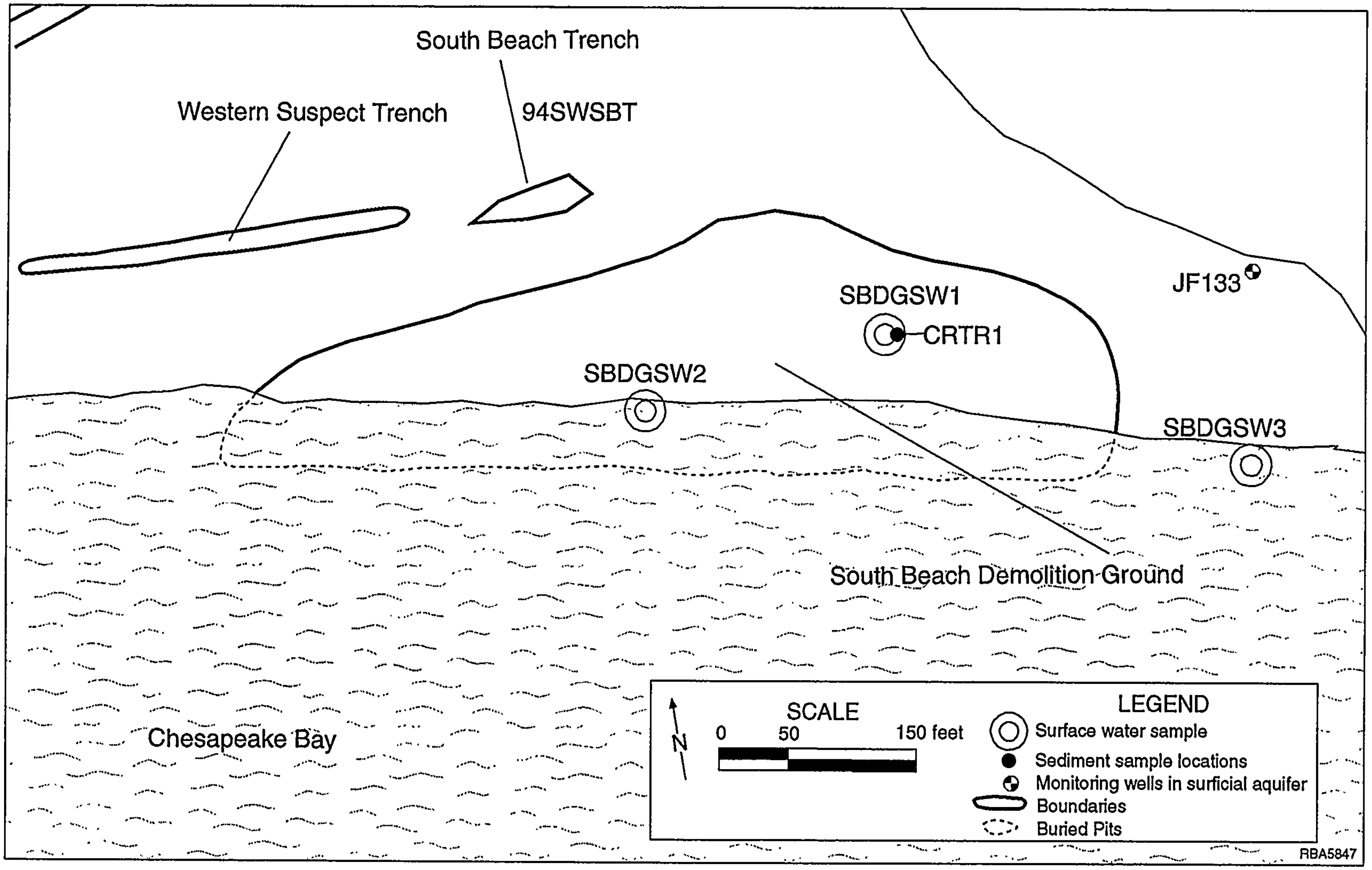

FIGURE A.5-1 Locations of Surface Water and Sediment Samples at the SBDG AOC: 1995

A.5.4 Surface Water and Sediments

Nearshore surface water and sediment samples were collected in 1988 by the USGS and in 1992 by the EPA (see Section A.1.4.1). The data indicate that the level of contamination offshore is very low.

In 1995, Argonne collected one sample (SBDGSW1) from standing water in an onshore demolition crater; a sediment sample (CRTR1) was also collected from this location. Two samples (SBDGSW2 and SBDGSW3) were collected from offshore areas immediately south of the SBDG AOC (Figure A.5-1). The surface water samples were analyzed for VOCs, metals, cyanide, water chemistry, and explosives-related compounds. The results are summarized in Tables A.5-1 and A.5-2. The sediment sample was analyzed for metals and explosives-related compounds. The results are summarized in Table A.5-3.

TABLE A.5-1 Analytical Results for Selected VOCs in Surface Water Samples Collected near the SBDG AOC: 1995[a]

	Concentration (µg/L) by Sample Location		
Parameter	SBDGSW1 (Onshore)	SBDGSW2 (Offshore)	SBDGSW3 (Offshore)
Acetone	<10	7.0 BJ	6.0 BJ
Benzene	<10	<10	<10
Carbon tetrachloride	<10	<10	<10
Chlorobenzene	<10	<10	<10
1,1-Dichloroethene	<10	<10	<10
cis-1,2-Dichloroethene	NT	NT	NT
trans-1,2-Dichloroethene	NT	NT	NT
1,2-Dichloroethene (total)	<10	<10	<10
Ethylbenzene	<10	<10	<10
Methylene chloride	9.0 BJ	12 B	5.0 BJ
1,1,2,2-Tetrachloroethane	<10	<10	<10
Tetrachloroethene	<10	<10	<10
Toluene	<10	<10	<10
1,1,2-Trichloroethane	<10	<10	<10
Trichloroethene	<10	<10	<10
Vinyl chloride	<10	<10	<10
Xylenes	<10	<10	<10

[a] Notation: B = analyte also found in the associated blank; J = estimated value; NT = not tested.

TABLE A.5-2 Analytical Results for Selected Metals in Surface Water Samples Collected near the SBDG AOC: 1995[a]

Parameter	Concentration (µg/L) by Sample Location SBDGSW1 (Onshore)	SBDGSW2 (Offshore)	SBDGSW3 (Offshore)	Freshwater Pond Background (µg/L)[b,c]	Estuarine River Background (µg/L)[b,d]
Arsenic	<1.8	<1.8	<1.8	NA	16
Cadmium	<3.0	<3.0	<3.0	NA	0.85
Calcium	6,070	46,700	45,300	NA	NA
Chromium	<8.0	<8.0	<8.0	8.0	123
Copper	<23	<23	<23	NA	48
Iron	5,260	242	307	5,750	65,000
Lead	1.6	<0.90	<0.90	6.0	70
Magnesium	3,820	108,000	131,000	NA	NA
Mercury	<0.10	<0.10	<0.10	NA	0.21
Zinc	67	68	16	76	240

[a] Notation: NA = not available.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

[c] Freshwater pond calculated background values were used as comparison criteria for SBDGSW1 (onshore).

[d] Estuarine river calculated background values were used as comparison criteria for SBDGSW2 and SBDGSW3 (offshore).

Acetone and methylene chloride were the only VOCs detected in the surface water samples (Table A.5-1). No metals were detected at levels exceeding the calculated background (Table A.5-2). Although cadmium was not detected, its detection limit (3.0 mg/kg) was above the calculated background (0.85 mg/kg) As a result, it is unknown whether the cadmium concentrations in these samples were above the calculated background level. Cyanide and explosives-related compounds were not detected.

No metals were detected in the sediment sample at levels exceeding the calculated background (Table A.5-3). No explosives-related compounds were detected.

In 1997, investigators from the University of Maryland's Agricultural Experiment Station collected a sediment sample from a location near sample SBDGSW2 (Figure A.5-1). The sample was analyzed for VOCs, metals, base neutral and acid compounds, PCBs, pesticides, herbicides, and explosive-related compounds (Burton and Turley 1997). The only organic compound detected was

TABLE A.5-3 Analytical Results for Selected Metals in the Sediment Sample Collected from the Crater at the SBDG AOC: 1995[a]

Parameter	Concentration (mg/kg) at Location CRTR1	Freshwater Pond Background (mg/kg)[b]
Arsenic	0.55	8.0
Cadmium	0.88	0
Calcium	356	NA
Chromium	8.0	125
Copper	***86***	33
Iron	4,300	54,000
Lead	27	66
Magnesium	662	NA
Mercury	<0.065	0.30
Zinc	54	247

[a] Notation: NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from sediment data in ICF Kaiser Engineers (1995).

di-n-butylphthalate, a base neutral or SVOC, at 3,100 mg/kg. The only metal detected above the calculated background (for estuarine marsh sediment) was zinc, with a concentration of 7 mg/kg. Although arsenic was not detected, its detection limit (40 mg/kg) was above the calculated background (9 mg/kg). As a result, it is unknown whether the arsenic concentrations in this sample were above the calculated background. Low levels of explosives-related compounds were detected; however, none was above 0.52 mg/kg.

A.6 SOUTH BEACH TRENCH AREA OF CONCERN

A.6.1 Screening Investigations

A.6.1.1 Soil Gas

A passive soil gas investigation conducted in February 1994 at the RCP AOC extended to an area north of the SBT and the Western Suspect Trench (Prasad and Martino 1994b). Figure A.6-1 shows the locations of the soil gas monitoring points. The compounds analyzed were the VOCs on the EPA CLP TCL.

Acetone and styrene were detected at four sample locations near the Western Suspect Trench and the SBT (133, 134, 145, and 146) (Table A.6-1). The acetone emission rates ranged from 9.0 ng/m^2/min (location 146) to 26 ng/m^2 /min (location 145). The styrene emission rate was 24 ng/m^2/min^2 (location 145). Because the samples were collected near marshes, it is likely that the two compounds occur naturally in the areas considered. Therefore, it was determined that most of these detections represent natural subsurface conditions.

A.6.1.2 In Situ X-Ray Fluorescence

Field XRF measurements were conducted at five locations in the SBT during a dry season when the trench bottom was exposed (XRSBT1–5, Figure A.6-2). Levels of zinc in all sample locations measured in the SBT were elevated when compared with similar measurements taken at other J-Field sites. Elevated levels of copper were detected at sample location XRSBT5.

A.6.1.3 Geophysical Surveys

In 1995, three exploratory profiles were conducted at the Western Suspect Trench west of the SBT. The profiles were parallel and were collected along approximate south-to-north transects by using electromagnetic conductivity, electromagnetic induction, and magnetometer methods (Davies et al. 1995). Electrical induction and magnetic anomalies were found near the center of the suspect trench (Davies et al. 1995). However, the conductivity measurements did not show a similar pattern. No GPR anomalies were noted. The magnetics data indicated the presence of buried metallic objects along each profile.

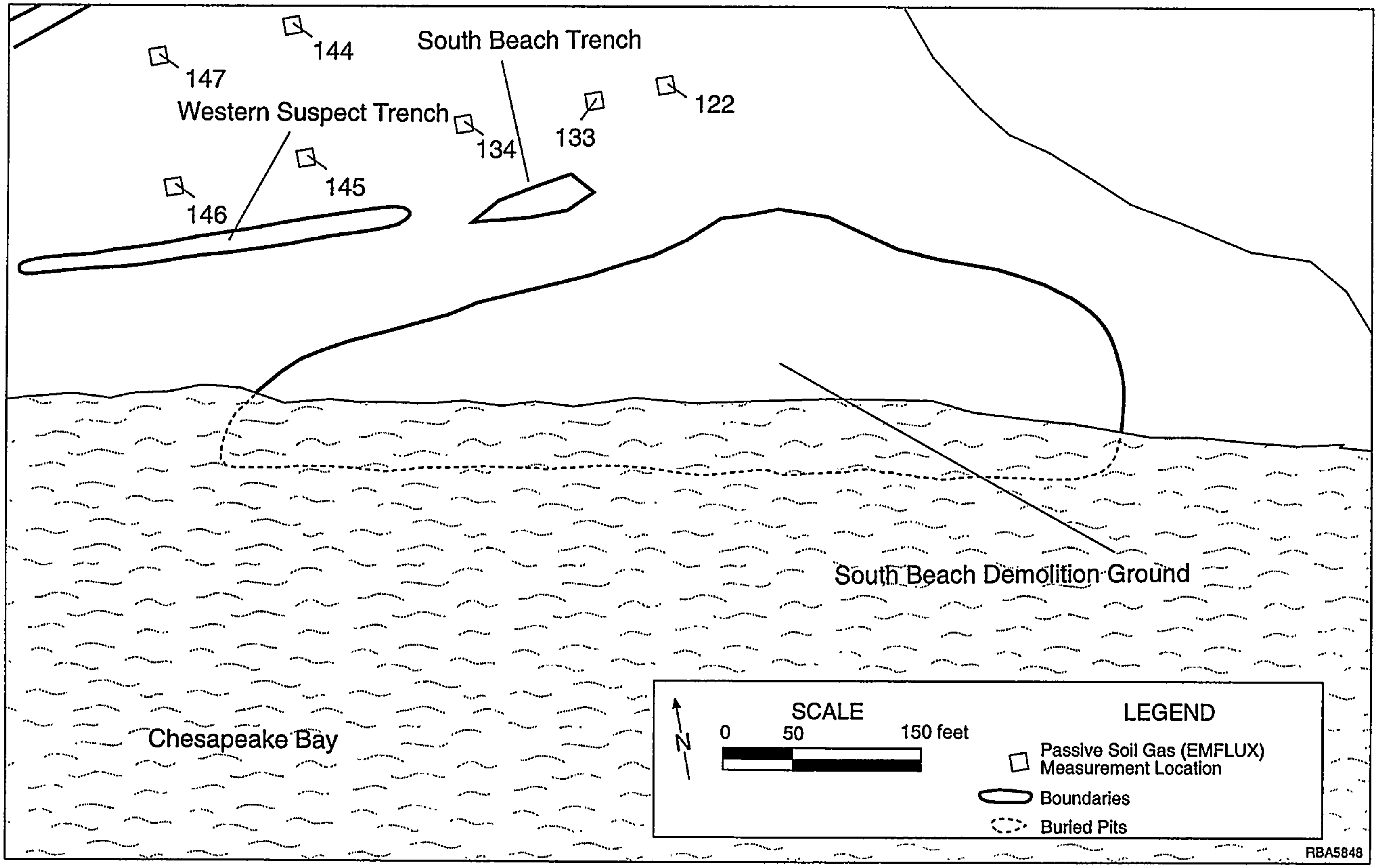

FIGURE A.6-1 Locations of EMFLUX Soil Gas Samples near the SBT AOC

TABLE A.6-1 Emission Flux Rates near the SBT AOC[a]

		Flux Rate ($ng/m^2/min$) by Sample Location			
Parameter	QL[b]	133	134	145	146
Acetone	6.4	22	–	26	9.0
Styrene	1.0	–	–	25	–

[a] Notation: A hyphen denotes value below the reported quantitation level.

[b] QL = reported emission flux rate quantitation level.

Source: Prasad and Martino (1994b).

A.6.2 Soil Analyses

A.6.2.1 Surface Soil

Analysis of a single surface soil sample collected in the SBT AOC as part of an environmental survey in 1983 (Nemeth 1989) indicated a low level of chlordane (53 µg/kg). In 1988, the USGS collected two soil samples in the SBT AOC (locations 21 and 22) (Figure A.1-7). The samples were collected at a depth of 1 ft and analyzed for indicator parameters, VOCs, SVOCs, metals, and explosives-related compounds (Hughes 1992). Acetone was the only organic compound detected (10–25 mg/kg). No SVOCs or explosives-related compounds were detected. Metals were present in low concentrations, including lead (2–22 mg/kg), copper (7–15 mg/kg), and chromium (7–9 mg/kg). These results do not corroborate the anomalies found in the field XRF surveys, which indicated elevated levels of zinc.

A.6.2.2 Subsurface Soil

A soil boring (RCPBOR3) was drilled in the Western Suspect Trench. Soil samples were collected at 2-ft depth intervals from 0 to 8 ft (Figure A.6-3). The samples were analyzed for VOCs, SVOCs, metals, and CSM/CSM degradation products.

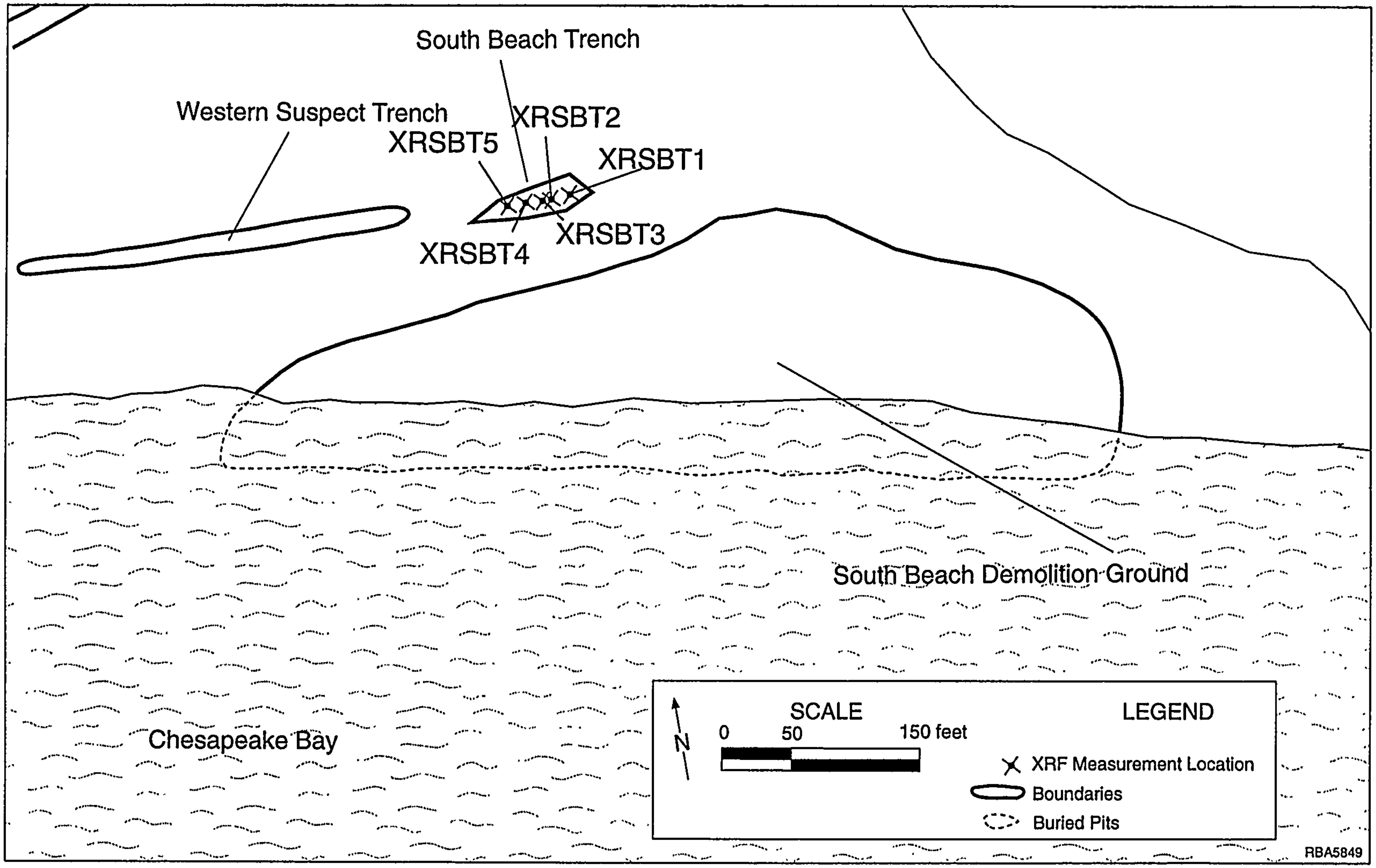

FIGURE A.6-2 Locations of X-Ray Fluorescence Measurements at the SBT AOC

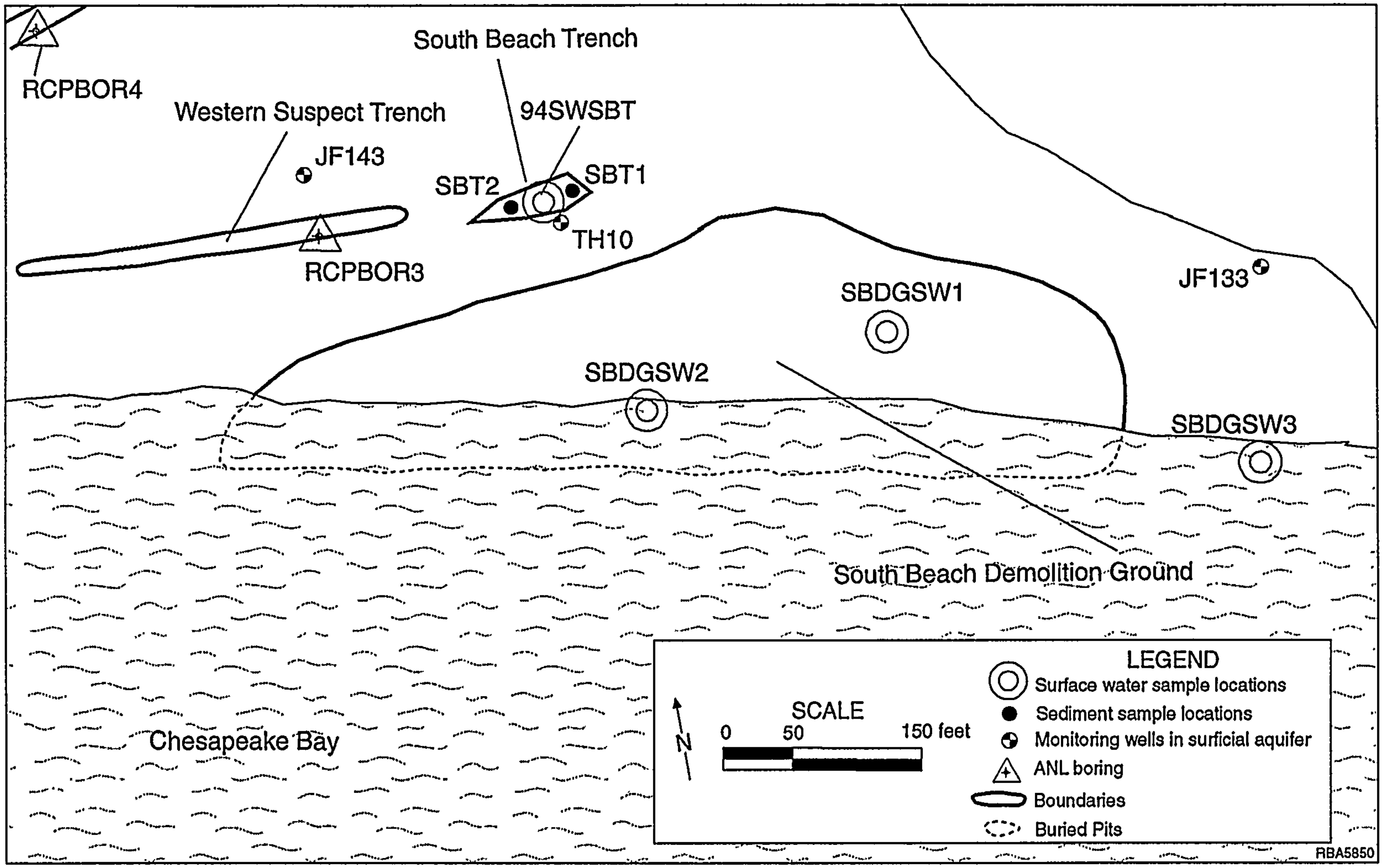

FIGURE A.6-3 Locations of Soil Borings, Monitoring Wells, and Surface Water and Sediment Samples at the SBT AOC

No VOCs were detected in the soil samples from boring RCPBOR3. The only SVOC detected was di-n-butylphthalate, which was estimated to be present at concentrations less than the detection limit in each case. Di-n-butyl phthalate was estimated at concentrations of 210, 250, 230, and 230 µg/kg in samples from depth intervals of 0–2, 2–4, 4–6, and 6–8 ft, respectively. Di-n-butylphthalate was also detected in laboratory blank samples.

No metal contaminants were detected at levels exceeding the calculated background. Although mercury was not detected, its detection limit (0.090–0.11 mg/kg) was slightly above the calculated background (0.80 mg/kg). As a result, it is unknown whether the mercury concentrations in the RCPBOR3 samples were above the calculated background level. No CSM/CSM degradation products were detected.

A.6.3 Groundwater

Monitoring well TH10 (Figure A.6-3) was installed south of the SBT during the 1977 environmental survey (Nemeth 1989). The well was completed at a depth of 18 ft, with a 10-ft screened interval at the bottom (land surface elevation is 7.2 ft MSL). Water collected from this well was analyzed for extractable organic compounds; analyses indicated the presence of hydrocarbons, dimethylnaphthalene, and n,n-dimethylformamide. This well was also sampled as part of the RFA, and analyses of VOCs, SVOCs, PCBs and pesticides were conducted. No contaminants were detected (Nemeth 1989). Well JF143 was later installed at a depth of 10 ft, with a 5-ft screened interval at the bottom.

The USGS sampled well TH10 in 1991 as part of Phase I of the hydrological assessment. The water was analyzed for VOCs, metals, water quality parameters, ions, and explosives-related compounds. No contamination was detected. Samples collected from wells TH10 and JF143 during the summer of 1994 were analyzed for VOCs, general chemistry, and total and dissolved metals. No VOCs were detected. Iron was the only metal that exceeded the AWQC. Hardness was calculated from the samples collected from these wells: 256 mg/L (total) and 274 mg/L (dissolved). Iron was detected at 3,420 µg/L (total) and 876 µg/L (dissolved) in TH10 and 2,270 µg/L (total) and 64 µg/L (dissolved) in JF143. The AWQC for iron (total) is 1,000 µg/L, and the secondary maximum concentration level is 300 µg/L. However, iron is not considered to be a problem in this environment. Lead was also detected at 3.6 µg/L (TH10) and 3.3 µg/L (JF143). Lead is hardness dependent and must be adjusted accordingly. This adjustment provides a lead (total) AWQC level of 11 µg/L. The lead concentration found was below this level and the MCL of 50 µg/L.

A.6.4 Surface Water and Sediment

In 1994, one surface water sample (94SWSBT) was collected from within the SBT (Figure A.6-3). The sample was analyzed for VOCs, SVOCs, metals, TOX, PCBs, pesticides, CSM/CSM degradation products, explosives-related compounds, and gross alpha and gross beta activity. No VOCs (except TRCLE at 3.0 µg/L), SVOCs, PCBs, pesticides, CSM/CSM degradation products, or explosives-related compounds were detected. The TOX concentration was 230 µg/L. Radiochemical analyses showed gross alpha and beta activity to be lower than the mean background as reported in ICF Kaiser Engineers (1995). The results of the metals analyses are summarized in Table A.6-2. Only zinc was detected at a level slightly higher than the calculated background.

TABLE A.6-2 Analytical Results for Selected Metals in the Surface Water Sample Collected from the SBT AOC: 1994[a]

Parameter	Concentration (µg/L) at Location 94SWSBT	Freshwater Pond Background (µg/L)[b]
Arsenic	1.6 B	NA
Cadmium	<3.0	NA
Calcium	5,890	NA
Chromium	<5.0	8.0
Copper	<3.0	NA
Iron	1,290	5,750
Lead	<1.0	6.0
Magnesium	2,060 B	NA
Mercury	<0.20	NA
Zinc	***77 D***	76

[a] Notation: B = analyte also found in the associated blank; D = sample was diluted for analysis; NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from freshwater pond data in ICF Kaiser Engineers (1995).

Two sediment samples (SBT1 and SBT2) were also collected in 1994 from within the SBT (Figure A.6-3). The samples were analyzed for the same parameters as the surface water sample. They were also tested for cyanide. No VOCs, SVOCs, PCBs, pesticides, CSM/CSM degradation products, or explosives-related compounds were detected. Cyanide also was not detected. The results of the metals analyses are summarized in Table A.6-3. Several metals, including chromium, iron, lead, and zinc, were detected at levels exceeding the calculated background. The highest concentrations were found in sample SBT2 (0–6 in.).

TABLE A.6-3 Analytical Results for Selected Metals in Sediment Samples Collected from the SBT AOC: 1994[a]

	Concentration (mg/kg) by Sample Location				
Parameter	SBT1 (0-6 in.)	SBT1 (6-12 in.)	SBT2 (0-6 in.)	SBT2 (6-12 in.)	Freshwater Pond Background (µg/L)[b]
Arsenic	1.1	1.1	4.8	1.4	NA
Cadmium	1.3	1.4	3.3	1.7	NA
Calcium	145 B	150 B	409	190 B	NA
Chromium	6.6	5.5	***13***	7.1	8.0
Copper	32 E	12 E	21	10 E	NA
Iron	4,490	4,500	***11,300***	5,250	5,750
Lead	***14***	***7.7***	***28***	***8.4***	6.0
Magnesium	641	613	1,480	842	NA
Mercury	<0.12	<0.090	<0.10	<0.10	NA
Zinc	54	33	***105***	51	76

[a] Notation: B = analyte also found in the associated blank; E = estimated value; NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from freshwater pond data in ICF Kaiser Engineers (1995).

A.7 ROBINS POINT DEMOLITION GROUND AREA OF CONCERN

A.7.1 Screening Investigations

A.7.1.1 Soil Gas

No soil gas surveys were conducted at the RPDG AOC.

A.7.1.2 In Situ X-Ray Fluorescence

Field XRF measurements were taken at 22 locations at the RPDG AOC (Figure A.7-1). The XRF measurements are qualitative in nature and were used for screening purposes. Elevated zinc levels were detected at sample locations XRK20 and XRRPDG7. Elevated levels of silver were detected at sample location XRK19.

A.7.1.3 Geophysical Surveys

No geophysical surveys were conducted at the RPDG AOC.

A.7.2 Soil Analyses

A.7.2.1 Surface Soil

Surface soil collected from the RPDG AOC during the 1986 RFA was analyzed for VOCs, metals, and explosives-related compounds. No contamination was detected (Nemeth 1989).

In 1991, the USGS collected five soil samples from the RPDG AOC (locations 37–41; Figure A.1-7). These samples, collected at 1-ft depths, were analyzed for indicator parameters, VOCs, SVOCs, metals, and explosives-related compounds (Hughes 1992). VOCs and SVOCs were not detected. Most metal concentrations in these samples were lower than the background levels derived by using soil data reported in ICF Kaiser Engineers (1995). One sample (location 37) had levels of copper (76 mg/kg) about four times higher than the calculated background (20 mg/kg). No explosives-related compounds were found.

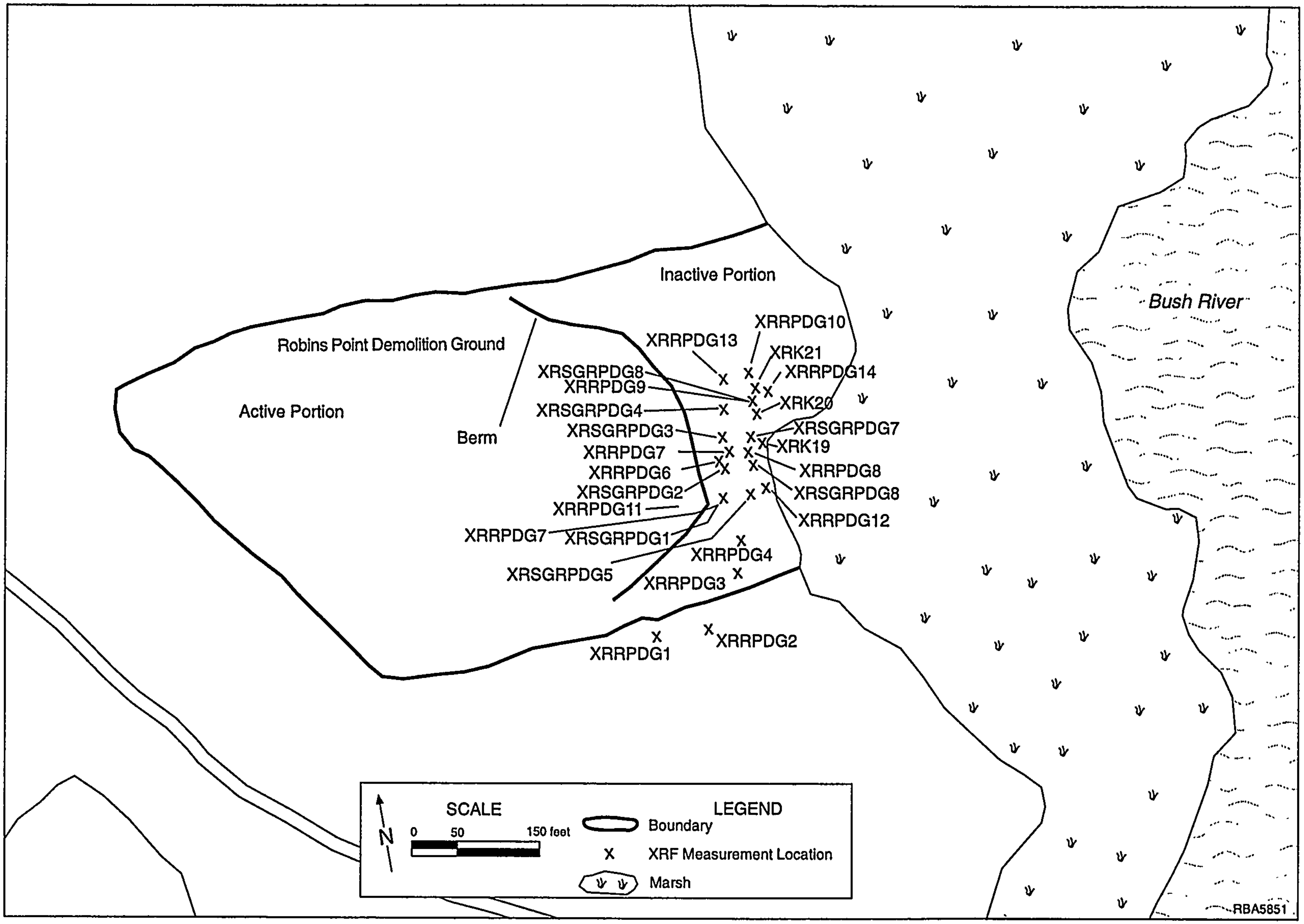

FIGURE A.7-1 Locations of X-Ray Fluorescence Measurements at the RPDG AOC

In 1994, surface soil samples were collected from six locations (RPDG2–5, RPDG7, and RPDG9) at an area east of the berm; RPDG16 is a blind duplicate of RPDG5 (Figure A.7-2). RPDG5 and RPDG16 were located in an area in which XRF measurements indicated elevated levels of silver and zinc. The samples were analyzed for metals, cyanide, CSM/CSM degradation products, and explosives-related compounds. A subset of samples (RPDG3, RPDG4, and RPDG9) was also analyzed for gross alpha and gross beta activity. Table A.7-1 summarizes the results of the metals analyses.

Only mercury and silver were detected at levels slightly above the calculated background (Table A.7-1). Cyanide and CSM/CSM degradation products were not detected. One sample, RPDG16 (the blind duplicate of RPDG5), had low levels of 2,4-DNT (1,140 µg/kg). Radiochemical analyses showed gross alpha and gross beta activities to be lower than the mean backgrounds of 5.2 and 3.0 pCi/g, respectively, as reported in ICF Kaiser Engineers (1995).

A.7.2.2 Subsurface Soil

No subsurface soils were collected at the RPDG AOC.

A.7.3 Groundwater

The general direction of groundwater movement in the Talbot aquifers (Units A and C) appears to be away from the RPDG AOC toward the Bush River. However, because only two wells exist in the immediate area, the exact groundwater flow direction cannot be determined. The vertical movement of groundwater appears to be down through the aquifers; however, offshore, there may be upward flow from each of the three Talbot aquifers into the Bush River. Movement in the surficial and confined aquifers is affected by the tides (USGS 1991).

Two monitoring wells (JF153 and JF163) (Figure A.7-3) were installed in the active portion of the RPDG AOC (west of the investigated area) in 1992 and were sampled during the summer of 1994. These wells are screened in the surficial aquifer at depths of 10 ft. The screened interval for both wells is 5 ft at 5–10 ft below ground surface. Information on ground surface elevations was unavailable. The groundwater samples collected from these wells were analyzed for VOCs, metals (total and dissolved), and other inorganic parameters. Table A.7-2 summarizes the metals results.

No VOCs were detected in the groundwater samples. Low levels of TOX (13 µg/L) were detected in well JF163.

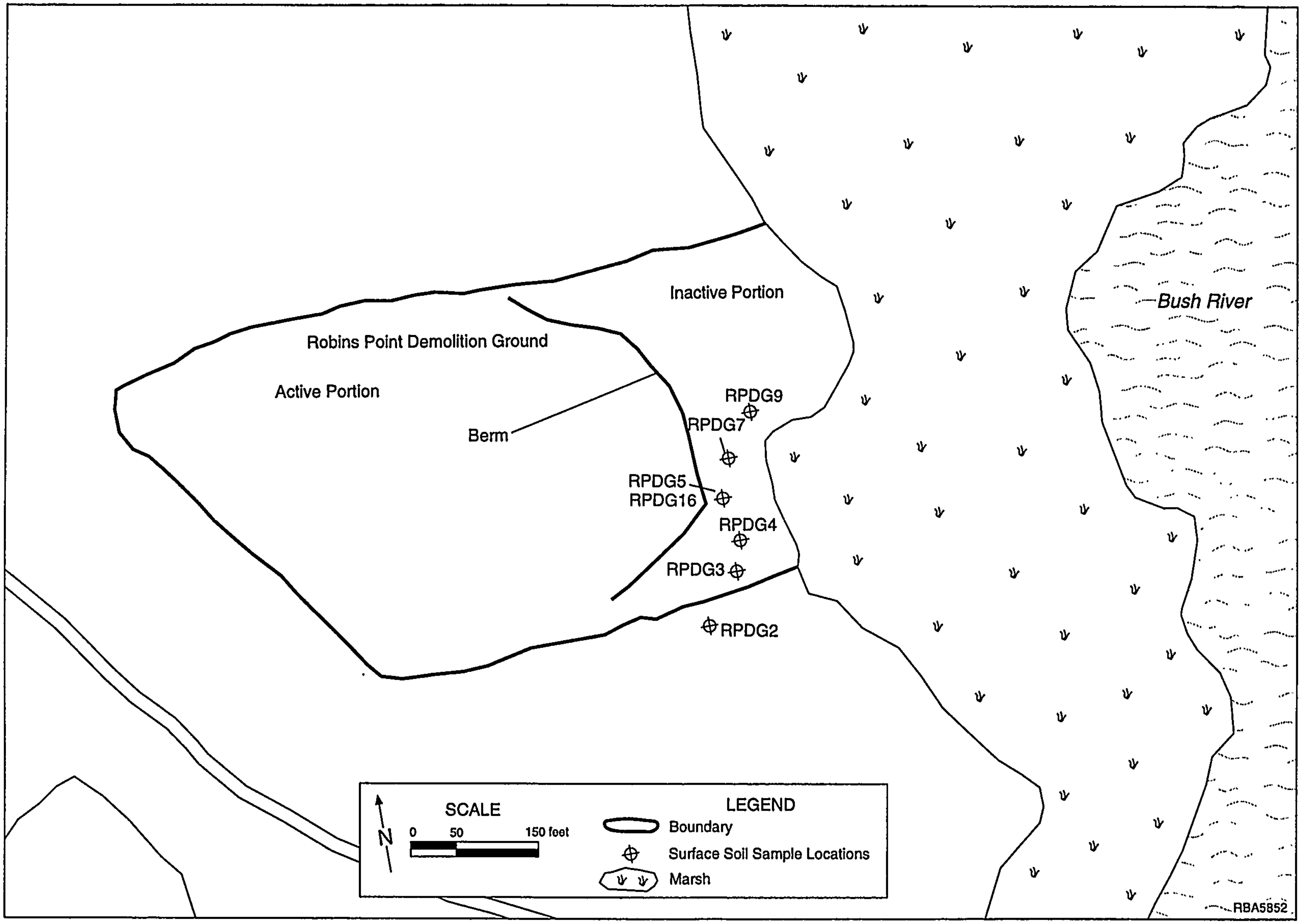

FIGURE A.7-2 Locations of Surface Soil Samples at the RPDG AOC

TABLE A.7-1 Analytical Results for Selected Metals in Surface Soil Samples Collected from the RPDG AOC: 1995[a]

	Concentration (mg/kg) by Sample Location			
Parameter	RPDG2	RPDG3	RPDG4	RPDG5
Arsenic	3.0	4.4	2.8	2.3
Cadmium	<0.74	<0.88	<0.68	<0.68
Calcium	106	141	151	111
Chromium	11	10	12	13
Copper	10	15	11	11
Iron	12,500	11,400	14,000	14,100
Lead	27	38	15	35
Magnesium	648	721	919	735
Mercury	<0.060	***0.11***	<0.050	<0.060
Silver	<0.27	<0.33	<0.25	<0.25
Zinc	29	38	52	82

	Concentration (mg/kg) by Sample Location			
Parameter	RPDG7	RPDG9	RPDG16	Background (mg/kg)[b]
Arsenic	2.6	1.2	2.7	5.0
Cadmium	<0.70	<0.71	<0.69	0.70
Calcium	116	91	117	NA
Chromium	12	5.2	11	41
Copper	15	9.5	7.1	20
Iron	11,800	5,360	12,700	23,400
Lead	22	11	12	61
Magnesium	863	434	968	NA
Mercury	0.090	<0.060	0.063	0.10
Silver	***10***	<0.26	<0.26	0.40
Zinc	55	25	64	118

[a] Notation: NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

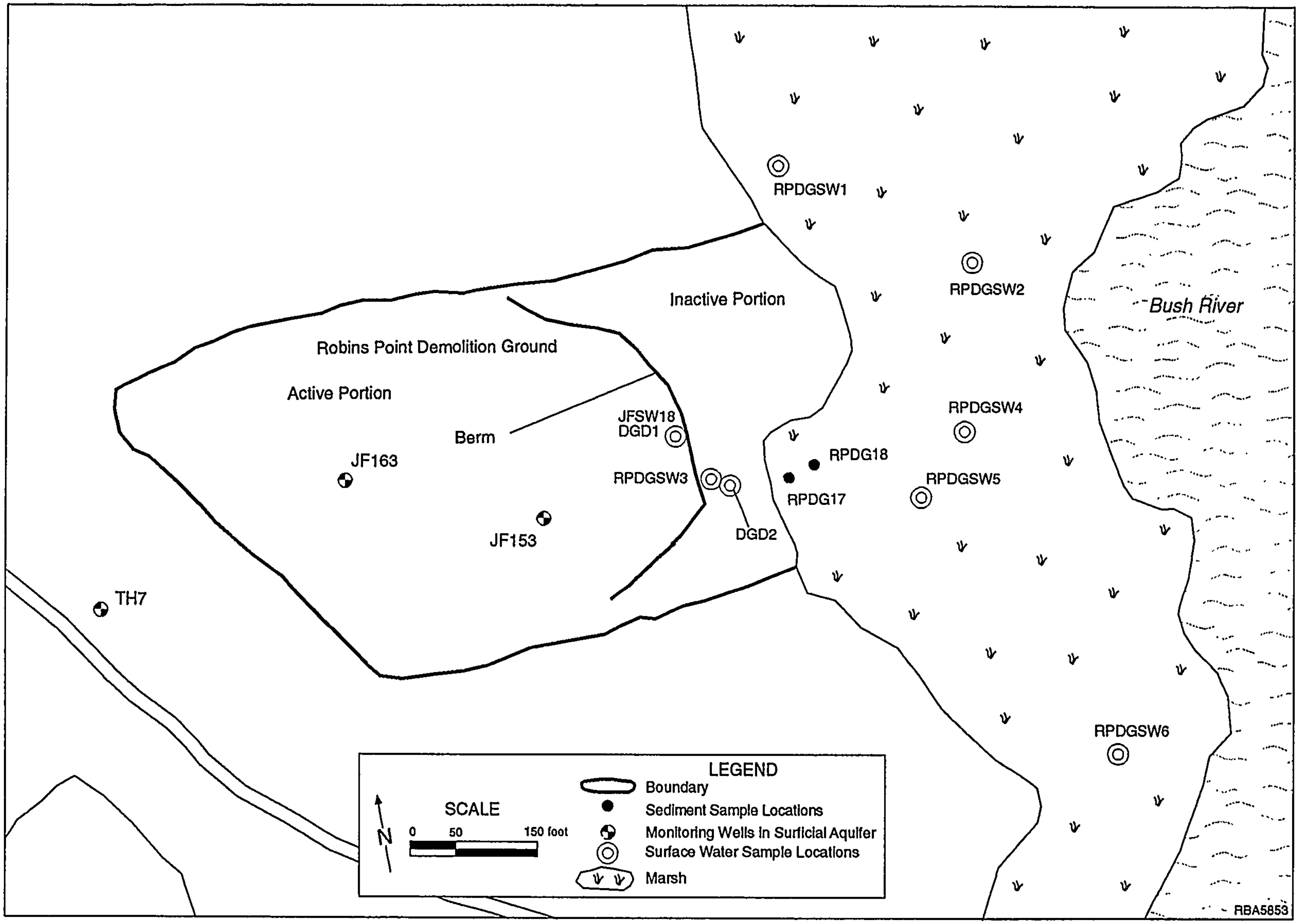

FIGURE A.7-3 Locations of Monitoring Wells and Surface Water and Sediment Samples at the RPDG AOC: 1994 and 1995

TABLE A.7-2 Analytical Results for Selected Metals in Groundwater Samples Collected from the RPDG AOC: 1994[a]

Parameter	AWQC	MCL	Well JF153	Well JF163
	Concentration (µg/L) by Sample Location			
Dissolved metals				
Arsenic	NA	NA	<1.0	<1.0
Aluminum	NA	NA	106	360
Barium	NA	NA	33	45
Cadmium	NA	NA	<3.0	<3.0
Calcium	NA	NA	1,510	559
Chromium	NA	NA	<5.0	<5.0
Cobalt	NA	NA	7.0 B	7.0 B
Copper	NA	NA	<3.0	<3.0
Iron	NA	NA	33	32
Lead	NA	NA	<1.0	<1.0
Magnesium	NA	NA	5,070	8,340
Manganese	NA	NA	49	17
Mercury	NA	NA	<0.20	<0.20
Nickel	NA	NA	13	<12
Potassium	NA	NA	343V	669
Zinc	NA	NA	27	17
Total metals				
Arsenic	NA	50	4.3 B	<2.0
Aluminum	NA	NA	3,420	1,300
Barium	NA	2,000	53	37
Cadmium	HD	10	<3.0	<3.0
Calcium	NA	NA	1,530	532
Chromium	11[b]	50	<5.0	<5.0
Cobalt	NA	NA	10	14
Copper	HD	1,000	3.9 B	<3.0
Iron	1,000	300	***4,280***	***1,030***
Lead	HD	50	3.4	<1.0
Magnesium	NA	NA	5,660	8,080
Manganese	NA	NA	72	21
Mercury	0.012	2	<0.20	<0.20
Nickel	58	100	26	19
Potassium	NA	NA	1,020	906
Zinc	HD	5,000	23	11

[a] Notation: B = analyte also found in the associated blank; HD = hardness dependent; NA = not available. Sample concentrations equal to or exceeding the MCL and/or AWQC are presented in bold italics.

[b] AWQC is for hexavalent chromium.

Except for iron, none of the metals detected in the groundwater samples exceeded the AWQC or MCLs established by the EPA. The average hardness (as calcium carbonate) of the groundwater from the two wells was 31 mg/L.

A.7.4 Surface Water and Sediment

Nearshore surface water and sediment samples were collected in 1992 by the EPA. The results of this investigation are reported in Section A.1.4. The data from surface water and sediment samples indicate that the level of contamination offshore is very low.

Between 1993 and 1995, 11 surface water samples and 2 sediment samples (RPDG17 and RPDG18) were collected from the RPDG AOC (Figure A.7-3). Samples were collected in the cleared area east of the berm and in the marsh area east of the cleared area. A few samples were also collected in the active area west of the berm. Although the active area was outside the scope of the RI, samples were collected for reference.

In 1993, the USGS collected one surface water sample (JFSW18) from the active area and two surface water samples (JFSW17 and JFSW19) from the marsh (Figure A.1-9). The samples were analyzed for VOCs, SVOCs, metals, PCBs, and pesticides. No VOCs, SVOCs, PCBs, or pesticides were detected. Table A.7-3 summarizes the metals results. Elevated metals, including chromium, copper, iron, lead, and zinc, were detected in both marsh and active area samples (Table A.7-3).

In 1995, Argonne collected one surface water sample from the active area (DGD1, co-located with JFSW18), two surface water samples from the cleared area (DGD2 and RPDGSW3), and five surface water samples from the marsh (RPDGSW1–2 and RPDGSW4–6, Figure A.7-3). The DGD series samples were analyzed for VOCs, SVOCs, metals, PCBs, pesticides, general chemistry, TOX, CSM/CSM degradation products, explosives-related compounds, and cesium-137. The RPDG series samples were analyzed for metals, cyanide, and explosives-related compounds.

No VOCs, SVOCs, PCBs, pesticides, CSM/CSM degradation products, or cesium-137 was detected in the DGD series samples. Table A.7-4 summarizes the metals results. Metals were highest in marsh area (RPDGSW series) samples. Several metals exceeded the calculated background, including arsenic, chromium, copper, iron, lead, and zinc. TOX values were 17 µg/L (DGD1) and 39 µg/L (DGD2). No cyanide was detected in the RPDG series samples. RDX was detected in two samples: DGD1 (3.8 µg/L) and DGD2 (3.1 µg/L).

TABLE A.7-3 Analytical Results for Selected Metals in Surface Water Samples Collected from the RPDG AOC: 1993[a]

Parameter	Concentration (µg/L) by Sample Location			Estuarine Marsh Background (µg/L)[b,c]	Freshwater Marsh Background (µg/L)[b,d]
	JFSW17	JFSW18	JFSW19		
Arsenic	<2.0	<2.0	<2.0	2.0	NA
Cadmium	<4.0	<4.0	<4.0	NA	NA
Calcium	5,720	1,850 B	12,000	NA	NA
Chromium	9.9 B	6.6 B	<6.0	7.0	15
Copper	***16 B***	***15 B***	6.8 B	8.0	10
Iron	6,390	572	1,020	3,385	18,810
Lead	***17***	<1.0	2.6 B	4.0	6.0
Magnesium	10,800	1,350 B	21,500	NA	NA
Mercury	<0.10	<0.10	<0.10	NA	NA
Zinc	***69***	***64***	16	22	61

[a] Notation: B = analyte also found in associated blank; NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from estuarine and freshwater marsh data in ICF Kaiser Engineers (1995).

[c] Estuarine marsh calculated background values were used as comparison criteria for JFSW17 and JFSW19 (samples from the marsh area).

[d] Freshwater marsh calculated background values were used as comparison criteria for JFSW18 (sample from the active area)

Two sediment samples (RPDG17 and RPDG18) were also collected from the marsh in 1995. The samples were analyzed for metals, cyanide, CSM/CSM degradation products, and explosives-related compounds. No cyanide, CSM/CSM degradation products, or explosives-related compounds were detected. Table A.7-5 summarizes the metals results. No metals were detected above the calculated background levels.

TABLE A.7-4 Analytical Results for Selected Metals in Surface Water Samples Collected from the RPDG AOC: 1995[a]

	Concentration (µg/L) by Sample Location				
Parameter	DGD1	DGD2	RPDGSW1	RPDGSW2	RPDGSW3
Arsenic	2.8 B	3.0 B	***3.2***	***12***	<1.8
Cadmium	<4.0	<4.0	<3.0	4.5	<3.0
Calcium	6,970	3,960	24,700	109,000	5,690
Chromium	5.0 B	<5.0	<8.0	***39***	<8.0
Copper	***14 B***	8.2 B	***28***	***65***	***28***
Iron	691	5,200	15,000	***88,400***	13,400
Lead	2.5 B	3.8	***15***	***228***	5.9
Magnesium	3,440 B	2,590 B	49,000	122,000	3,120
Mercury	<0.20	<0.20	<0.10	1.0	<0.10
Zinc	***400 E***	***136 E***	***32***	***582***	44

	Concentration (µg/L) by Sample Location			Estuarine Marsh Background (µg/L)[b,c]	Freshwater Marsh Background (µg/L)[b,d]
Parameter	RPDGSW4	RPDDGSW5	RPDGSW6		
Arsenic	<3.6	***4.4***	***9.5***	2.0	NA
Cadmium	3.3	<3.0	<3.0	NA	NA
Calcium	56,900	50,000	49,900	NA	NA
Chromium	***16***	***17***	***37***	7.0	15
Copper	***59***	***75***	***52***	8.0	10
Iron	***30,800***	***57,500***	***191,000***	3,385	18,810
Lead	***92***	***109***	***87***	4.0	6.0
Magnesium	96,900	87,000	90,700	NA	NA
Mercury	0.38	0.39	0.71	NA	NA
Zinc	***233***	***1,398***	***257***	22	61

[a] Notation: NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from estuarine and freshwater marsh data in ICF Kaiser Engineers (1995).

[c] Estuarine marsh calculated background values were used as comparison criteria for RPDGSW1, RPDGSW2, RPDGSW4, and RPDGSW6 (samples from the marsh area).

[d] Freshwater marsh calculated background values were used as comparison criteria for DGD1, DGD2, and RPDGSW3 (samples from the active and cleared areas).

TABLE A.7-5 Analytical Results for Selected Metals in Sediment Samples Collected from the RPDG AOC: 1995[a]

	Concentration (mg/kg) by Sample Location		
Parameter	RPDG17	RPDG18	Estuarine Marsh Background (mg/kg)[b]
Arsenic	2.9	3.4	9.0
Cadmium	<1.1	<1.7	2.0
Calcium	882	2,000	NA
Chromium	11	13	60
Copper	30	25	90
Iron	11,100	10,200	49,900
Lead	55	57	80
Magnesium	1,110	1,770	NA
Mercury	0.11	0.16	0.50
Zinc	127	121	365

[a] Notation: NA = not available.

[b] Background values were derived from sediment data in ICF Kaiser Engineers (1995).

A.8 ROBINS POINT TOWER SITE AREA OF CONCERN

A.8.1 Screening Investigations

A.8.1.1 Soil Gas

No soil gas surveys were conducted at the RPTS AOC.

A.8.1.2 In Situ X-Ray Fluorescence

Field XRF measurements were conducted at three areas in the RPTS AOC, one in the north area and two in the south area (Figure A.8-1). These areas were divided into grids by using 15-ft nodes, and soil samples in different locations and depths were surveyed. The results showed no elevated levels of metals at these locations.

A.8.1.3 Geophysical Surveys

No geophysical surveys were conducted at this AOC.

A.8.1.4 Radioactivity Surveys

Previous field inspection in the RPTS AOC found no visual evidence of soil contamination, and no soil sampling or analysis was conducted before this RI. In 1988, a field radioactivity survey was conducted, and no radiation above normal background level was detected (Nemeth 1989).

In 1994, a radioactivity field survey was conducted at four gridded areas (Figure A.8-1) that were identified as disturbed sites through interviews, aerial photographs, and field observations (SciTech 1995). The survey was conducted by using a portable monitor with a probe selected to detect radium and strontium-90. The results at most of the survey points were within the background range, 60–70 cpm. The maximum reading was 120 cpm (SciTech 1995), only slightly higher than background. Surface soil samples were collected at eight locations (RCPS2–3, RPTS6–10, and RPTS12), and slightly elevated readings were obtained by the radioactivity screening survey. These samples were analyzed for gross alpha and gross beta radioactivity. Radiochemical analyses showed gross alpha and beta activity to be lower than the mean background (5.2 and 3.0 pCi/g, respectively) as reported in ICF Kaiser Engineers (1995).

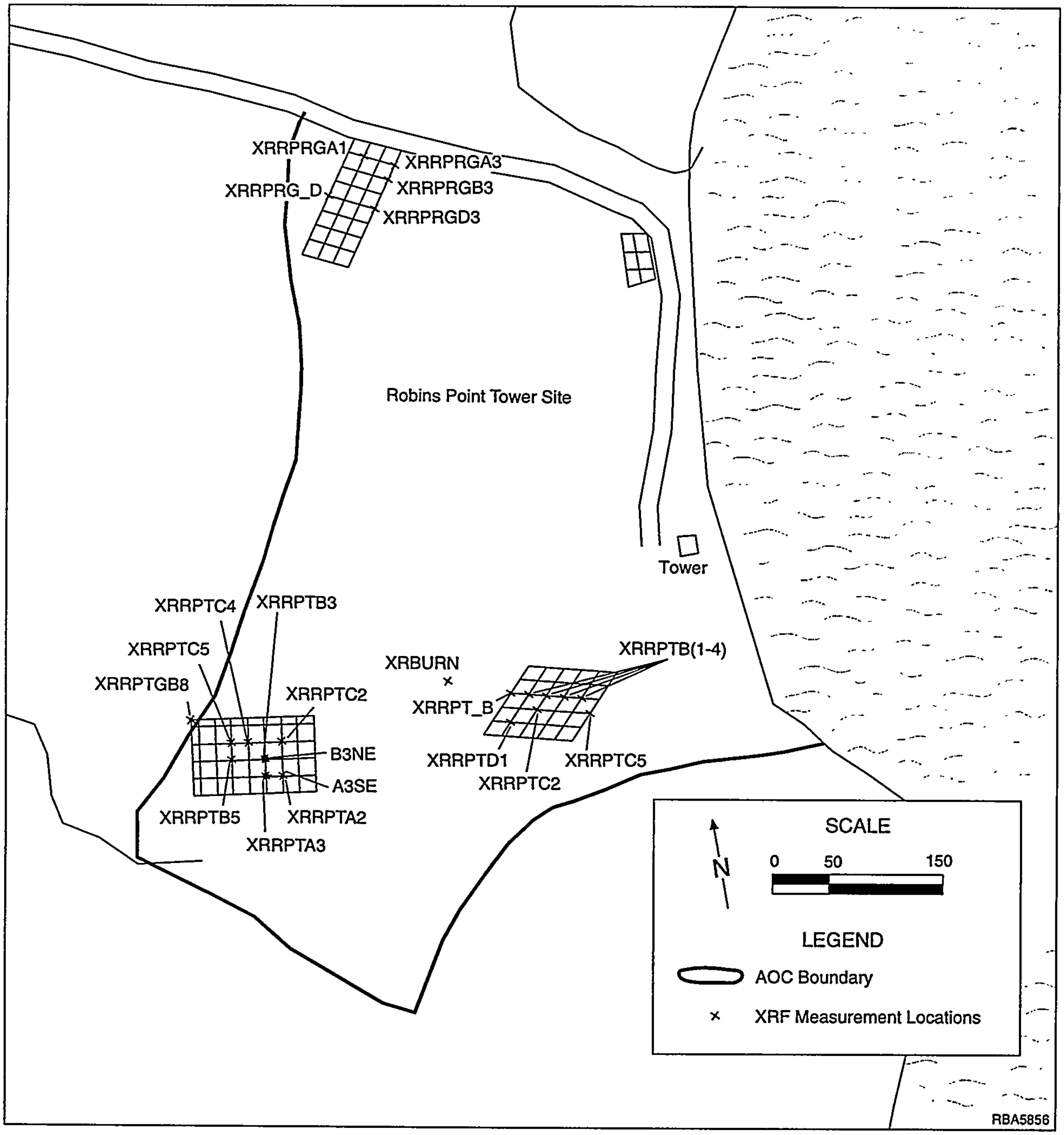

FIGURE A.8-1 Locations of X-Ray Fluorescence Measurements and Radioactivity Field Survey Grids at the RPTS AOC

A.8.2 Soil Analyses

A.8.2.1 Surface Soil

In 1994, surface soil samples were collected from six locations at the RPTS AOC (RPTS1, RPTS6–9, and RPTS12) (Figure 4.8-2). The samples were analyzed for metals and general chemistry. Table A.8-1 summarizes the results. Most of the samples had metal levels below the calculated background. Low levels of mercury and selenium were detected in samples collected from the southwestern part of the AOC. These levels were only slightly higher than the calculated background.

Surface soil samples collected from four locations (RPTS2, RPTS6, RPTS8, and RPTS12) were analyzed for SVOCs. Most of these samples had SVOC levels below the corresponding detection limits. The only SVOCs detected were benzo(b)fluoranthene (67 µg/kg in RPTS2) and bis(2-ethylhexyl)phthalate (52 µg/kg in RPTS 8). The phthalate concentration was very low and probably a result of laboratory contamination.

A.8.2.2 Subsurface Soil

No subsurface soil samples were collected at the RPTS AOC.

A.8.3 Groundwater

Groundwater samples from monitoring well TH11 (Figure A.8-3) were analyzed for extractable organic compounds during the 1978 Environmental Contamination Survey. Well TH11 was completed at a depth of 18 ft with a screened interval at the bottom (land surface elevation is 4.1 ft MSL). The results indicated very low levels of triethylchlorobenzene and TCLEE (Nemeth 1989). As part of the 1986 RFA, the well was sampled for VOCs, SVOCs, pesticides, and PCBs. None were detected.

In 1988, the USGS installed an additional monitoring well (JF1) near the tower as part of a hydrological assessment (Sonntag 1991; Hughes 1993). The well is screened in the Potomac Group (Figure A.8-3) at a depth of 300 ft. The screened interval is 5 ft at 208–213 ft below ground surface (land surface elevation is 5.0 ft MSL). Groundwater samples were analyzed for VOCs, SVOCs, metals, and water quality parameters. Well JF1 showed low levels of VOC contamination (2.3 µg/L of 111TCE at a depth of 185–190 ft). However, this finding must be taken as provisional because one of the two quality control water blanks also showed TCLEA, TCLEE, and TRCLE

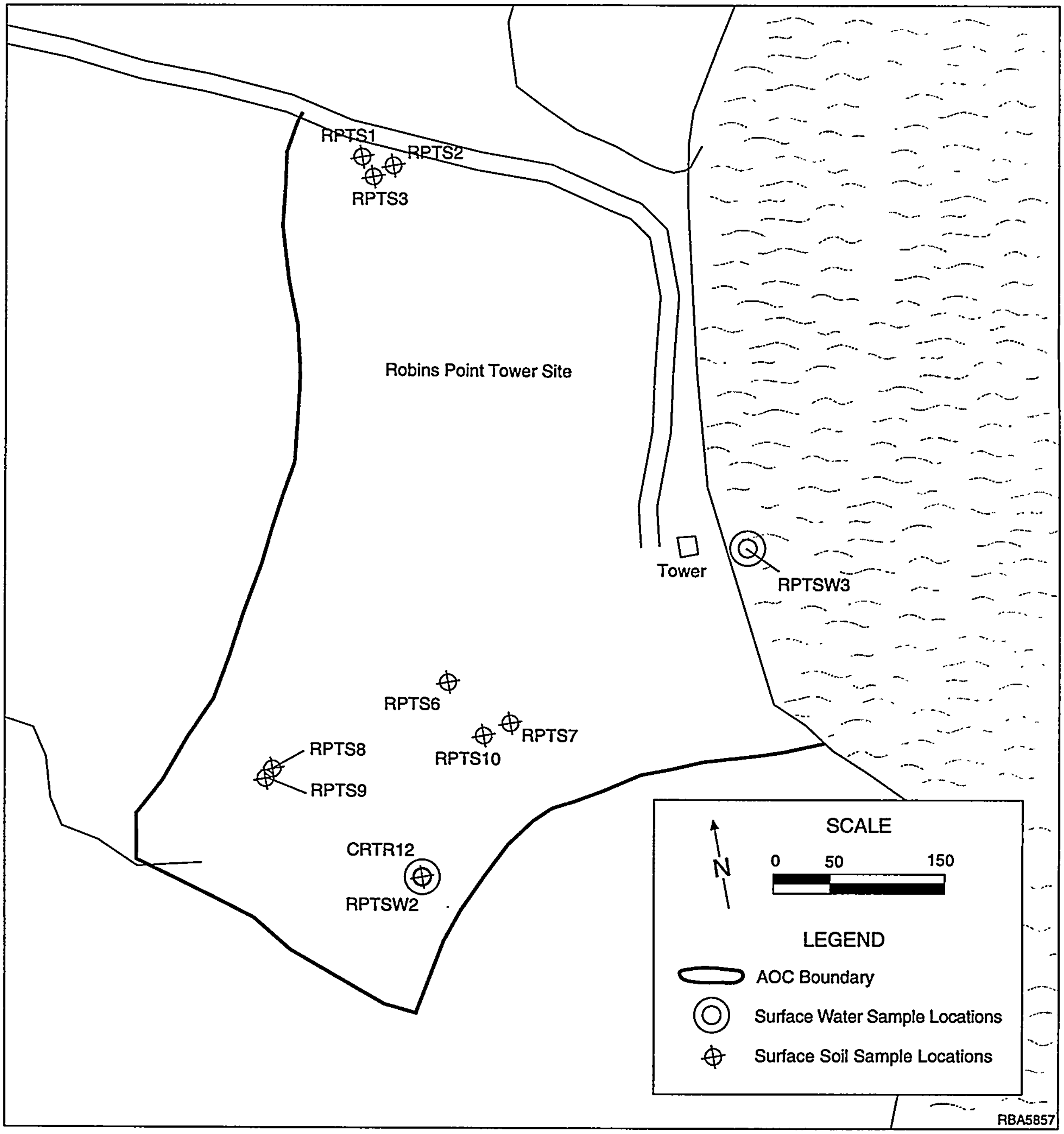

FIGURE A.8-2 Locations of Surface Soil and Surface Water Samples at the RPTS AOC

TABLE A.8-1 Analytical Results for Selected Metals in Surface Soil Samples Collected from the RPTS AOC: 1994[a]

	Concentration (mg/kg) by Sample Location			
Parameter	RPTS1	RPTS6	RPTS7	RPTS8
Arsenic	2.1	2.1	2.4	2.8
Cadmium	0.46	0.55	<0.40	<0.38
Calcium	83	192	161	232
Chromium	7.4	9.2	8.0	6.3
Copper	10	4.6	7.3	6.3
Iron	8,390	11,200	9,400	7,630
Lead	13	9.5	11	20
Magnesium	682	816	55	481
Mercury	0.078	0.052	0.078	***0.12***
Zinc	25	24	27	28

	Concentration (mg/kg) by Sample Location		
Parameter	RPTS9	RPTS12	Background (mg/kg)[b]
Arsenic	2.1	2.6	5.0
Cadmium	<0.39	<0.39	0.70
Calcium	133	208	NA
Chromium	7.2	9.5	41
Copper	10	4.5	20
Iron	7,580	11,900	23,400
Lead	23	10	61
Magnesium	548	836	NA
Mercury	***0.15***	0.083	0.10
Zinc	38	24	118

[a] Notation: NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were dervied from soil data in ICF Kaiser Engineers (1995).

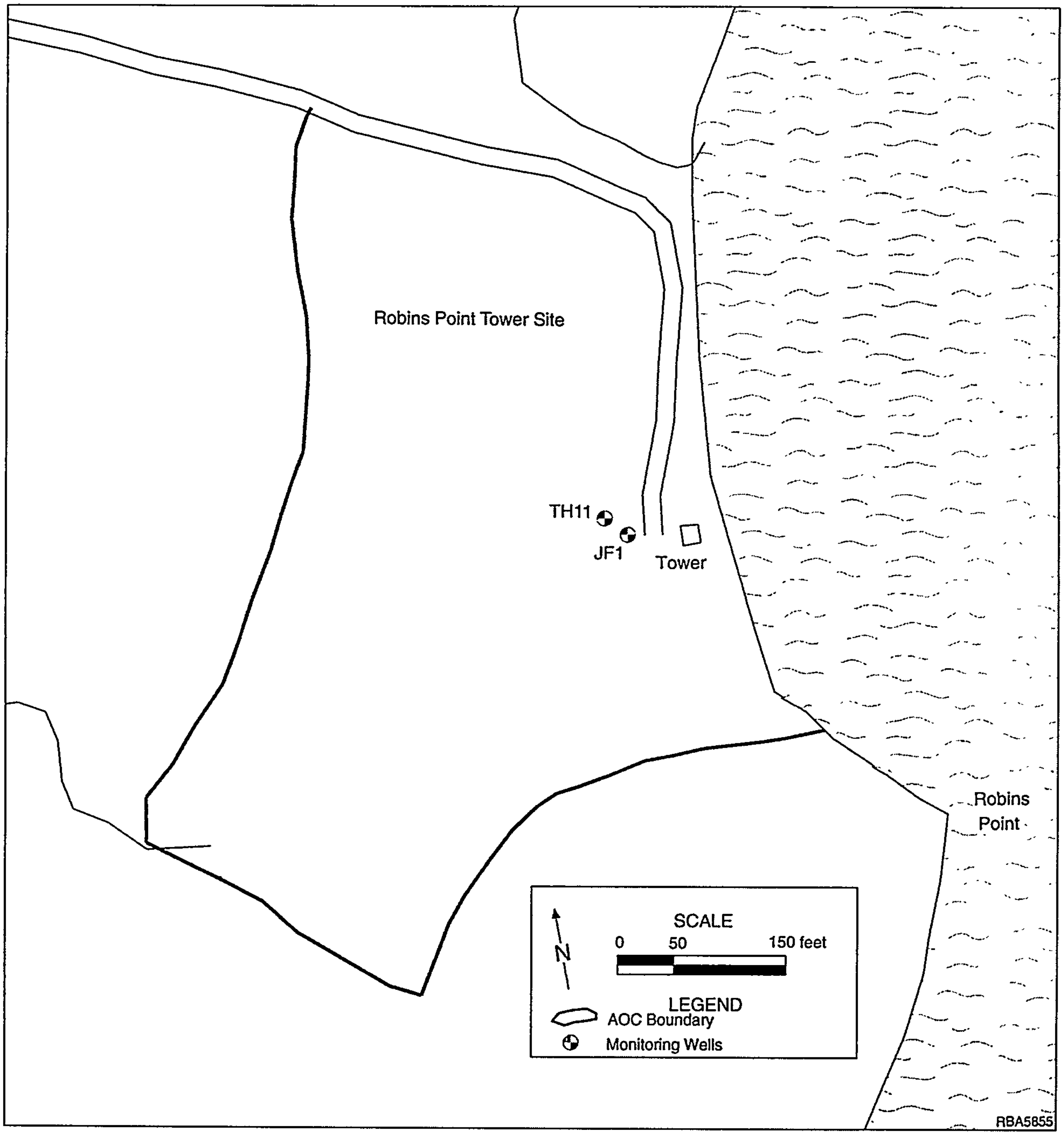

FIGURE A.8-3 Locations of Monitoring Wells at the RPTS AOC contamination (Hughes 1992). An upgradient well (JF2) of similar depth, located outside the tower site and at the J-Field gate entrance, also showed detectable TRCLE concentrations at that time. Acetone and 1,1-dichloroethane were detected at concentrations of 4 and 1 µg/L, respectively, in 1992 (Hughes 1992).

In summer 1994, groundwater samples were collected from TH11 and JF1. The TH11 samples were analyzed for VOCs, general chemistry, and explosives-related compounds. The JF1 samples were analyzed for VOCs only. Neither well contained VOCs above the detection limits. No explosives-related compounds were detected.

A.8.4 Surface Water and Sediments

Nearshore surface water and sediment samples were collected in 1992 by the EPA. The results of the investigation are reported in Section A.1.4. The data for surface water and sediment indicate that the level of contamination offshore is very low.

In 1995, two surface water samples were collected. Sample RPTSW2 was collected from a relict crater, and RPTSW3 was collected offshore (Figure A.8-2). The samples were analyzed for VOCs, metals, and cyanide. Sample RPTSW2 was also analyzed for major anions. Only low levels of acetone and methylene chloride were detected in the samples. Table A.8-2 summarizes the metals results. Lead was detected at levels exceeding the calculated background in sample RPTSW2, taken from the crater. Zinc exceeded the calculated background in both samples. Cyanide was not detected in either sample.

TABLE A.8-2 Analytical Results for Selected Metals in Surface Water Samples Collected from the RPTS AOC: 1995[a]

	Concentration (μg/L) by Sample Location			
Parameter	RPTS2	RPTS3	Estuarine River Background (μg/L)[b,c]	Freshwater Pond Background (μg/L)[b,d]
Arsenic	<1.8	6.2	NA	NA
Cadmium	<3.0	<3.0	NA	NA
Calcium	4,560	36,700	NA	NA
Chromium	<8.0	<8.0	NA	8.0
Copper	<23	<23	5.0	NA
Iron	1,580	412	2,140	5,750
Lead	***15***	2.1	3.0	6.0
Magnesium	3,140	87,000	NA	NA
Mercury	<0.10	<21	NA	NA
Zinc	***3,860***	***18***	15	76

[a] Notation: NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from estuarine river and freshwater pond data in ICF Kaiser Engineers (1995).

[c] Estuarine river calculated background values were used as comparison criteria for RPTS3 (offshore).

[d] Freshwater pond calculated background values were used as comparison criteria for RPTS2 (onshore, crater).

A.9 SITE X1

A.9.1 Screening Investigations

A.9.1.1 Soil Gas

No soil gas surveys were conducted at Site X1.

A.9.1.2 In Situ X-Ray Fluorescence

An XRF field survey of Site X1 was conducted in 1996. No significant metal anomalies were detected.

A.9.1.3 Geophysical Surveys

Exploratory geophysical surveys (including electromagnetic, GPR, and magnetic surveys) of two of the three shallow depressions (the two westernmost) at the site were conducted in early 1995 (Davies et al. 1995). Two exploratory profiles were taken of each of the two depressions. Magnetic anomalies were found near the center of each depression; however, no GPR anomaly was detected. The third depression was not surveyed because it did not show evidence of ground disturbance.

A.9.2 Soil Analyses

In 1996, surface soil samples were collected from nine locations at Site X1 (X1S1–X1S9, Figure A.9-1). The samples were analyzed for metals only. Table A.9-1 summarizes the results. In sample X1S5, the lead concentration exceeded the calculated background. Other samples had mercury and selenium at or slightly above the calculated background (Table A.9-1). No other samples had metal concentrations exceeding the calculated background values.

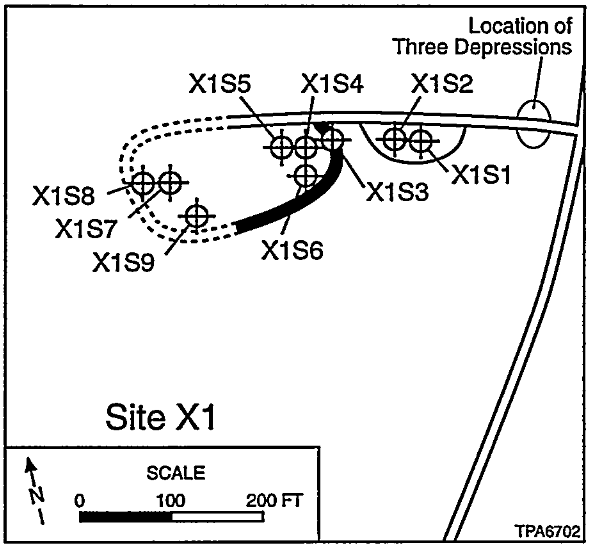

FIGURE A.9-1 Locations of Surface Soil Samples at Site X1: 1996

A.9.3 Groundwater

No groundwater samples were collected at Site X1.

A.9.4 Surface Water and Sediment

No surface water or sediment samples were collected at Site X1.

TABLE A.9-1 Analytical Results for Selected Metals in Surface Soil Samples Collected from Site X1: 1994[a]

	Concentration (mg/kg) by Sample Location					
Parameter	X1S1	X1S2	X1S3	X1S4	X1S5	X1S6
Arsenic	1.4	2.1	1.3	2.2	1.8	1.6
Cadmium	0.39	<0.37	<0.35	<0.38	<0.37	<0.36
Calcium	400	365	207	207	481	288
Chromium	9.9	8.7	6.7	6.7	9.3	8.7
Copper	4.3	3.4	<1.8	2.5	15	5.2
Iron	10,600	9,860	7,740	7,440	12,400	7,390
Lead	12	9.8	4.7	24	***109***	14
Magnesium	919	898	609	666	896	689
Mercury	0.093	0.088	0.075	***0.11***	0.079	***0.12***
Selenium	0.16	0.16	0.10	0.096	<0.087	<0.084
Zinc	27	25	22	19	65	29

	Concentration (mg/kg) by Sample Location			
Parameter	X1S7	X1S8	X1S9	Background (mg/kg)[b]
Arsenic	1.6	1.9	0.91	5.0
Cadmium	<0.44	<0.38	0.40	0.70
Calcium	5,860	1,070	1,680	NA
Chromium	8.2	8.1	9.1	41
Copper	7.9	5.4	3.7	20
Iron	7,360	8.080	9,930	23,400
Lead	17	11	11	61
Magnesium	885	924	784	NA
Mercury	***0.14***	***0.10***	0.092	0.10
Selenium	***0.45***	***0.42***	0.14	0.40
Zinc	58	22	28	118

[a] Notation: NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

A.10 AREA A

A.10.1 Screening Investigations

A.10.1.1 Soil Gas

A passive soil gas investigation was conducted with EMFLUX soil gas collection devices at 29 locations (300-329) at the three trenches (A-1, A-2, and A-3) in Area A in July 1994 (Prasad and Martino 1994b). The locations of the trenches and soil gas sampling points are shown in Figure A.10-1.

Of the 33 compounds targeted in the survey, 11 were detected at one or more of the trenches. Because the sampling points were located near marshes and because chromatographic peaks indicating high levels of terpenes were detected, acetone, benzene, bromomethane, 2-butanone, carbon disulfide, chloromethane, styrene, toluene, and xylene were likely to occur naturally in the areas sampled. However, two compounds that were detected do not occur naturally: TCLEE (in trench A-3) and TRCLE (in trenches A-1 and A-2).

As summarized in Table A.10-1, 10 compounds were detected in soil gas samples from trench A-3. As summarized in Table A.10-2, nine compounds were detected in trenches A-1 and A-2, but only the TRCLE detection is significant because it represents contamination at the site. TRCLE was detected at relatively low emission rates (0.5–1.3 ng/m^2/min) at 10 of the 13 sampling points. Sample locations 317 and 321, in trench A-1, had the highest emission rates of TRCLE (1.2 and 1.3 ng/m^2/min, respectively). Sample location 319, also in trench A-1, had a moderately high emission rate of TRCLE (0.9 ng/m^2/min). This sample location also had the highest emission rates of benzene (5.7 ng/m^2/min) and toluene (4.5 ng/m^2/min), and the second highest emission rate of xylene (1.8 ng/m^2/min).

A.10.1.2 In Situ X-Ray Fluorescence

No field XRF surveys were conducted in Area A.

A.10.1.3 Geophysical Surveys

No geophysical surveys were conducted in Area A.

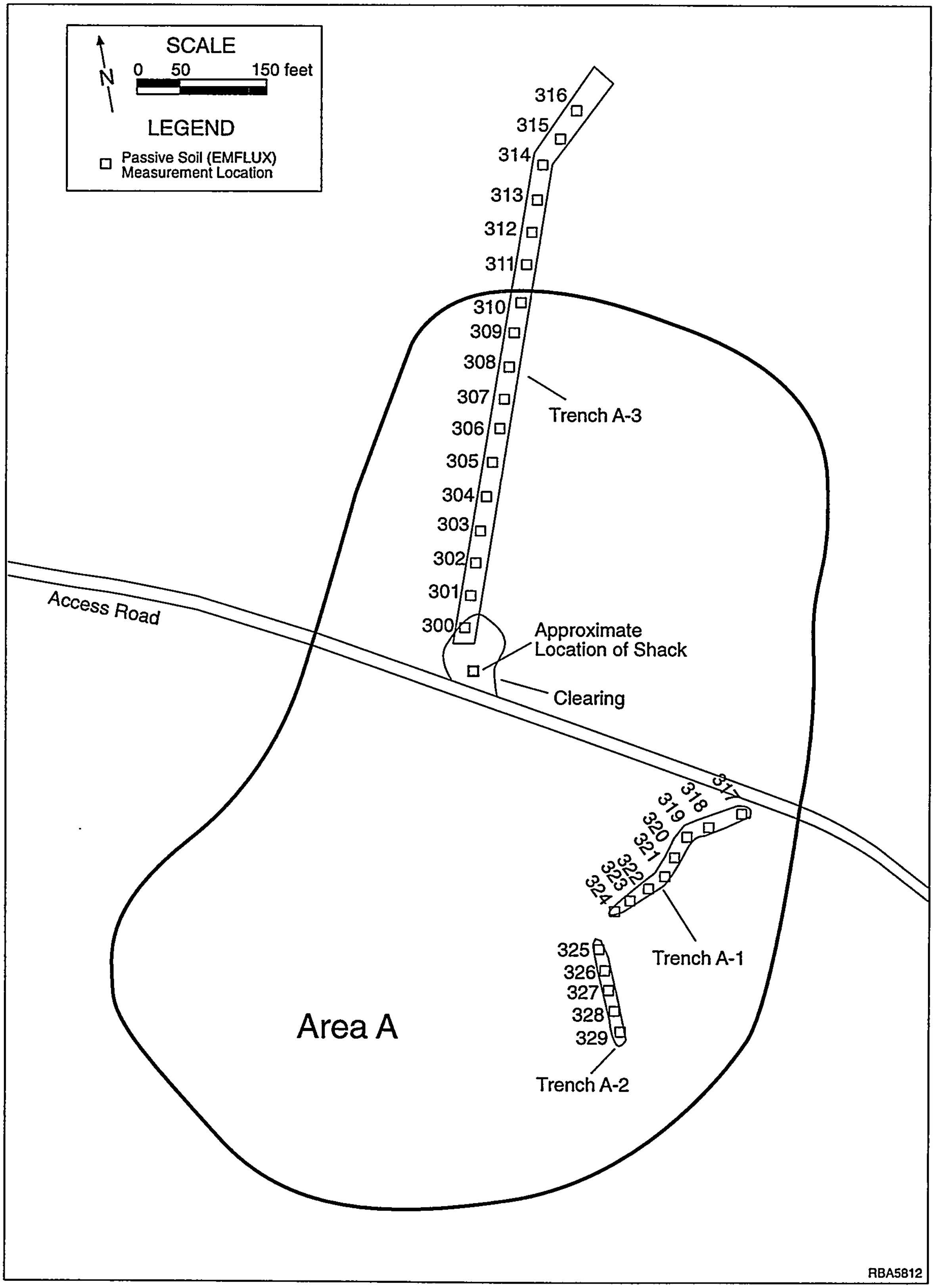

FIGURE A.10-1 Locations of Soil Gas Monitoring Points at Area A

TABLE A.10-1 Emission Flux Rates of Passive Soil Gas in Area A, Trench A-3[a]

		Flux Rate (ng/m^2/min) by Sample Location						
Parameter	QL[b]	300	301	302	303	304	305	305D
Acetone	3.2	7.6	35	32	20	12	70	10
Benzene	0.8	–[b]	3.4	1.5	1.8	2.6	3.6	1.6
Bromomethane	15	–	20	16	–	–	121	–
2-Butanone	2.5	–	5.7	6.7	3.3	–	19	–
Carbon disulfide	8.1	–	15	8.8	14	–	37	–
Chloromethane	1.4	–	6.5	3.3	4.8	2.7	25	–
Styrene	0.5	33	30	1.5	10	15	15	32
Tetrachloroethene	0.5	–	–	–	–	–	–	–
Toluene	0.5	0.6	1.9	0.6	1.3	0.6	2.2	1.0
Xylene (total)	0.5	–	0.9	0.5	0.7	0.9	2.2	–

		Flux Rate (ng/m^2/min) by Sample Location						
Parameter	QL[b]	306	307	308	309	310	311	312
Acetone	3.2	48	16	20	12	13	6.3	5.0
Benzene	0.8	5.1	–	1.1	1.2	1.4	–	0.9
Bromomethane	15	34	–	15	–	17	–	–
2-Butanone	2.5	8.5	–	–	–	–	–	–
Carbon disulfide	8.1	29	–	16	–	24	–	–
Chloromethane	1.4	20	–	–	8.7	11	1.4	–
Styrene	0.5	46	19	57	–	–	–	–
Tetrachloroethene	0.5	–	–	–	–	–	–	–
Toluene	0.5	3.1	1.5	0.8	–	–	–	–
Xylene (total)	0.5	–	0.7	1.0	–	–	–	–

TABLE A.10.1 (Cont.)

Parameter	Flux Rate ($ng/m^2/min$) by Sample Location					
	QL[b]	313	313D	314	315	316
Acetone	3.2	69	6.2	14	12	36
Benzene	0.8	4.5	–	1.6	1.0	2.1
Bromomethane	15	84	–	21	–	31
2-Butanone	2.5	13	–	2.9	–	3.4
Carbon disulfide	8.1	43	–	–	–	–
Chloromethane	1.4	35	2.7	6.3	–	18
Styrene	0.5	–	–	5.1	1.9	–
Tetrachloroethene	0.5	–	–	0.5	–	–
Toluene	0.5	1.7	–	–	1.7	0.5
Xylene (total)	0.5	1.0	–	–	–	–

[a] Notation: A hyphen denotes value below the reported quantitation level.

[b] QL = emission-flux-rate quantitation levels.

Source: Prasad and Martino (1994b).

A.10.2 Soil Analyses

No soil samples were collected at Area A.

A.10.3 Groundwater

No monitoring wells were installed or sampled in Area A in the past or as part of the RI.

A.10.4 Surface Water and Sediment

Because soil gas data revealed no significant contamination in trench A-3, sediment was sampled only in trenches A-1 and A-2 (Figure A.10-2). Three sediment samples were collected from each of the two trenches; one sample, ARASED7, was a duplicate. The seven sediment samples (ARASED1–7) were collected from the 0- to 6-in. interval. Samples ARASED1 and ARASED7

TABLE A.10-2 Emission Flux Rates of Passive Soil Gas in Area A, Trenches A-1 and A-2[a]

		Flux Rate (ng/m^2/min) by Sample Location						
Parameter	QL[b]	317	317D	318	319	320	321	322
Acetone	3.2	–	6.4	14	16	12	10	14
Benzene	0.8	–	0.8	2.0	5.7	0.9	–	1.2
2-Butanone	2.5	–	–	–	–	–	–	–
Carbon disulfide	8.1	–	–	30	21	–	–	–
Chloromethane	1.4	–	–	–	–	–	2.3	–
Styrene	0.5	–	–	–	–	–	–	12
Toluene	0.5	–	–	2.3	4.5	0.8	–	1.8
Trichloroethene	0.5	1.2	–	0.8	0.9	–	1.3	0.7
Xylene (total)	0.5	–	–	1.1	1.8	–	–	–

		Flux Rate (ng/m^2/min) by Sample Location						
Parameter	QL[b]	323	324	325	326	327	328	329
Acetone	3.2	20	23	6.5	86	80	17	16
Benzene	0.8	1.5	2.4	–	3.2	1.8	–	–
2-Butanone	2.5	–	–	–	7.8	7.1	2.9	–
Carbon disulfide	8.1	22	–	–	59	74	–	13
Chloromethane	1.4	–	–	–	–	–	–	–
Styrene	0.5	–	–	–	0.7	–	–	–
Toluene	0.5	1.5	1.5	–	3.2	1.6	–	–
Trichloroethene	0.5	0.7	0.7	–	–	0.8	0.5	0.5
Xylene (total)	0.5	1.1	0.5	–	1.6	0.8	–	–

[a] Notation: A hyphen denotes value below the reported quantitation level.

[b] QL = emission-flux-rate quantitation level.

Source: Prasad and Martino (1994b).

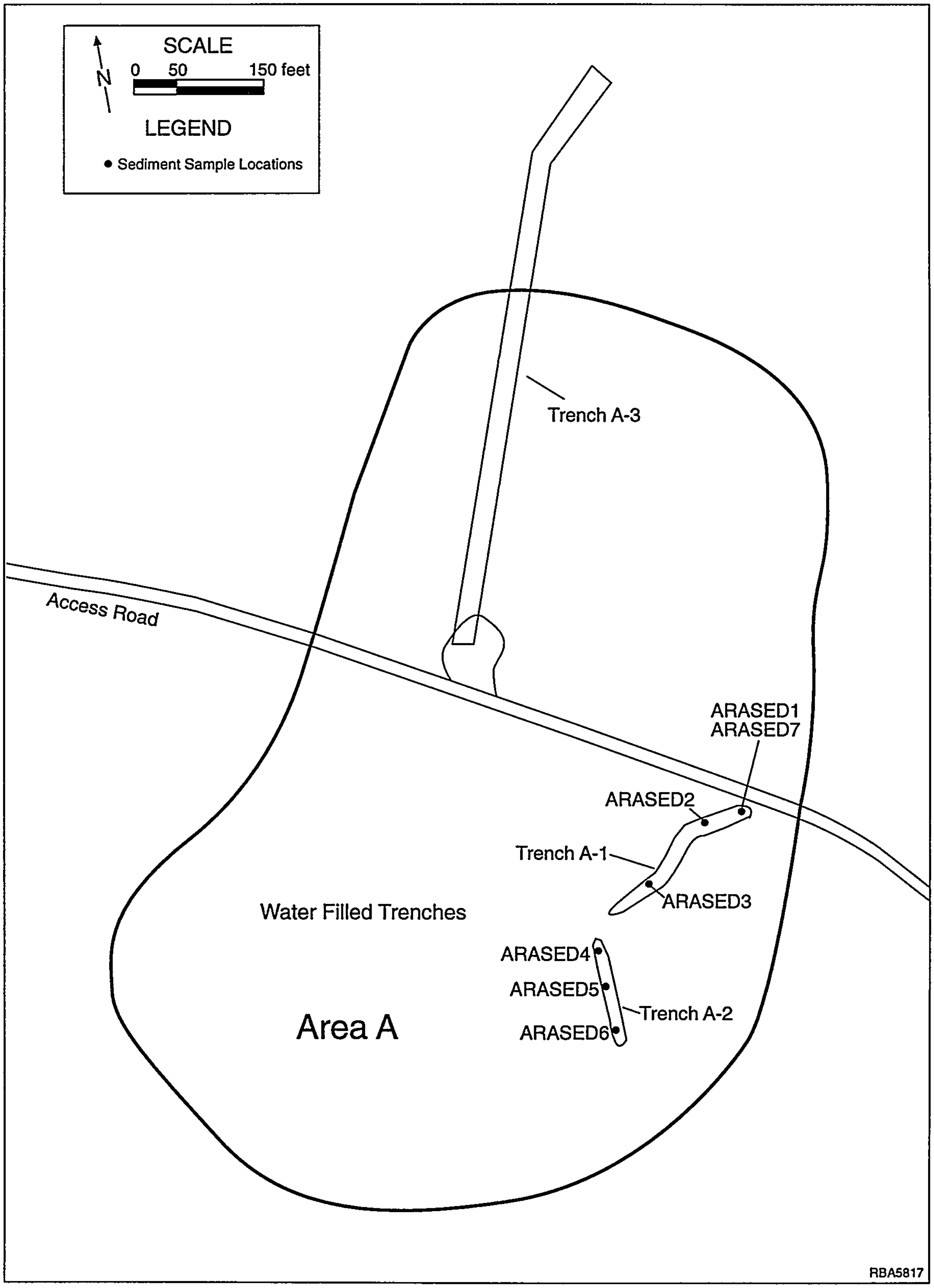

FIGURE A.10-2 Locations of Sediment Samples at Area A

were colocated. The sediment samples were analyzed for metals, VOCs, and SVOCs. No surface water samples were collected from Area A.

The results of the VOC and SVOC analyses for those samples with detectable concentrations (either estimated or quantifiable concentrations) indicated that all naturally occurring organic compounds measured from these samples were at concentrations lower than the calculated background level (where available). For those organic compounds that do not occur naturally and that are not otherwise ubiquitous in the environment, a background value could not be calculated. Therefore, for those compounds, the method detection limit served as a surrogate to the calculated background for the following discussion.

Two compounds, acetone and 2-butanone, were detected at concentrations above the detection limit but below 1,000 µg. These positive, but low, analytical results are also not considered significant because the compounds could be laboratory contaminants. Although the passive soil gas study detected TRCLE as well as a number of organic compounds, no TRCLE was detected in the sediment samples collected from trenches A-1 and A-2. The results indicated that all metals concentrations measured in these samples were lower than the calculated background levels.

A.11 AREA B

A.11.1 Screening Investigation

A.11.1.1 Soil Gas

No soil gas surveys were conducted in Area B.

A.11.1.2 In Situ X-Ray Fluorescence

An XRF field survey was conducted in 1996. No significant metal anomalies were detected.

A.11.1.3 Geophysical Surveys

No geophysical surveys were conducted in Area B.

A.11.2 Soil Analyses

In 1996, surface soil samples were collected from 10 locations at Area B (ARBS1–10, Figure A.11-1). The samples were analyzed for metals only. To obtain a profile across the area, these samples were collected in the area of mounded soil and across the disturbed area observed in aerial photographs. Table A.11-1 summarizes the results. Most of the samples had metal levels below the calculated background levels. Metals were found at levels exceeding the calculated background in samples from the central and southern portions of the site: cadmium (up to 1.4 mg/kg in ARBS1), copper (up to 40 mg/kg in ARBS5), lead (up to 82 mg/kg in ARBS1), nickel (up to 26 mg/kg in ARBS3), and zinc (up to 159 mg/kg in ARBS1).

A.11.3 Groundwater

No groundwater samples were collected at Area B.

A.11.4 Surface Water and Sediment

No surface water or sediment samples were collected at Area B.

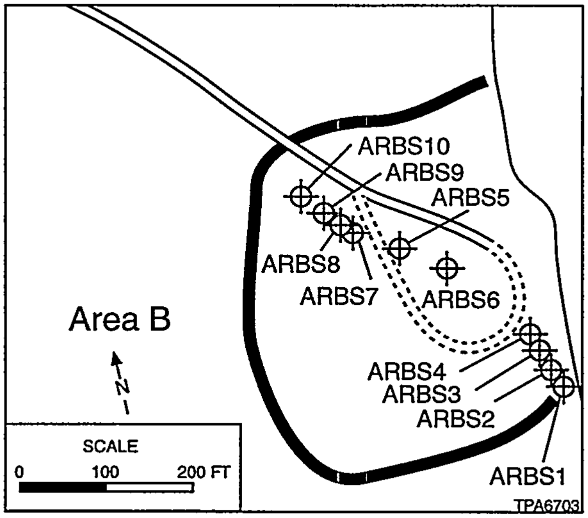

FIGURE A.11-1 Locations of Surface Soil Samples at Area B: 1996

TABLE A.11-1 Analytical Results for Metals in Surface Soil Samples Collected from Area B: 1996[a]

	Concentration (mg/kg) by Sample Location										
Parameter	ARBS1	ARBS2	ARBS3	ARBS4	ARBS5	ARBS6	ARBS7	ARBS8	ARBS9	ARBS10	Background (mg/kg)[b]
Arsenic	2.1	3.4	1.9	1.4	2.2	2.8	1.2	1.6	2.1	2.0	5.0
Cadmium	***1.4***	***1.0***	***0.74***	<0.64	***0.71***	<0.64	<0.72	<0.69	***0.75***	***0.77***	0.70
Calcium	2,170	2,870	1,370	931	16,700	221	251	260	354	318	NA
Chromium	10	13	14	11	19	9.6	7.3	9.4	9.2	8.6	41
Copper	8.6	11	11	7.9	***41***	4.3	5.5	5.4	6.5	6.6	20
Iron	7,870	9,950	12,900	10,200	21,200	11,300	7,040	9,840	10,200	8,970	23,400
Lead	***82***	***63***	10	6.3	5.7	6.2	14	6.1	6.7	14	61
Magnesium	796	1,170	2,680	1,380	2,590	855	672	772	782	721	NA
Mercury	***0.18***	***0.21***	0.066	0.077	0.062	<0.060	<0.069	<0.065	<0.067	0.079	0.10
Nickel	6.8	8.1	***26***	7.3	***24***	4.8	5.7	5.9	6.6	7.5	20
Zinc	***159***	104	35	35	27	21	23	35	27	31	118

[a] Notation: NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Bckground values were derived from soil data in ICF Kaiser Engineers (1995).

A.12 AREA C

A.12.1 Screening Investigations

A.12.1.1 Soil Gas

No soil gas surveys were conducted at Area C.

A.12.1.2 In Situ X-Ray Fluorescence

An XRF field survey was conducted in 1996. No significant anomalies were detected.

A.12.1.3 Geophysical Surveys

No geophysical surveys were conducted in Area C.

A.12.2 Soil Analyses

In 1996, surface soil samples were collected from four locations in areas of disturbed soil at Area C (ARCS1–4, Figure A.12-1). The samples were analyzed only for metals. Table A.12-1 summarizes the results. For all metals except lead and mercury, concentrations were below the calculated background levels in all four samples. Mercury was detected above background in all samples, and lead was above background in sample ARCS4.

A.12.3 Groundwater

No wells were installed or sampled in Area C in the past or as part of the RI.

A.12.4 Surface Water and Sediment

No surface water or sediment samples were collected at Area C.

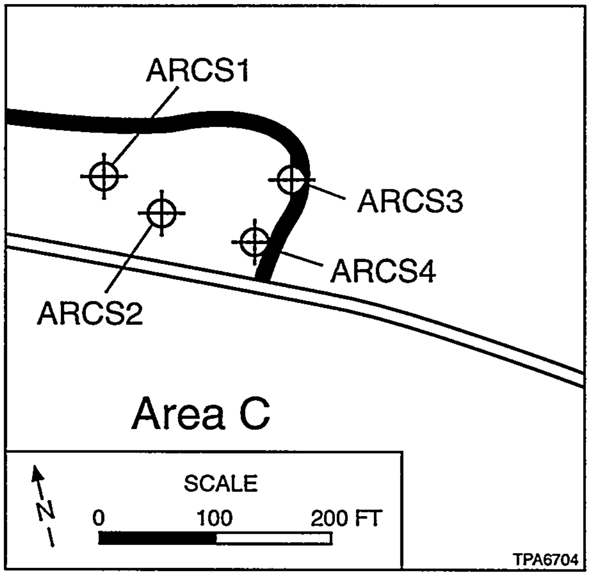

FIGURE A.12-1 Locations of Surface Soil Samples at Area C: 1996

TABLE A.12-1 Analytical Results for Selected Metals in Surface Soil Samples Collected from Area C: 1996[a]

	Concentration (µg/kg) by Sample Location				
Parameter	ARCS1	ARCS2	ARCS3	ARCS4	Background (mg/kg)[b]
Arsenic	2.6	1.5	1.6	3.6	5.0
Cadmium	<0.36	0.47	<0.38	0.59	0.70
Calcium	234	1,100	100	1,570	NA
Chromium	8.7	11	8.1	15	41
Copper	6.6	9.8	5.6	12	20
Iron	8,900	10,500	6,670	13,000	23,400
Lead	31	53	54	***90***	61
Magnesium	748	1,220	607	806	NA
Mercury	***0.17***	***0.18***	***0.16***	***0.36***	0.10
Zinc	25	50	20	63	118

[a] Notation: NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

A.13 RUINS SITE ACROSS FROM THE WHITE PHOSPHORUS BURNING PITS AREA

A.13.1 Screening Investigations

A.13.1.1 Soil Gas

In 1994, an EMFLUX soil gas survey was conducted at six locations (sampling points 330-335), near the Suspect Filled Trench area (Figure A.13-1). Low emission rates of acetone, 2-butanone, chloromethane, benzene, styrene, toluene, and xylene were detected in some samples. Because the emission rates were low and the compounds could occur naturally, they are not considered to have been artificially introduced into the Ruins Site (Prasad and Martino 1994b). However, a low emission rate (0.5 ng/m^2/min) of TRCLE, which does not occur naturally, was detected at two locations (330 and 333).

A.13.1.2 In Situ X-Ray Fluorescence

An XRF field survey was conducted in 1996 at seven locations (XRRU6–12) southwest of the four retaining wall structures (Figure A.13-1). No significant metal anomalies were detected.

A.13.1.3 Geophysical Surveys

Electromagnetic surveys (including electromagnetic conductivity and electromagnetic induction measurements) and total field magnetic surveys were conducted along three profiles perpendicular to the Suspect Filled Trench (Davies et al. 1995). Although anomalies were noted at the ends of the profiles in the electromagnetic data, the patterns did not reflect a trench feature. Also, no anomalies were found at the center of the profiles where the targeted suspect trench was located. For the magnetic data, all three profiles show anomalies near their centers and their ends (Davies et al. 1995). These anomalies did not correlate well with the anomalies in the electromagnetic data. It is inferred that the suspect trench might be an old road bed.

A.13.2 Soil Analyses

In 1995, two surface soil samples (RUNS1 and RUNS2) were collected from the southwestern side of the retaining wall structure (Figure A.13-2). The samples were analyzed for

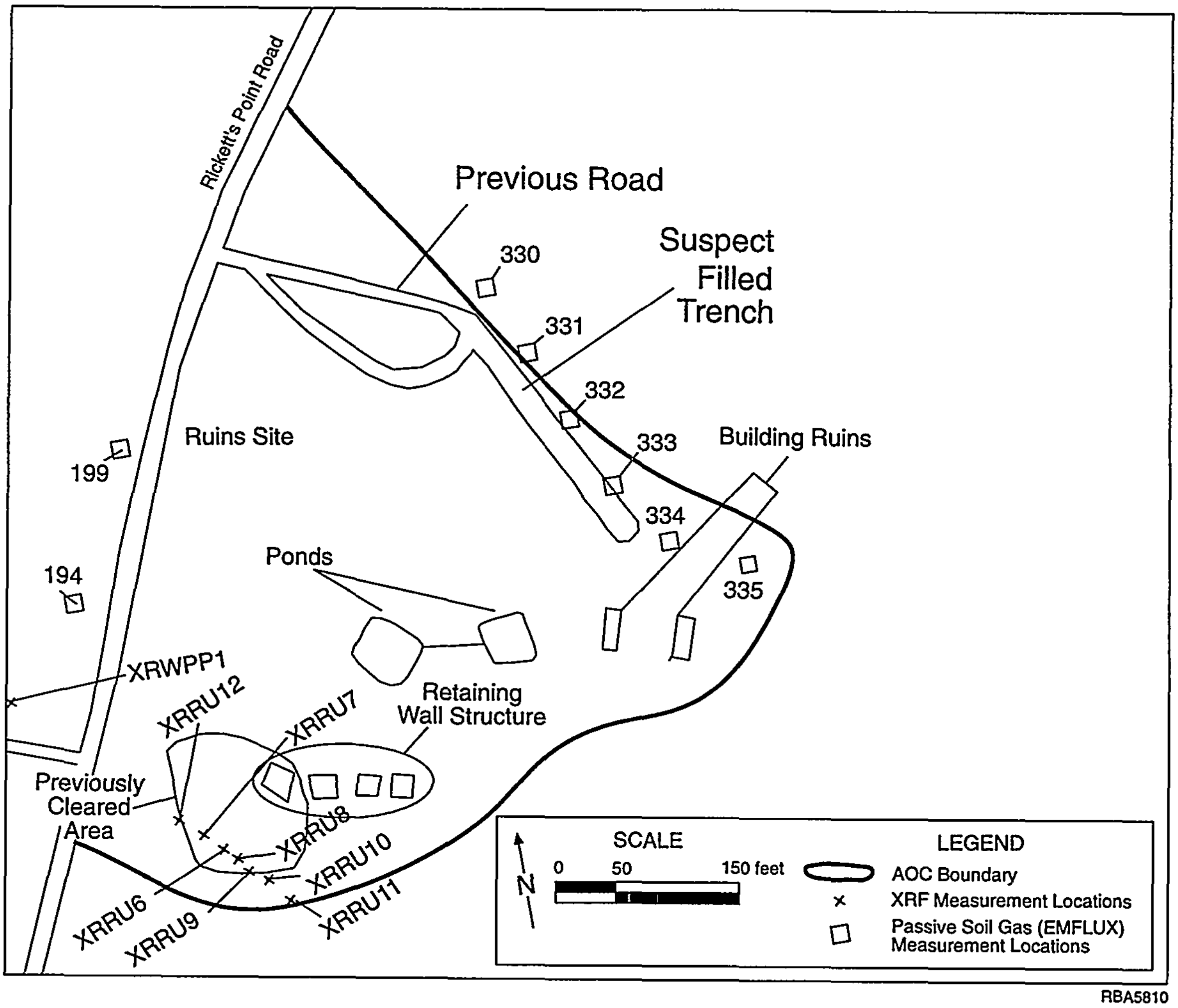

FIGURE A.13-1 Locations of Passive Soil Gas and X-Ray Fluorescence Measurements at the Ruins Site

metals only; the analytical results indicated that metal levels in these two samples did not exceed the calculated background (Table A.13-1).

A.13.3 Groundwater

No monitoring wells were installed or sampled at the Ruins Site in the past or as part of the RI.

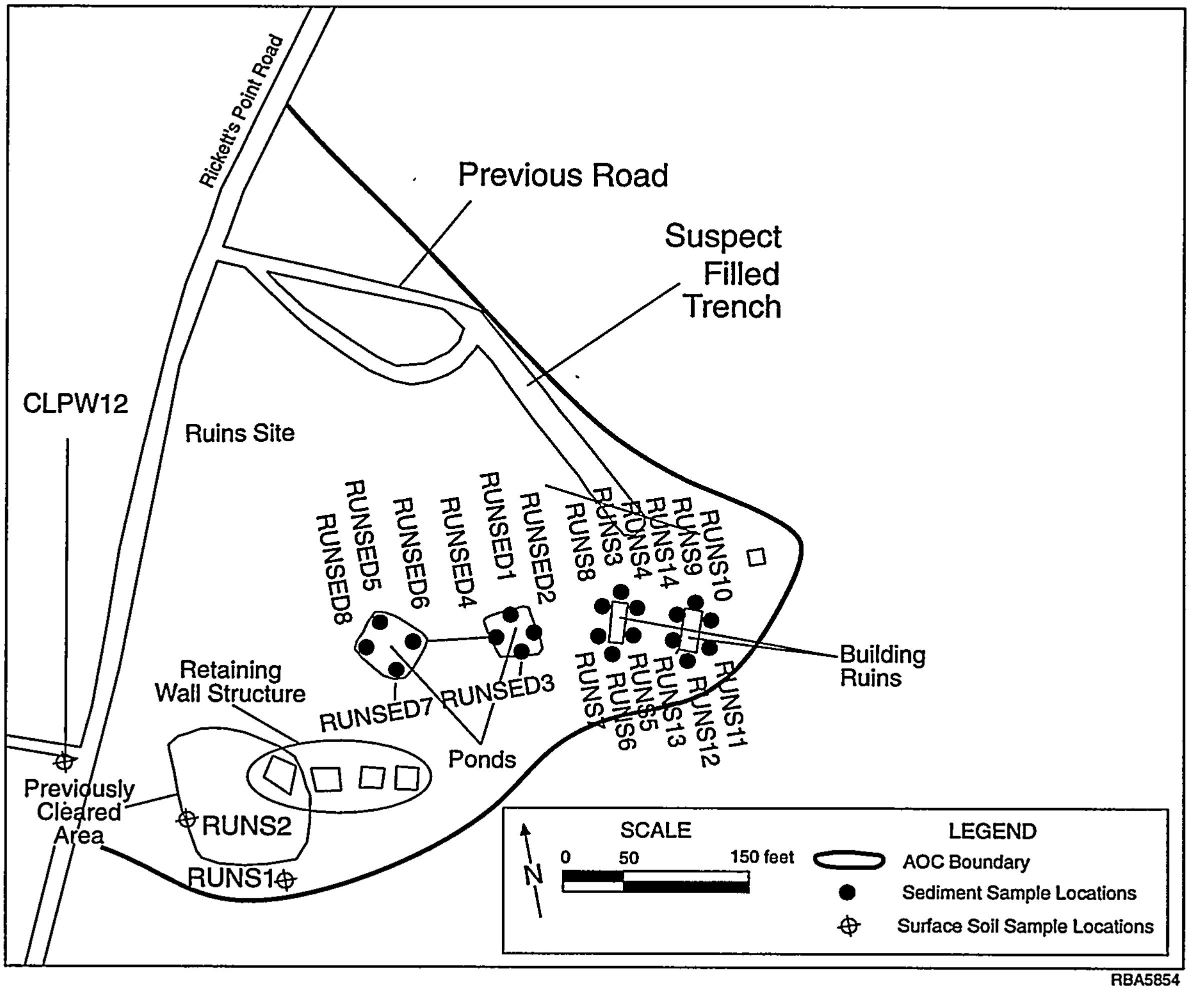

FIGURE A.13-2 Locations of Soil and Sediment Samples at the Ruins Site

A.13.4 Surface Water and Sediment

In total, 20 sediment samples were collected at the Ruins Site in May 1995 (Figure A.13-2). Twelve were collected from around the building ruins in the eastern part of the site (RUNS3–14), and eight were collected from the two ponds in the central part of the site (RUNSED1–8). All samples were collected at a depth of 0–6 in. The sediment samples were analyzed for metals only. No surface water samples were collected. Tables A.13-2 and A.13-3 summarize the results.

Elevated concentrations of metals were detected in four sediment samples (RUNS4, RUNS6, RUNS10, and RUNS11) from around the building ruins (Table A.13-2). Of particular note were the concentrations of barium (2,250 mg/kg), chromium (99 mg/kg), copper (199 mg/kg), and lead (138 mg/kg) in sample RUNS6 taken from the southern side of the easternmost building remnant. Only cadmium was slightly elevated (relative to the calculated background) in samples collected in the ponds (Table A.13-3).

TABLE A.13-1 Analytical Results for Selected Metals in Surface Soil Samples Collected from the Ruins Site across from the WPP AOC: 1995[a]

	Concentration (mg/kg) by Sample Location		
Parameter	RUNS1	RUNS2	Background (mg/kg)[b]
Arsenic	2.2	2.3	5.0
Cadmium	<0.38	***0.70***	0.70
Calcium	130	286	NA
Chromium	6.8	6.5	41
Copper	7.4	4.6	20
Iron	6,020	7,460	23,400
Lead	21	12	61
Magnesium	619	731	NA
Mercury	0.074	<0.067	0.10
Zinc	29	18	118

[a] Notation: NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

TABLE A.13-2 Analytical Results for Selected Metals in Sediment Samples Collected around the Building Remnants at the Ruins Site across from the WPP AOC: 1995[a]

	Concentration (mg/kg) by Sample Location				
Parameter	RUNS3	RUNS4	RUNS5	RUNS6	RUNS7
Arsenic	2.4	0.83	0.51	1.7	0.92
Barium	44	***164***	41	***2,250***	93
Cadmium	0.48	0.72	<0.38	1.3	0.53
Calcium	384	407	482	8,350	246
Chromium	3.7	12	3.0	***99***	8.6
Copper	<2.8	16	<2.9	***199***	8.4
Iron	4,380	4,090	2,460	17,400	3,770
Lead	5.2	41	7.3	***138***	21
Magnesium	394	453	305	9,310	509
Mercury	<0.053	<0.054	<0.053	<0.051	<0.061
Zinc	13	87	7.9	88	19

	Concentration (mg/kg) by Sample Location				
Parameter	RUNS8	RUNS9	RUNS10	RUNS11	RUNS12
Arsenic	0.84	1.2	1.4	2.0	1.4
Barium	56	31	46	35	45
Cadmium	<0.37	0.89	***5.2***	***11***	1.9
Calcium	287	153	552	1,380	2,860
Chromium	5.0	5.2	8.4	5.4	6.8
Copper	<2.8	5.1	13	4.0	6.4
Iron	6,090	4,940	6,510	6,180	5,930
Lead	6.8	10	23	9.9	8.1
Magnesium	393	458	594	566	629
Mercury	<0.052	<0.068	<0.059	<0.061	<0.077
Zinc	12	18	28	14	37

TABLE A.13-2 (Cont.)

Parameter	Concentration (mg/kg) by Sample Location RUNS13	Concentration (mg/kg) by Sample Location RUNS14	Freshwater Marsh Background (mg/kg)[b]
Arsenic	0.65	1.5	8.0
Barium	21	44	160
Cadmium	<0.36	1.2	5.0
Calcium	182	281	NA[b]
Chromium	<0.96	6.1	44
Copper	<2.8	7.9	61
Iron	2,910	4,450	41,880
Lead	3.8	13	96
Magnesium	153	479	NA
Mercury	<0.050	0.063	0.30
Zinc	12	26	184

[a] Notation: NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from freshwater marsh sediment data in ICF Kaiser Engineers (1995).

TABLE A.13-3 Analytical Results for Selected Metals in Sediment Samples Collected from Two Ponds at the Ruins Site across from the WPP AOC: 1995[a]

	Concentration (mg/kg) by Sample Location				
Parameter	RUNSED1	RUNSED2	RUNSED3	RUNSED4	RUNSED5
Arsenic	6.9	0.87	1.4	0.84	0.68
Cadmium	***0.67***	<0.49	<0.50	<0.51	<0.50
Calcium	364	275	275	444	189
Chromium	19	10	9.8	12	13
Copper	8.4	3.5	4.8	5.8	6.0
Iron	24,700	13,800	8,760	8,590	10,500
Lead	8.7	6.0	5.1	8.2	4.2
Magnesium	1,320	609	695	807	831
Mercury	0.034	0.022	0.035	0.040	0.026
Zinc	30	28	27	32	39

	Concentration (mg/kg) by Sample Location			Freshwater Pond Background (mg/kg)[b]
Parameter	RUNSED6	RUNSED7	RUNSED8	
Arsenic	1.8	0.96	1.3	8.0
Cadmium	<0.51	<0.49	***0.52***	0
Calcium	219	92	168	NA[b]
Chromium	7.1	6.6	8.5	125
Copper	6.5	2.1	6.0	10
Iron	6,600	5,090	8,170	54,000
Lead	5.7	3.6	7.3	66
Magnesium	596	375	849	NA
Mercury	0.030	0.027	0.044	0.30
Zinc	38	25	49	247

[a] Notation: NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Background values were derived from freshwater pond sediment data in ICF Kaiser Engineers (1995).

A.14 AREA D

The major concern at Area D is the impact of the craters on the environment. Area D has been incorporated into the sitewide crater study (see Section A.15). No separate evaluation is provided in this section.

A.15 CRATERS

The first stage of RI crater sampling was conducted in the spring of 1995. The investigation included a systematic study of potential contamination problems associated with the craters at J-Field. In total, 19 sediment samples (CRTR1–CRTR12, CRTR1A, CRTR1B, DG1, TBCA, and TBCB), including 2 duplicate samples (CRTR3 dup, CRTR5 dup), were collected in 16 craters (Figure A.15-1). These craters are located in upland areas and in low-lying marsh areas. Samples CRTR1A and CRTR1B were obtained from the same crater, located south of the HE Demolition Ground in the TBP AOC. Sample CRTR1A was collected at a depth interval of 0–6 in., and sample CRTR1B was collected from a depth interval of 6–12 in. Samples from other craters were collected at depth intervals of 0–6 in. Sample locations are shown in Figure A.15-1.

Because metals are common components of ordnance and are persistent in the environment, all sediment samples were analyzed for TAL metals. Of the 19 samples, 5 (TBCA, CRTR3, CRTR3 dup, CRTR6, and CRTR9) were also analyzed for explosives to determine whether residual explosives represent potential contamination. Because VOCs and SVOCs are not components of ordnance, they were not analyzed in the samples.

Table A.15-1 shows the metal content of the sediment samples collected from the craters and the calculated background levels, which were derived from ICF Kaiser Engineers (1995) for freshwater marsh sediment. With only a few exceptions, the sediment samples had metal concentrations below the calculated background levels.

Sample CRTR1B, the only sample collected from 6–12 in. deep, had an elevated arsenic content (15 mg/kg), which is nearly twice the calculated background level (7.6 mg/kg). Sample CRTR1 had a copper content of 86 mg/kg, slightly higher than the calculated background level (61 mg/kg). Samples CRTR3, CRTR5, and CRTR6 had silver concentrations of 0.32, 0.27, and 4.8 mg/kg, respectively, all of which exceeded the calculated background level (0.19 mg/kg). Arsenic and copper are common contaminants in open burning and detonation waste disposal sites at J-Field. Potential sources of arsenic may be chemical agents, such as adamsite and lewisite.

A common feature shared by craters CRTR1, CRTR1B, CRTR3, CRTR5, and CRTR6 is their location near the demolition grounds at J-Field (Figure A.15-1). CRTR1B and CRTR3 are located near the HE Demolition Ground in the southeastern part of the TBP AOC; CRTR1 is located near the SBDG AOC; and CRTR5 and CRTR6 are located near the RPDG. Therefore, it is possible that metal contaminants found in the craters are related to nearby demolition operations (e.g., transport of the contaminants by wind could have occurred).

Sediment samples CRTR3, CRTR3 dup, CRTR6, CRTR9, and TBCA were also analyzed for explosives and their degradation products. Each analyte tested had a concentration level below its corresponding quantitation limit.

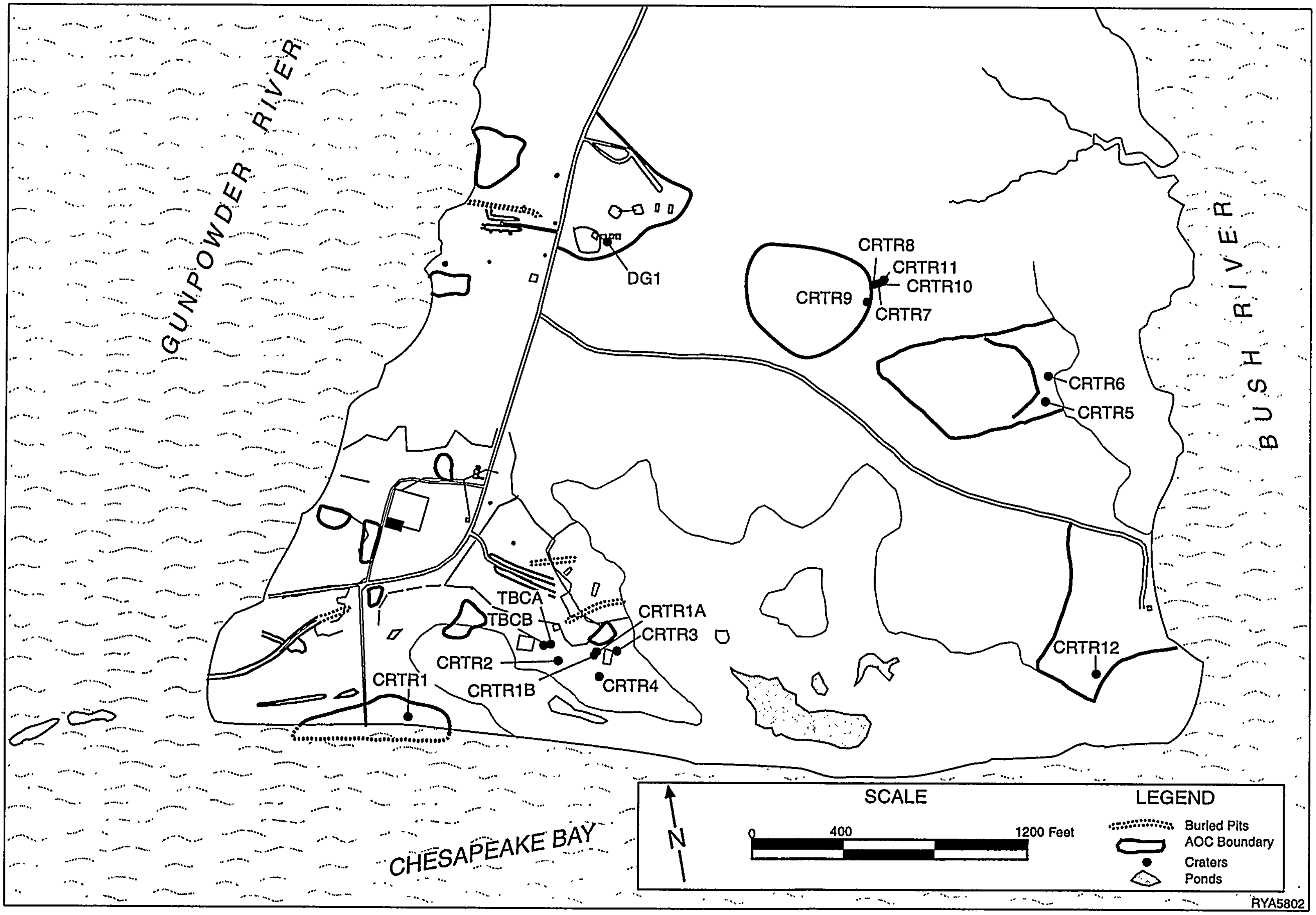

FIGURE A.15-1 Locations of Craters Sampled at J-Field

TABLE A.15-1 Analytical Results for Selected Metals in Sediment Samples Collected from Various Craters at J-Field: 1995[a]

	Concentration (mg/kg) by Sample Location											
Parameter	DG1	CRTR1A	CRTR1B	CRTR1	CRTR2	CRTR3	CRTR3 dup (CRTR A)	CRTR4	CRTR5	CRTR5 dup (CRTR B)	Mean Background (mg/kg)[b]	Freshwater Marsh Background (mg/kg)[c]
Aluminum	4,740	NA	NA	4,550	9,750	10,600	11,600	11,100	6,380	5,850	12,000	27,040
Antimony	BQL	NA	NA	BQL	BQL	0.80	0.93	0.51	0.33	0.36	0.72	2.3
Arsenic	1.5	<10	*15*	0.55	4.1	4.3	3.4	2.4	2.0	2.3	2.4	7.6
Barium	30	84	84	30	44	62	72	85	41	40	81	160
Beryllium	0.27	NA	NA	0.18	0.39	0.54	0.60	0.60	0.34	0.33	1.5	3.7
Cadmium	0.38	<10	<10	0.88	1.0	1.4	1.7	1.3	1.7	1.3	1.3	5.0
Calcium	986	NA	NA	356	422	3,560	3,500	2,100	181	192	3,280	10,240
Chromium	8.0	31	28	8.0	14	13	15	15	9.6	8.2	29	44
Cobalt	2.7	NA	NA	2.4	3.1	5.2	5.7	5.8	3.3	2.6	13	33
Copper	8.0	19	<10	*86*	12	19	24	17	25	34	27	61
Iron	5,700	NA	NA	4,300	14,500	15,100	15,100	13,200	9,440	6,790	22,900	41,880
Lead	6.6	65	18	27	25	12	18	26	27	26	36	96
Magnesium	595	NA	NA	662	970	1,240	1,440	1,450	762	710	3,120	5,560
Manganese	42	NA	NA	37	40	86	94	68	37	35	442	672
Mercury	BQL	<10	<10	BQL	BQL	0.079	0.092	0.080	0.086	BQL	0.14	0.32
Nickel	4.9	26	18	5.8	7.7	9.5	12	11	7.1	4.8	36	98
Potassium	285	NA	NA	364	447	439	503	572	399	341	942	2,142
Selenium	BQL	<10	<10	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.36	0.84
Silver	BQL	<10	<10	BQL	BQL	BQL	*0.32*	BQL	*0.21*	*0.27*	0.070	0.19
Sodium	69	NA	NA	101	73	83	91	84	86	81	2,270	7,690
Thallium	BQL	NA	NA	BQL	BQL	BQL	BQL	BQL	BQL	BQL	NA	NA
Vanadium	12	73	60	11	20	21	25	25	13	11	39	76
Zinc	24	91	45	54	34	49	60	70	119	92	69	184

TABLE A.15-1 (Cont.)

	Concentration (mg/kg) by Sample Location										Freshwater
Metal	CRTR6	CRTR7	CRTR8	CRTR9	CRTR10	CRTR11	CRTR12	TBCA	TBCB	Mean Background (mg/kg)[b]	Marsh Background (mg/kg)[c]
Aluminum	8,110	858	3,620	12,000	4,040	8,910	8,780	13,500	12,000	12,000	27,040
Antimony	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.72	2.3
Arsenic	2.1	BQL	BQL	3.6	0.47	1.8	1.6	4.7	2.4	2.4	7.6
Barium	35	11	19	27	24	25	45	97	***239***	81	160
Beryllium	0.40	0.11	0.14	0.50	0.13	0.14	0.71	0.55	0.59	1.5	3.7
Cadmium	0.70	BQL	BQL	2.5	BQL	0.67	BQL	1.2	1.8	1.3	5.0
Calcium	208	194	48	148	67	44	465	525	6,990	3,280	10,240
Chromium	9.8	1.3	3.1	12	5.1	9.8	9.5	15	20	29	44
Cobalt	4.4	BQL	BQL	2.2	BQL	2.0	3.3	4.5	5.9	13	33
Copper	12	2.1	6.1	6.5	4.3	13	7.1	22	36	27	61
Iron	10,600	412	916	37,200	3,560	12,000	6,770	19,000	11,800	22,900	41,880
Lead	29	3.7	4.5	7.2	6.0	6.2	11	25	35	36	96
Magnesium	862	82	136	390	285	591	1,050	1,350	1,820	3,120	5,560
Manganese	40	11	5.0	20	11	20	60	49	95	442	672
Mercury	0.14	BQL	BQL	BQL	BQL	BQL	0.099	0.095	0.25	0.14	0.32
Nickel	7.7	BQL	BQL	4.7	BQL	3.9	9.0	9.7	14	36	98
Potassium	405	94	197	386	201	364	544	534	891	942	2,142
Selenium	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.36	0.84
Silver	***4.8***	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.070	0.19
Sodium	62	47	46	49	61	48	112	84	84	2,270	7,690
Thallium	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	NA	NA
Vanadium	16	1.0	4.4	21	8.6	17	16	21	21	39	76
Zinc	62	3.7	5.4	20	10	15	45	65	65	69	184

[a] Notation: BQL = below quantitation limit; NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Data from ICF Kaiser Engineers (1995). Background mean is the mean for sediment collected from freshwater ponds.

[c] Background values were derived from freshwater marsh sediment data in ICF Kaiser Engineers (1995).

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APPENDIX B:

SAMPLE LOG OF WASTE SENT TO J-FIELD

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Argonne National Laboratory (ANL) conducted a search of the archival records of the Historical Research and Response Team located in Building 5232, Edgewood Area, Aberdeen Proving Ground, Maryland. The records searched included:

- Organizational History Files of Edgewood Arsenal 1917–1942,
- Organizational History Files of Chemical Warfare Center 1942–1946, and
- Organizational History Files of the Technical Escort Unit (TEU) 1942 to 1985.

The Organizational History Files of the Edgewood Arsenal were reviewed because this organization existed at the beginning of the "timeline" of the military activities conducted in the Edgewood area. TEU Organizational History Files were reviewed for the timeline subsequent to the early 1940s to obtain a relatively complete assessment of J-Field activities. Organizational files of the TEU were relied on, more so than other files in the archives, because TEU has historically been, and continues to be, responsible for J-Field operations.

The Organizational History Files of Edgewood Arsenal 1917–1942 and Organizational History Files of the Chemical Warfare Center 1942–1946 did not provide any information regarding the types or quantities of materials handled at the J-Field site. The organizational files focused on production activities associated with the manufacture of military materiel in the Edgewood area; no mention was made of the J-Field site.

Records searched in the Organizational History Files of the TEU included files with the following titles spanning the years 1942–1985:

- Guard and Security History (former version of TEU),
- TEU History,
- General History,
- TEU Quarterly History Reports,
- TEU SOPs,

- Historical Reviews (Annual), and
- Tech Escort Photographs and Slides.

Files titled "Trip Reports" from the period 1942–1965 were also reviewed initially. However, these files were only reviewed in a cursory fashion since, in general, such files summarize the key incidents associated with off-site activities such as TEU activities at Rocky Mountain Arsenal, Colorado; Dugway Proving Ground, Utah; and Anniston Army Depot, Alabama.

In addition to the review of hard copy versions of texts, letters, reports, etc., ANL examined photographs and slides. The records examined in the file drawer titled "Tech Escort Photographs and Slides" included the following:

- Disposal Opns: J Field,
- E. 26 Rad Escort (historical),
- Rad Escort (historical),
- Maps of EA Fields,
- Toxic Pit, and
- J Field.

In many cases, it was difficult, if not impossible, to determine that the activities depicted in the photographs indeed occurred somewhere at the J-Field site. In some cases, however, knowledge of the terrain and site history allowed the investigators to substantiate that the activities depicted did occur within the J-Field site. In general, the photographs did not contribute to an understanding of the types and quantities of materials handled at J-Field. The photographs did serve to corroborate the generally understood modus operandi at the site, that is, the destruction and disposal of bulk toxic agents and/or toxic materials, chemical munitions, explosive components, and propellants by demolition, burning, and venting.

One of the earliest references to the J-Field site is included in a document on the early history of the TEU:

> During the period covered by this report, Technical Escort Detachment personnel conducted many operations at Army Chemical Center, Maryland. These included clearance of "O" field, burning pits and area and the demilitarization and salvage

operations at "J" Field. (History of the Technical Escort Detachment, Army Chemical Center [1 January 1951–30 June 1951]).

The information available in the TEU Organizational History Files is scant. Annual and quarterly historical reports are not available for the entire period covered by the files. For example, there was no information in the TEU files on the construction specifications for the various burning pits at the J-Field site. The collection of quarterly and annual reports leaves gaps in the timeline. In addition, the level of detail within the historical reports that are present varies considerably. In some cases, the historical reports provided a detailed description of the type and quantities of materials disposed of at the J-Field site (see Table B.1 for a sample for 1953). However, in some cases, only generalized summary information is available:

1. This unit's three operational fields are constantly engaged in the destruction, disposal, burning, detonation, demilitarization and decontamination of toxic agents, toxic materials, toxic laboratory samples, contaminated items, Chemical Corps munitions and related items.

2. The following data represents the total weight of materials handled and man hour expended in operation in the three fields during the reporting period.

Month	Weight (tons)	Man Hours
January	31.73	3,626
February	37.43	3,173
March	41.24	3,497

(Third Quarter FY 1960 Quarterly Historical Report, U.S. Army Chemical Corps, Technical Escort Unit (1502), Army Chemical Center, Maryland).

As a result of the incomplete nature of the records contained in the files of the Historical Records and Response Team, it is not possible to ascertain, with any certainty, the type and quantity of materials disposed of at the J-Field site. However, by reviewing the sample provided in Table B.1, one can infer that, in general, the J-Field site was used for the disposal of a wide variety of primarily ordnance-related materials, including fuses, grenades, bombs, bursters, rockets, mortar rounds, artillery rounds, explosives, and chemical warfare agent.

TABLE B.1 Sample Log of Waste Sent to J-Field: 1953

Time	Item	Type	Content	Destruction Process	Quantity
12/31/51	Booster for fuse	M146	Tetryl		617
12/31/51	Fuse	M147		Disassembly	500
12/31/51	Fuse	M146		Disassembly	617
12/31/51	Fuse	M173		Disassembly	20
12/31/51	Fuse	4.2	Chemical mortar	Disassembly	700
12/31/51	Fuse	M201			4,620
12/31/51	Grenade (rifle)		HC smoke	Disassembly	2,396
12/31/51	Scrap iron			Salvage	98,870
12/31/51	Shell	57-mm	WP	Salvage WP and metal body	1,980
12/31/51	Tube burster for fuse	M147	Tetryl	Burning	40
1/1/52	Black powder		Black powder	Burning	800
1/1/52	Bomb	T3	Nerve gas	Burning	5
1/1/52	Bomb	E54	Nerve gas	Burning	22
1/1/52	Bomb, 500-lb each		AC	Detonation	2
1/1/52	Bomb, 500-lb each		CK	Detonation	2
1/1/52	Booster cup from fuse	PD M51A4		Detonation	324
1/1/52	Brass			Salvage	7,500
1/1/52	Burster	M12 type B		Detonation and burning	800
1/1/52	Cylinder		Nerve gas	Burning	8
1/1/52	Explosive		TNT, tetryl, lead azide	Detonation	30
1/1/52	Fuse	M84 M65A1	Tetryl	Detonation	
1/1/52	Fuse	M84, M65, M52	Explosive	Detonation	
1/1/52	Rocket, Navy, 5-ft Fused	MK 10 model 0	PWP	Detonation	2
1/1/52	Scrap iron			Salvage	11,900
1/1/52	Shell	105-mm	HD		2
1/1/52	Shell	4.2	CG		2
1/1/52	Shell	4.2	FS		2
1/1/52	Shell, chemical mortar, fused	4.2	CG and FS	Detonation	2
1/1/52	Shell, complete round w/fuse	4.2	Chemical mortar	Detonation	
1/1/52	Shell, fused	4.2	Chemical mortar		1

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
1/1/52	Tube burster	M8		Burning	800
2/1/52	Ammunition, rounds	30- & 50-caliber		Disassembly	1,000
2/1/52	Black powder		Black powder	Burning	150
2/1/52	Bomb, linear shape charge	M47A2	PWP	Detonation	85
2/1/52	Brass			Salvage	7,300
2/1/52	Cylinder		Carbon disulfide & chlorine	Venting	7
2/1/52	Cylinder (chemical)			Detonation, salvage metal	46
2/1/52	Cylinder (chemical), 100-lb			Disassembly and venting	34
2/1/52	Fuse (super quick)	M54		Disassembly	230
2/1/52	Fuse	M48A3		Disassembly	106
2/1/52	Grenade (rifle)	M19	WP	Disassembly	20
2/1/52	High-grade die-cast metal		Zinc		21,850
2/1/52	Mixed scrap				72,700
2/1/52	Nickel cylinder, special type		HCN	Venting	
2/1/52	Rocket A.T.	2.36 practice		Disassembly	1
2/1/52	Scrap iron				36,500
2/1/52	Scrap steel				101,200
2/1/52	Shell (illuminating)	81-mm		Disassembly	135
2/1/52	Shell (illuminating)	60-mm		Disassembly	20
2/1/52	Tank			Detonation and burning	7
3/1/52	Aluminum			Salvage	1,500
3/1/52	Fuse (time and super quick)	E39		Disassembly	17
3/1/52	Iron, unprepared			Salvage	4,500
3/1/52	Iron, unprepared			Salvage	7,250
3/1/52	Iron, unprepared			Salvage	4,400
3/1/52	Iron, unprepared			Salvage	2,800
3/1/52	Iron, unprepared			Salvage	5,200
3/1/52	Iron, unprepared			Salvage	17,000
3/1/52	Iron, unprepared			Salvage	26,150
3/1/52	Scrap aluminum			Salvage	2,000
	Scrap aluminum			Salvage	5,250
3/1/52					
3/1/52	Scrap iron			Salvage	7,300

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
3/1/52	Scrap steel			Salvage	2,300
3/1/52	Shell, chemical mortar w/fuse	4.2			8
3/1/52	Steel, unprepared			Salvage	18,100
6/30/52	Aluminum			Salvage	4,500
6/30/52	Bomb	M70	Nerve gas		5
6/30/52	Bomb	E54	Nerve gas		4
6/30/52	Bomb (German)	250-kg	Nerve gas		1
6/30/52	Burster	M13	WP		1,100
6/30/52	Detonator			Mixed	80
6/30/52	Grenade	M15	WP		1
6/30/52	Grenade, rifle	M19	WP		2
6/30/52	Howitzer			Burning, decontamination	
6/30/52	Igniter w/fuse and burster	M13	WP		63
6/30/52	Scrap iron			Salvage	10,840
6/30/52	Scrap iron			Salvage	17,150
6/30/52	Shell	4.2	Nerve gas		17
6/30/52	Shell	105-mm	Nerve gas		13
6/30/52	Shell	4.2	Unknown		1
6/30/52	Shell	81-mm	WP		7
6/30/52	Shell	81-mm	Unknown		1
6/30/52	Shell, German	10.5-cm	Nerve gas		1
6/30/52	Sodium igniter w/fuse and burster	M14			100
7/9/52	Burster from fuse	M147			961
7/9/52	Burster, mixed				24
7/9/52	Burster, obsolete and deteriorated				1,267
7/9/52	Fuse	M84		Disassembly	284
7/9/52	Fuse	M54		Disassembly	1,867

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/9/52	Fuse w/booster	M54			64
7/9/52	Grenade	M19	HE		5
7/9/52	Primer, percussion mixed				65
7/9/52	PWP barrel		PWP	Burning	44
7/9/52	Shell	60-mm	WP		2
7/9/52	Shell	81-mm	WP		1
7/9/52	Shell	105-mm	WP		1
7/9/52	Shell	57-mm	WP		1
7/9/52	Shell (illuminating)	81-mm			1
7/9/52	Shell, unknown w/fuse and burster	4.2	WP		7
7/9/52	Shell w/burster	75-mm			2
7/9/52	Shell w/burster	105-mm			6
7/9/52	Shell w/fuse	81-mm			4
7/9/52	Shell w/fuse	60-mm			1
7/9/52	Shell w/fuse and burster	57-mm			4
7/9/52	Shell w/fuse and burster	75-mm	WP		6
7/9/52	TNT		TNT		25
10/6/52	Ballistute (stick)				90
10/6/52	Black powder		Black powder		11,200
10/6/52	Bomb	M70	H gas		1
10/6/52	Bomb	M74			28
10/6/52	Bomb	E54R1			21
10/6/52	Bomb (German)		Chemicals		7
10/6/52	Bomb (Japanese)		Incendiary		4
10/6/52	Bomb (Japanese)		Chemicals		7
10/6/52	Bomb (Japanese)				1
10/6/52	Bomb (Japanese), 250-lb		Chemicals & HE	Disassembly	1
10/6/52	Bomb tail assembly, Japanese		Chemicals	Disassembly	
10/6/52	Bomb, 250-kg		Nerve gas		5
10/6/52	Bomb	M50 & M50X			772
10/6/52	Booster for RG				140
10/6/52	Burster	C8R1			19
10/6/52	Burster		Tetryl		600

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
10/6/52	Burster	M14			40
10/6/52	Burster	M-4A1			20
10/6/52	Burster	MK4B			2
10/6/52	Burster				30
10/6/52	Cartridge grenade launcher				3,800
10/6/52	CN smoke pots		CN		70
10/6/52	Container				2
10/6/52	Copper			Salvage	1,000
10/6/52	Cylinder		CNS		1
10/6/52	Detonator	M15			300
10/6/52	Detonator	M15	Lead inserts		300
10/6/52	Floating smoke pot	M4A2		Disassembly	23
10/6/52	Fuse and burster assembly				48
10/6/52	Fuse	M1		Disassembly	26,315
10/6/52	Fuse	M173		Disassembly	3
10/6/52	Fuse	M156		Disassembly	3,507
10/6/52	Fuse	M174		Disassembly	1
10/6/52	Fuse	M2		Disassembly	1,000
10/6/52	Fuse	M201		Disassembly	36,555
10/6/52	Fuse	M3		Disassembly	50
10/6/52	Fuse	M103			6
10/6/52	Fuse	M9			15
10/6/52	Fuse	M1			23,000
10/6/52	Fuse	M503A1			30
10/6/52	Fuse	2.36	WP		9
10/6/52	Fuse w/Tetrze cap	4.2			3,100
10/6/52	Grenade (rifle)	M19	Chemicals		11
10/6/52	Grenade (rifle)	M19	WP	Disassembly	1,344
10/6/52	Grenade (rifle)	M19			993
10/6/52	Grenade head (rifle)		WP		274
10/6/52	Grenade head (rifle)		WP (colored)		4,500
10/6/52	Grenade	M19			20
10/6/52	H gas, 50-gal drum		H gas		1

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
10/6/52	Igniter	M13	WP		1,600
10/6/52	Igniter	M13 & M14			2,250
10/6/52	Igniter	MK9			30
10/6/52	Igniter and 100-lb bomb	AWM9	WP		3,500
10/6/52	Ignition cartridge				60
10/6/52	Linen projector				1
10/6/52	Magnesium thermite section			Disassembly	8,485
10/6/52	Metal drum			Salvage	3,200
10/6/52	Mixed burster, booster detonator				2,100
10/6/52	Can		Mustard gas		12
10/6/52	Picric acid		Picric acid		8
10/6/52	Primer				70
10/6/52	Scrap iron			Salvage	8,900
10/6/52	Scrap Iron			Salvage	186,404
10/6/52	Shell	75-mm	Chemicals		30
10/6/52	Shell	57-mm	Chemicals		5
10/6/52	Shell	60-mm	Chemicals		31
10/6/52	Shell	81-mm	Chemicals		14
10/6/52	Shell	105-mm	Chemicals		11
10/6/52	Shell	2.36	Chemicals		4
10/6/52	Shell	4.2	Chemicals		25
10/6/52	Shell	57-mm	WP		8
10/6/52	Shell	105-mm	WP		1
10/6/52	Shell	4.2	Mustard gas		11
10/6/52	Shell	81-mm	Illuminating		1
10/6/52	Shell	75-mm			4
10/6/52	Shell	4.2-mm			4
10/6/52	Shell	105-mm			1
10/6/52	Shell	4.2-mm	Phosgene		2
10/6/52	Shell	4.2-mm	Nerve gas		50
10/6/52	Shell	4.2-mm	CG		2
10/6/52	Shell	60-mm	I11 shell filling		130
10/6/52	Shell		I11 shell filling		270

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
10/6/52	Shell	15-mm	Nerve gas		11
10/6/52	Shell	10.5-cm	Nerve gas		122
10/6/52	Shell	105-mm			3
10/6/52	Shell	4.2			1
10/6/52	Shell (German)	10-cm	Smoke		3
10/6/52	Shell, (German)	15-cm	Chemicals	Disassembly	1
10/6/52	Tail section	81-mm shell		Disassembly	4,525
10/6/52	Zinc			Salvage	4,200
10/6/52		W1A1	Mustard gas		7
1/9/53	Bomb	E54R6	Nerve gas	Burning	1
1/9/53	Bomb	M74	Incendiary	Burning	11
1/9/53	Bomb	M69		Explosives removed	69
1/9/53	Burster	T-2		Detonation	750
1/9/53	Burster from Japanese munitions			Detonation	3
1/9/53	Container (2-qt)		Nerve gas	Burning	38
1/9/53	Cylinder		PS	Venting	8
1/9/53	Detonator for rocket	2.36		Detonation	37,900
1/9/53	Fuse	M201		Detonation	140,835
1/9/53	Fuse	T-119E		Detonation	48
1/9/53	Fuse	M54		Detonation	17
1/9/53	Fuse	M6A4		Detonation	1,350
1/9/53	Fuse	T-119E		Disassembly, metal salvage, and explosives destruction	4,950
1/9/53	Fuse	M1	Explosives	Disassembly, metal salvage, and explosives destruction	28,100
1/9/53	Fuse	M84	Explosives	Disassembly, metal salvage, and explosives destruction	72
1/9/53	Fuse	PD-E4R2	Explosives	Disassembly, metal salvage, and explosives destruction	100
1/9/53	Fuse	M3	Burster	Burster removed	343
1/9/53	Fuse	E40-1-RS	Burster	Burster removed	150
1/9/53	Fuse	M54	Explosives	Disassembly, metal salvage, and explosives destruction	3,035

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
1/9/53	Fuse	E-24		Demilitarization by disassembly for Rand E Command	50
1/9/53	Fuse	M82		Disassembly	24
1/9/53	Grenade (rifle)	M19	WP	Detonation	974
1/9/53	Grenade (rifle)	M19		Detonation	19,300
1/9/53	Grenade (rifle)		WP	Disassembly and salvage	23,333
1/9/53	Grenade	AN M8	HC	Burning	2,285
1/9/53	Grenade	M6	CN-DM	Burning	924
1/9/53	Grenade		Colored smoke	Burning	1,840
1/9/53	Grenade	M14	Thermic	Demilitarization for Rand E Command	51
1/9/53	Ignitor	M2		Burning	6,000
1/9/53	Ignitor	MK-9		Burning	5,150
1/9/53	Mixed: slider, booster, burster			Detonation	1,400
1/9/53	Mortar tail section	81-mm		Removal of ignition cartridges	2,986
1/9/53	Nitro-cellulose		Nitro-cellulose	Detonation	300
1/9/53	Pellet		Tetryl	Detonation	115
1/9/53	Primer	M38		Detonation	2,400
1/9/53	Rocket head	2.36	WP	Salvage WP	1,248
1/9/53	Shell	155-mm	WP	Detonation	1
1/9/53	Shell	105-mm, 155-mm, 90-mm	Rotating bands removed	Salvage metal	206
1/9/53	Shell	105-mm	WP	Removal of explosives	1
1/9/53	Shell	155-mm	H	Burning	15
1/9/53	Shell	4.2	Nerve gas	Burning	382
1/9/53	Shell	155-mm	Colored smoke	Burning	82
1/9/53	Shell	75-mm	H	Burning	782
1/9/53	Shell	60-mm	WP	Detonation	19
1/9/53	Shell	4.2	WP	Detonation	3
1/9/53	Shell	57-mm	WP	Haul to WP plant for reclamation of WP, metal salvage	12,426
1/9/53	Shell	155-mm	WP	Haul to WP plant for reclamation of WP, metal salvage	144

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
1/9/53	Shell	105-mm	WP	Haul to WP plant for reclamation of WP, metal salvage	145
1/9/53	Shell	57-mm	WP	Removal of explosives	18
1/9/53	Shell	81-mm	WP	Removal of explosives	
1/9/53	Shell	105-mm		Shell previously decontaminated	13
1/9/53	Smoke pot	M4A2 & M5	Smoke	Burning	890
4/6/53	Ammunition - complete rounds	75-mm, 76-mm, 105-mm, 90-mm		Disassembly	109
4/6/53	Ammunition (rifle rounds)	57-mm	WP	Detonation	17
4/6/53	Black powder		Black powder	Burning	40
4/6/53	Bomb, 500-lb		Inert	Opening by means of explosives	46
4/6/53	Bomb	ANM50 X		Burning	90
4/6/53	Bomb		HT	Burning	26
4/6/53	Bomb	M74	Inert	Opening by explosives	15
4/6/53	Bomb	M74	Inert	Opening, emptying, metal salvaging	501
4/6/53	Bomb, 500-lb		Simulant	Opened by explosives	28
4/6/53	Booster, lead, and slider		Tetryl	Detonation	60
4/6/53	Burster		WP	Burning	43
4/6/53	Burster		Tetryl	Detonation	1,295
4/6/53	Burster for shell	60-mm		Detonation	91
4/6/53	Casing	57-mm		Disassembly	10
4/6/53	Casing	105-mm		Disassembly	1
4/6/53	Casing	90-mm		Disassembly	7
4/6/53	Casing	105-mm		Disassembly	2
4/6/53	Cylinder		H	Burning	2
4/6/53	Cylinder - commercial type		PS	Agent transferred to portable cylinder	22
4/6/53	Cylinder - commercial type			Venting	3
4/6/53	Cylinder - commercial type		SO_2	Venting	9
4/6/53	Cylinder, 100-lb		SO_2	Venting	30
4/6/53	Delay elements for fuse	M48		Detonation	110
4/6/53	Detonator			Detonation	88,450
4/6/53	Drum	55-gal	Contaminated waste	Burning	8

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
4/6/53	Experimental		Incendiaries	Detonation	2
4/6/53	Experimental bomb	10-lb		Detonation	1
4/6/53	Filter		air	Burning	5
4/6/53	Fuse	T-119E		Burning	391
4/6/53	Fuse	M503		Detonation	27
4/6/53	Fuse	4.2		Detonation	2
4/6/53	Fuse	M154		Detonation	185
4/6/53	Fuse	T-119E		Detonation	3,000
4/6/53	Fuse	M2		Detonation	17
4/6/53	Fuse	E42R1		Detonation	12
4/6/53	Fuse	M50		Detonation	24
4/6/53	Fuse	T119E		Detonation	1
4/6/53	Fuse	M48		Detonation	1
4/6/53	Fuse	M62		Detonation	24
4/6/53	Fuse	M84		Detonation	9
4/6/53	Fuse	E-24		Detonation	13
4/6/53	Fuse	T-119E		Disassembly	600
4/6/53	Fuse	M201		Disassembly	1,300
4/6/53	Fuse	T-173		Disassembly	150
4/6/53	Fuse	M51A1		Disassembly	625
4/6/53	Fuse	M54A4		Disassembly	177
4/6/53	Fuse	M2		Disassembly	2,320
4/6/53	Fuse	M82		Disassembly	350
4/6/53	Fuse	M503		Disassembly	75
4/6/53	Fuse	M110		Disassembly	1
4/6/53	Fuse	M126		Disassembly	1
4/6/53	Fuse	M146		Disassembly	7
4/6/53	Fuse	M174		Disassembly	143
4/6/53	Fuse	4.2-in.		Disassembly	30
4/6/53	Fuse	4.2-in. E41R2		Disassembly	483
4/6/53	Fuse	T-38		Disassembly	170
4/6/53	Fuse	M52		Disassembly	82
4/6/53	Fuse	M51A3		Disassembly	90

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
4/6/53	Fuse	E-41R2		Disassembly	120
4/6/53	Fuse	E-24		Disassembly	297
4/6/53	Fuse	M84		Disassembly	65
4/6/53	Fuse	M3		Disassembly	4
4/6/53	Fuse	M50A3		Disassembly	16
4/6/53	Fuse	M82A1		Disassembly	31
4/6/53	Fuse	T-36		Disassembly	186
4/6/53	Fuse	M1		Disassembly	4
4/6/53	Fuse	M108		Disassembly	2
4/6/53	Fuse	M48		Disassembly	180
4/6/53	Fuse	M56A1		Disassembly	1
4/6/53	Fuse	M86		Disassembly	6
4/6/53	Fuse	M54		Disassembly	277
4/6/53	Fuse	M51A4		Disassembly	110
4/6/53	Fuse	M154		Disassembly	3,282
4/6/53	Fuse	M54A1		Disassembly	110
4/6/53	Fuse - arming devices	E-24		Detonation	210
4/6/53	Fuse removed from shell		Inert		119
4/6/53	Grenade		CN	Burning	40
4/6/53	Grenade (rifle)	M19	WP	Burning	40
4/6/53	Grenade	M7	CN	Burning	3,202
4/6/53	Grenade		Colored smoke	Burning	15,100
4/6/53	Grenade		CN, DM	Burning	450
4/6/53	Heads rocket motors and burster	2.36-in.	Inert		344
4/6/53	Pellet		Tetryl	Detonation	222
4/6/53	Pellet		Tetryl	Detonation	40,000
4/6/53	Pellet		Tetryl	Detonation	101
4/6/53	Percussion primer			Disassembly and detonation	108
4/6/53	Percussion primer			Detonation	22,500
4/6/53	Primer			Removal from artillery casing	35
4/6/53	Primer ignition shell	81-mm		Detonation	111
4/6/53	Primer removed from artillery casing			Detonation	41
4/6/53	Recoiless casing	75-mm		Disassembly	1

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
4/6/53	Recoiless casing	105-mm		Disassembly	4
4/6/53	Recoiless rifle	57-mm	WP	Detonation	5
4/6/53	Recoiless round	57-mm		Disassembly	20
4/6/53	Rocket	4.5	HN	Burning	1
4/6/53	Rocket head	2.75-in.	FS	Detonation	1
4/6/53	Rocket head	3.5	H	Burning	12
4/6/53	Rocket head	4.5	Nerve gas	Burning	92
4/6/53	Rocket	2.36-in.	WP	Removal of head from motors	345
4/6/53	Rotating band	90-mm, 105-mm	Inert		50
4/6/53	Shell	4.2	Nerve gas	Burning	5
4/6/53	Shell	105-mm		Burning	1
4/6/53	Shell			Burning	231
4/6/53	Shell	4.2	CG	Detonation	15
4/6/53	Shell	4.2		Detonation	39
4/6/53	Shell	155-mm		Detonation	2
4/6/53	Shell	105-mm		Detonation	1
4/6/53	Shell		WP	Detonation	257
4/6/53	Shell	57-mm	WP	Detonation	4
4/6/53	Shell	60-mm	WP	Detonation	9
4/6/53	Shell	105-mm	WP	Detonation	1
4/6/53	Shell	60-mm	WP	Disassembly	178
4/6/53	Shell	75-mm		Removal of rotating bands	15
4/6/53	Shell	105-mm		Removal of rotating bands	13
4/6/53	Shell	76-mm		Removal of rotating bands	8
4/6/53	Shell, illuminating	81-mm		Disassembly	21
4/6/53	Slider			Detonation	50
4/6/53	Slider			Detonation	650
4/6/53	Slider fuse	4.2-in.		Disassembly	1,775
4/6/53	Tail fin	81-mm		Disassembly	3,131
4/6/53		A1C13		Hydrolysis	650
7/8/53	Black powder		Black powder	Burning	3,800
7/8/53	Bomb	1,000-lb		Detonation	1
7/8/53	Bomb, 500-lb		PT-1	Burning	1

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/8/53	Bomb	M69	H	Burning	80
7/8/53	Bomb	M69	NP	Burning	10
7/8/53	Bomb	E22	G	Burning	2
7/8/53	Bomb	E54	G	Burning	37
7/8/53	Bomb	T-3		Burning	10
7/8/53	Bomb	E50		Burning	200
7/8/53	Bomb, 500-lb		CK	Detonation	2
7/8/53	Bomb, vented	M78	CK		4
7/8/53	Bomb, 500-lb		CG	Detonation	3
7/8/53	Bomb, 500-lb		PT-1	Detonation	33
7/8/53	Bomb, 500-lb			Detonation	3
7/8/53	Bomb, 500-lb		CK	Burning	3
7/8/53	Booster	T119E1	Tetryl	Detonation	4,500
7/8/53	Burster	90-mm		Detonation	12
7/8/53	Burster	155-mm		Detonation	288
7/8/53	Burster	105-mm		Detonation	87
7/8/53	Burster			Detonation	3
7/8/53	Clusters (38 bombs/cluster)			Burning	6
7/8/53	Container (ton)	Type E		Burning, opening by explosives	2
7/8/53	Cylinder of Diborene			Burning	5
7/8/53	Detonator	T119E1		Detonation	3.6
7/8/53	Drum		G gas	Burning	6
7/8/53	Drum		H	Burning	11
7/8/53	Flare - aircraft	MK		Burning	420
7/8/53	Fuse	T119E1		Detonation	997
7/8/53	Fuse	E25R5		Detonation	17
7/8/53	Fuse	M83		Detonation	7
7/8/53	Fuse	M2		Detonation	17
7/8/53	Fuse	M26		Detonation	9
7/8/53	Fuse	M54		Detonation	32
7/8/53	Can (40-gal)		G-contaminated waste	Burning	4
7/8/53	Bottle		G		4
7/8/53	Shell	4.2-in.	G	Burning	57

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/8/53	Grenade	AN-M14	Incendiary	Burning	6,152
7/8/53	Grenade	M6	CN, DM	Burning	57,042
7/8/53	Bottle		H		4
7/8/53	Illuminating shell	81-mm M301A1		Detonation	1
7/8/53	Illuminating canister	M316		Detonation	7
7/8/53	Illuminating shell	60-mm		Detonation	14
7/8/53	Magnesium section	4.2-in.		Detonation	623
7/8/53	Mixed booster			Detonation	500
7/8/53	Mixed detonator			Detonation	200
7/8/53	Mixed lead			Detonation	300
7/8/53	Mortar shell	4.2		Detonation	1
7/8/53	Mortar shell	60-mm		Burning	30
7/8/53	Mortar shell	88-mm	WP	Detonation	9
7/8/53	Nitro-cellulose			Detonation	1/2
7/8/53	Primer cord			Detonation	2
7/8/53	Primer			Detonation	15
7/8/53	Rocket head Mark-IV	5-in.		Detonation	1
7/8/53	Rocket head		H	Burning	30
7/8/53	Rocket	4.2-in.	G	Burning	5
7/8/53	Rotating band on shell, cut	75-mm	H		935
7/8/53	Shell	155-mm		Burning	1
7/8/53	Shell	105-mm	H	Burning	5
7/8/53	Shell	4.2-in.	H	Burning	1
7/8/53	Shell	57-mm	H	Burning	90
7/8/53	Shell		WP	Burning	1,057
7/8/53	Shell	4.2-in.	WP	Detonation	36
7/8/53	Shell	155-mm	G	Burning	18
7/8/53	Shell	75-mm		Burning	297
7/8/53	Shell	57-mm	G	Burning	5
7/8/53	Shell	105-mm	G	Burning	10
7/8/53	Shell	155-mm	G	Burning	9
7/8/53	Shell	105-mm	WP	Burning	2
7/8/53	Shell	4.2	WP	Detonation	71

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/8/53	Shell	155-mm	WP	Detonation	7
7/8/53	Shell	105-mm	WP	Detonation	9
7/8/53	Shell	4.2-in.	Sand	Detonation	35
7/8/53	Shell	76-mm		Detonation	15
7/8/53	Shell	90-mm		Detonation	20
7/8/53	Shell	57-mm		Detonation	122
7/8/53	Shell - inert	155-mm		Burning	26
7/8/53	Shell - inert	105-mm		Burning	5
7/8/53	Slider and misc			Detonation	100
7/8/53	Smoke pots	M1		Burning	1,892
7/8/53	Squib			Detonation	1
7/8/53	Tetryl		Tetryl	Detonation	800
1/6/54	Ballastite			Burning	300
1/6/54	Ballastite			Burning	400
1/6/54	Ballastite			Burning	651
1/6/54	Black powder			Burning	100
1/6/54	Bomb	T3	H	Burning	6
1/6/54	Bomb	250-kg	GB	Burning	1
1/6/54	Bomb	250-kg	G	Burning	1
1/6/54	Bomb	M50	Incendiary	Burning	20
1/6/54	Bomb	M50	Incendiary	Burning	150
1/6/54	Bomb	T3	H	Burning	4
1/6/54	Bomb	M47	WP	Burning	24
1/6/54	Bomb	M47		Burning	26
1/6/54	Bomb	M50x		Burning	300
1/6/54	Booster		Tetryl	Burning	100
1/6/54	Booster		Tetryl	Burning	30
1/6/54	Burster	T47		Detonation	2
1/6/54	Burster	57-mm		Detonation	2
1/6/54	Burster	M12		Detonation	4
1/6/54	Burster	M10		Burning	2
1/6/54	Burster	105-mm	Tetryl	Detonation	500
1/6/54	Burster		Tetryl	Detonation	500

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
1/6/54	Burster		Tetryl	Detonation	930
1/6/54	Cluster	E101		Burning	1
1/6/54	Cluster	E101	G	Burning	1
1/6/54	Container		HCN	Burning	85
1/6/54	Container (ton)	Type D		Burning	3
1/6/54	Cylinder		H	Burning	8
1/6/54	Cylinder			Detonation	6
1/6/54	Cylinder			Detonation	6
1/6/54	Detonator			Detonation	120
1/6/54	Drum		H residue	Burning	6
1/6/54	Drum	55-gal		Burning	13
1/6/54	Drum		H residue	Burning	4
1/6/54	Drum		H residue	Burning	3
1/6/54	Drum		G sludge	Burning	12
1/6/54	Drum		H sludge	Burning	11
1/6/54	Drum		H sludge residue	Burning	11
1/6/54	Fins, tail for mortar	81-mm		Disassembly	100
1/6/54	Fuse slider	M52, M58		Burning	95
1/6/54	Fuse	M82		Detonation	37
1/6/54	Fuse	M82		Detonation	3
1/6/54	Fuse	M54		Detonation	2
1/6/54	Fuse	M48		Disassembly	25
1/6/54	Fuse	E24R1		Disassembly	51
1/6/54	Fuse	M108		Disassembly	9
1/6/54	Fuse	PD M52		Disassembly	100
1/6/54	Fuse	M58		Disassembly	63
1/6/54	Fuse	M84		Disassembly	4
1/6/54	Fuse	M52		Disassembly	21
1/6/54	Fuse	M43		Disassembly	19
1/6/54	Fuse, booster head	M52		Detonation	3,500
1/6/54	Fuse components			Disassembly	9
1/6/54	Grenade		CN	Burning	15
1/6/54	Grenade	M47	CN	Burning	900

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
1/6/54	Ignition cartridges			Burning	25,000
1/6/54	Initiators booster			Burning	36
1/6/54	Insect repellant (gal)			Burning	8
1/6/54	Mortar	60-mm	WP	Detonation	15
1/6/54	Mortar rounds		WP	Burning	50
1/6/54	Percission primer			Burning	32,000
1/6/54	Primer	M32		Disassembly	2,291
1/6/54	Primer	M58		Disassembly	37
1/6/54	Primer	M49		Disassembly	1
1/6/54	Primer	M6		Disassembly	4
1/6/54	PTEN			Detonation	30
1/6/54	Rocket motor	4.5-in.		Disassembly	58
1/6/54	Sets gas identification			Burning	2
1/6/54	Shell	60-mm	WP	Burning	53
1/6/54	Shell	4.2-in.	FS	Detonation	6
1/6/54	Shell	57-mm		Detonation	3
1/6/54	Shell	4.2-in.	GG	Detonation	2
1/6/54	Shell complete	4.2-in.		Detonation	2
1/6/54	Shell dud rounds	57-mm		Detonation	17
1/6/54	Shell dud rounds	57-mm		Detonation	17
1/6/54	Slider (various)			Detonation	50
1/6/54	Slider for fuse	E24R1		Disassembly	8
1/6/54	Slider, various types			Disassembly	30
1/6/54	Smoke pot			Burning	13
1/6/54	Smoke shell	55-mm		Detonation	2
1/6/54	Tail assembly			Burning	380
1/6/54	Tail fin			Burning	1,000
1/6/54	Tetryl		Tetryl		10
1/8/54	Ammunition, round	E-54	CG	Burning	3
1/8/54	Ammunition, round	E-91	GB	Burning	5
1/8/54	Ammunition, round	4.2-in.	GB	Burning	2
1/8/54	Ammunition, round	4.2-in.	HD	Burning	11
1/8/54	Bomb	M47		Burning	3,057

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
1/8/54	Bomb	ANM 50X		Burning	28
1/8/54	Bomb	ANM 50		Burning	1,704
1/8/54	Bomb	500-lb		Burning	10
1/8/54	Bomb	T-3	H	Burning	63
1/8/54	Bomb		Incendiary	Burning	2,050
1/8/54	Bomb	M50	Incendiary	Detonation	77
1/8/54	Bomb	M76	Sand	Detonation	9
1/8/54	Bomb	M74		Detonation	3
1/8/54	Bomb	M50		Detonation	88
1/8/54	Bomb	M501		Detonation	31
1/8/54	Bomb	M47		Demill by disassembly	3
1/8/54	Bomb, inerted	M2		Disassembly	41
1/8/54	Bomb, with fuse	M69		Burning	1,414
1/8/54	Bomb, 500-lb			Detonation	10
1/8/54	Booster for fuse	VT		Detonation	180
1/8/54	Booster for fuse	M3		Detonation	94
1/8/54	Burster rifle grenade	M1941		Burning	44,800
1/8/54	Burster	M14	Tetryl	Burning	42
1/8/54	Burster	E12R1		Burning	5,872
1/8/54	Burster	M6		Detonation	100
1/8/54	Burster for fuse	M2		Detonation	392
1/8/54	Burster rifle grenade	M19A1		Detonation	9,600
1/8/54	Cluster	M12		Burning	1
1/8/54	Cluster	AN-M12	Incendiary	Disassembly	8
1/8/54	Cylinder		CG	Detonation	1
1/8/54	Cylinder		CG	Detonation	8
1/8/54	Drum	55-gal	G residue	Burning	8
1/8/54	Fin assembly with primer and cartridge	60-mm		Disassembly	13,600
1/8/54	Fin assembly with primer and cartridge	M4A1		Disassembly	16,800
1/8/54	Fin assembly with primer and cartridge	ML/A1		Disassembly	760
1/8/54	Fuse	M101		Detonation	1
1/8/54	Fuse-igniting hand grenade			Burning	100
1/8/54	Fuse, inerted	M173		Disassembly	2

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
1/8/54	Fuse, inerted	M157		Disassembly	2
1/8/54	Fuse	M52		Burning	62
1/8/54	Fuse	M48		Burning	4
1/8/54	Fuse	M1		Burning	300
1/8/54	Fuse	M503A1		Detonation	592
1/8/54	Fuse	M2		Detonation	28
1/8/54	Fuse	M54		Detonation	11
1/8/54	Fuse	M1		Detonation	6
1/8/54	Fuse	M52		Detonation	27
1/8/54	Fuse	M10A2		Detonation	196
1/8/54	Fuse	M503A1		Detonation	1,692
1/8/54	Fuse	M1		Disassembly	40,885
1/8/54	Fuse	M110		Disassembly	795
1/8/54	Fuse	M207		Disassembly	8,000
1/8/54	Fuse, various types			Detonation	400
1/8/54	Grenade		WP	Detonation	2
1/8/54	Grenade	T-329	WP	Detonation	1
1/8/54	Grenade	M19	WP	Detonation	7,300
1/8/54	Grenade (rifle)	M19A1		Detonation	4,000
1/8/54	Grenade	T-36	WP	Detonation	1
1/8/54	Grenade		WP	Detonation	2
1/8/54	Ignitor	M2		Burning	50
1/8/54	Ignitor		WP	Detonation	5
1/8/54	Ignitor, grenade			Detonation	4,400
1/8/54	Liquid,-gal		GB	Burning	2
1/8/54	PWP			Burning	2,000
1/8/54	Primer	M52		Disassembly	23
1/8/54	Rocket heads	4.2-in. ED		Burning	18
1/8/54	Rockets	4.5	HD	Burning	3
1/8/54	Rockets heads and tail fins, practice			Burning	1,200
1/8/54	Rolling pins		HB	Burning	2
1/8/54	SCAR rocket	2.25-in.		Detonation	2
1/8/54	Shell	105-mm		Burning	1

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
1/8/54	Shell	155-mm	GB	Burning	2
1/8/54	Shell	57-R	WP	Disassembly	54
1/8/54	Shell fin assembly	81-mm		Disassembly	2,400
1/8/54	Shell	155-mm		Burning	2
1/8/54	Shell	4.2-in.	H	Burning	332
1/8/54	Shell	75-mm	H	Burning	200
1/8/54	Shell	75-mm	HD	Burning	4
1/8/54	Shell	60-mm	WP	Burning	27
1/8/54	Shell	4.2-in.		Burning	6
1/8/54	Shell	4.2-in.	G	Burning	300
1/8/54	Shell	4.2-in.	GA	Burning	300
1/8/54	Shell	105-mm	HB	Burning	2
1/8/54	Shell	4.2-in.		Detonation	5
1/8/54	Shell	4.2-in.	WP	Detonation	1
1/8/54	Shell		WP	Detonation	32
1/8/54	Shell	4.2-in.		Detonation	16
1/8/54	Shell	4.2-in.		Detonation	37
1/8/54	Shell	76-mm M312	WP	Detonation	36
1/8/54	Shell	76-mm T15-E2	WP	Detonation	4
1/8/54	Shell	105-mm M325	WP	Detonation	2
1/8/54	Shell	4.2-in.	FS	Detonation	92
1/8/54	Shell	4.2-in.	GA	Detonation	100
1/8/54	Shell	105-mm		Disassembly	2
1/8/54	Shell with fuse and burster	4.2-in.	FS	Burning	6
1/8/54	Slider		Tetryl	Burning	250
1/8/54	Slider for fuse	M2 & M3		Detonation	115
1/8/54	Slider for fuse rocket	M4A1		Detonation	1,400
1/8/54	Spotting charge	M4		Burning	1
1/8/54	Spotting charges	M4		Detonation	40
1/8/54	Spotting charges	M4		Detonation	59
1/8/54	Tanks		Mustard	Burning	3
1/8/54	Tetryl		Tetryl	Burning	2,710
1/8/54	Tetryl		Tetryl	Detonation	7,015

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
4/3/54	Ammunition, round	4.2-in.	PWP	Detonation	6
4/3/54	Balisite			Burning	15
4/3/54	Blasting cap			Burning	11,850
4/3/54	Blasting cap, w/70-sec safety fuse			Burning	10,620
4/3/54	Bomb	M47		Burning & salvage	11,246
4/3/54	Bomb	T-3	H-	Burning	72
4/3/54	Bomb	M2A1	Incendiary	Burning	159
4/3/54	Bomb	M74	PT-1	Burning	1
4/3/54	Bomb	20-lb		Burning	3
4/3/54	Bomb	M47		Burning	985
4/3/54	Bomb w/fuse	M1A1	Incendiary	Burning	1,440
4/3/54	CG (oz)			Burning	3
4/3/54	Cluster	M19A1	Incendiary	Disassembly	7
4/3/54	Electric cap			Detonation	50
4/3/54	Electric squibs			Burning	7,900
4/3/54	Flamethrower ignition cyls			Burning	6
4/3/54	Flares - aircraft			Burning	90
4/3/54	Shell		FS	Detonation	36
4/3/54	Fuse	M10A2		Detonation	186
4/3/54	Fuse	VT, bar type		Disassembly	418
4/3/54	Fuse	M4A2		Disassembly	12
4/3/54	Fuse	AN-M102A2		Disassembly	1
4/3/54	Fuse	M82A1		Disassembly	150
4/3/54	Fuse	T50E4		Disassembly	12
4/3/54	Fuse	T51E1		Disassembly	30
4/3/54	Fuse	M51		Disassembly	65
4/3/54	Fuse	M82		Burning	11
4/3/54	Fuse	M11-A1		Disassembly	2,040
4/3/54	Fuse	M52		Disassembly	20,377
4/3/54	Fuse	M84		Disassembly	236
4/3/54	Fuse	M174		Disassembly	54
4/3/54	Fuse	M173		Disassembly	28
4/3/54	Fuse	M2		Disassembly	876

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
4/3/54	Fuse	M3		Disassembly	188
4/3/54	Fuse	M11-A1		Disassembly	105
4/3/54	Fuse	M52	PD	Detonation	69
4/3/54	Fuse slider	M52		Burning	1,210
4/3/54	Fuse w/o booster	M52		Burning	2,244
4/3/54	Fuse w/o burster	M4A1		Burning	1,216
4/3/54	Fuse w/slider and booster	1452		Detonation	520
4/3/54	Fuse	M51A5	PD	Disassembly	31
4/3/54	Grenade		CN	Burning	1
4/3/54	Grenade (rifle)		WP	Burning	38
4/3/54	Grenade burster (rifle)			Detonation	650
4/3/54	Grenade detonator assembly	WT-T5		Burning	2,400
4/3/54	HE rounds	90-mm	High explosive	Detonation	2
4/3/54	HE rounds	4.2-in.	High explosive	Detonation	2
4/3/54	HE Rounds	90-mm	High explosive		2
4/3/54	Illuminants	81-mm		Burning	186
4/3/54	MG and thermate		Incendiaries	Burning	200
4/3/54	Mortar shell	4.2-in.	GA, HE	Burning	200
4/3/54	Mortar shell				25
4/3/54	Nitro starch (lb)			Detonation	200
4/3/54	Primer cord (lb)			Detonation	20
4/3/54	Primer	M31A1		Burning	1,200
4/3/54	Primer	T-70		Disassembly	44
4/3/54	Primer, precussion	M31A3		Burning	350
4/3/54	Primer, percussion	M32		Demilling by disassembly	500
4/3/54	Propellant charge			Burning	500
4/3/54	PS (lb)			Burning	3
4/3/54	Bomb	M70		Detonation	3
4/3/54	Rocket	2.36-in.	WP, PWP		1
4/3/54	Rocket fuse	3.5-in.		Burning	31
4/3/54	Rocket head	MK-4	WP	Detonation	1
4/3/54	Rockets	2.25-in.		Detonation	3
4/3/54	Shell	60-mm	WP	Burning	9

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
4/3/54	Shell	90-mm	WP	Detonation	1
4/3/54	Shell	75-mm	HD	Burning	1,162
4/3/54	Shell		H	Burning	2
4/3/54	Shell	76-mm	WP	Burning	40
4/3/54	Shell	60-mm	WP	Detonation	4
4/3/54	Shell	90-mm	WP	Detonation	1
4/3/54	Shell	4.2-in.	CG	Detonation	9
4/3/54	Shell	75-mm	H		150
4/3/54	Shell	81-mm		Disassembly	179
4/3/54	Shell	76-mm		Disassembly	3
4/3/54	Shell (dud fired)	4.2-in.	CG		7
4/3/54	Shell, RCM	105	WP	Disassembly	5
4/3/54	Smoke pot	M1		Burning	2,415
4/3/54	Smokeless powder			Burning	8,610
4/3/54	Smokeless powder			Burning	20
4/3/54	Tail fin			Disassembly	144
4/3/54	Tetryl (lb)			Detonation	1,965
4/3/54	Thermate bomb, sectional			Burning	60
4/3/54	TNT (lb)			Detonation	20
4/3/54	Tracer elements			Burning	110
10/6/54	Bomb (fused)	E54R6	Simulant	Detonation	1
10/6/54	Bomb	M47		Burning	6,429
10/6/54	Bomb	M47	NP	Burning	204
10/6/54	Bomb	M76		Detonation	15
10/6/54	Bomb	M69	Incendiaries	Demill by disassembly	26
10/6/54	Burster			Burning	3
10/6/54	Burster	M23		Detonation	82
10/6/54	Burster	M10		Detonation	176
10/6/54	Burster	M12		Detonation	311
10/6/54	Burster	M4		Detonation	73
10/6/54	Burster	M4	Tetryl	Detonation	547
10/6/54	Burster	NA-AN M9	Sodium	Detonation	230
10/6/54	Burster assembly, grenade rifle	M19		Detonation	99,600

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
10/6/54	Cartridge	57-mm		Detonation	52
10/6/54	Cylinder, portable		CG	Burning	6
10/6/54	Cylinder, portable		CL	Burning	1
10/6/54	Cylinder, portable		CG	Detonation	6
10/6/54	Cylinder, portable		CL	Detonation	1
10/6/54	Detonator			Detonation	500
10/6/54	Dud shell	4.2-in.		Disassembly	1
10/6/54	Flash powder			Detonation	1
10/6/54	Frag grenade (dummy)			Disassembly	1
10/6/54	Fuse	M2		Disassembly	1
10/6/54	Fuse	M65		Burning	17
10/6/54	Fuse	M108		Detonation	11
10/6/54	Fuse	M50B		Detonation	36
10/6/54	Fuse	M84		Disassembly	32
10/6/54	Fuse (miscellaneous)			Detonation	8
10/6/54	Fuse mine	CML T8		Detonation	4
10/6/54	Fuse, various types			Detonation	15
10/6/54	Grenade, igniter			Detonation	61,200
10/6/54	Grenade	M7	CN	Burning	60
10/6/54	Grenade		CN	Burning	171
10/6/54	Incendiary	ANM50		Burning	65
10/6/54	Incendiary	ANM50X		Burning	22
10/6/54	Mine anti tank (heavy)	M6A1		Detonation	19
10/6/54	Mine anti tank (heavy)	M6E1		Detonation	5
10/6/54	Mortar tail fin	60-mm		Burning	267
10/6/54	Mortars	4.2-in.	H	Burning	1
10/6/54	Mortars	4.2-in.	CG	Burning	1
10/6/54	Mortars	81-mm M57A1	FS	Detonation	32
10/6/54	Primer	M30		Burning	2,500
10/6/54	Primer	M60		Detonation	3,750
10/6/54	Rockets	3.5-in.	HE	Detonation	7
10/6/54	Rockets	2.36-in.	HE	Detonation	15
10/6/54	Shell	105-mm		Burning	1

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
10/6/54	Shell	E-82	GB	Burning	1
10/6/54	Shell	90-mm T-92	WP	Detonation	3
10/6/54	Shell	76-mm M312	WP	Detonation	1
10/6/54	Shell			Detonation	1
10/6/54	Shell	105-mm M104		Burning	13
10/6/54	Shell	155-mm M110		Burning	7
10/6/54	Shell	155-mm M104		Detonation	14
10/6/54	Shell	155-mm M110		Detonation	26
10/6/54	Shell	57-mm	WP	Detonation	1,063
10/6/54	Shell	90-mm	WP	Detonation	150
10/6/54	Shell (fused)	57-mm	WP	Detonation	766
10/6/54	Shell	90-mm M71	HE	Detonation	2
10/6/54	Smoke pot	M1		Burning	271
10/6/54	Smokeless powder (lb)			Burning	1,400
10/6/54	Smokeless powder			Detonation	2,000
10/6/54	Tail fin with primer and cartridge	60-mm		Disassembly	23,134
10/6/54	Tetryl (lb)			Detonation	102
10/6/54	Tetryl (lb)			Detonation	195
10/6/54	TNT			Detonation	10
10/6/54	TNT (lb)			Detonation	341
1/5/55	Bomb	M47		Burning	265
1/5/55	Bomb		Magnesium	Burning	19
1/5/55	Bomb	M47		Detonation	2,367
1/5/55	Burster	M13		Burning	231,000
1/5/55	Burster	M12		Burning	54,900
1/5/55	Burster	M4E1		Detonation	950
1/5/55	Container, 1-ton			Detonation	18
1/5/55	Drum		Mustard sludge	Burning	7
1/5/55	Grenade (hand grenade)		WP	Burning	34
1/5/55	Grenade (rifle)	M19A1		Burning	10
1/5/55	Grenade		CN	Burning	10
1/5/55	Grenade		CN/DM	Burning	5
1/5/55	Pellet		Tetryl	Burning	945,000

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
1/5/55	Primer	M49		Burning	300
1/5/55	Shell	75-mm	WP	Detonation	42
1/5/55	Shell	155-mm M104		Detonation	37
1/5/55	Shell	155-mm M110		Detonation	22
4/5/55	Black powder		Black powder	Burning	1,692
4/5/55	Bomb	M54		Burning	47
4/5/55	Bomb	M47		Burning	172
4/5/55	Bomb	M69		Burning	224
4/5/55	Bomb (photoflare)			Detonation	3
4/5/55	Burster	M18		Burning	32,000
4/5/55	Burster	M14		Burning	500
4/5/55	Burster	M4		Detonation	150
4/5/55	Cartridge auxiliary			Burning	65
4/5/55	Cartridge case	.38-caliber		Burning	150
4/5/55	Cartridge case	90-mm		Detonation	365
4/5/55	Cartridge case	76-mm		Detonation	285
4/5/55	Cartridge case	120-mm		Detonation	30
4/5/55	Grenade		CD/DN	Burning	160
4/5/55	Container (ton)			Detonation	42
4/5/55	Container, 1 ton			Burning	12
4/5/55	Cylinder			Burning	36
4/5/55	Delay element			Burning	1
4/5/55	Detonator	M19A1		Burning	1,600
4/5/55	Detonator	M1		Burning	11,934
4/5/55	Detonator, mixed			Detonation	2,880
4/5/55	Electric cap	#4		Burning	400
4/5/55	Shell		FS	Detonation	2
4/5/55	Fuse	M503		Detonation	2,957
4/5/55	Fuse	M1		Burning	4,000
4/5/55	Fuse	M108		Detonation	800
4/5/55	Fuse	M2A1		Detonation	2,500
4/5/55	Grenade (hand grenade)			Detonation	12
4/5/55	Grenade (rifle)			Burning	23

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
4/5/55	Grenade (rifle)		Yellow smoke	Burning	90
4/5/55	Grenade	M15		Burning	3
4/5/55	Grenade		Tear gas	Burning	1,600
4/5/55	Grenade	M19A1		Detonation	115
4/5/55	Heat rocket head			Burning	23
4/5/55	Ignitor	M23		Detonation	102
4/5/55	Motor rocket			Detonation	299
4/5/55	Napalm barrel		Napalm	Burning	17
4/5/55	Pellet		Tetryl	Burning	8
4/5/55	Pellet		Tetryl	Burning	40
4/5/55	Percussion cap	M58		Burning	3
4/5/55	Primer detonator	M126		Burning	71,082
4/5/55	Primer	M45		Burning	2,000
4/5/55	Primer	M60		Burning	244,000
4/5/55	Primer	M60		Detonation	100,000
4/5/55	Primer	M60		Detonation	585
4/5/55	Primer	M48		Detonation	131
4/5/55	Primer detonator			Burning	26,900
4/5/55	Rocket, HVAP	3.25		Detonation	1
4/5/55	Rocket head	5-in.	G	Detonation	3
4/5/55	Rocket head	5-in., M25		Detonation	7
4/5/55	Rocket head	4.5	G	Detonation	36
4/5/55	Rocket motors	2.36		Detonation	540
4/5/55	Rocket motors	3.25		Detonation	73
4/5/55	Rocket motors	4.5		Detonation	2
4/5/55	Rotor with detonator			Burning	6
4/5/55	SCAR rocket	2.25		Detonation	1
4/5/55	Shell	4.2		Burning	379
4/5/55	Shell	4.2	CG	Detonation	130
4/5/55	Smokeless powder			Burning	1,972
7/5/55	Adapter booster	M20		Burning	50
7/5/55	Ammunition, round	155-mm	WP	Burning	1
7/5/55	Assembly stabilizer			Burning	29

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/55	Ball exper alive cap		Chlorate mix	Detonation	2
7/5/55	Black powder		Black powder	Burning	123
7/5/55	Black powder, cap		Black powder	Burning	6
7/5/55	Bomb	M69	Napalm	Burning	1,755
7/5/55	Bomb	E91		Burning	32
7/5/55	Bomb	M47		Detonation	11
7/5/55	Bomb	M78 500-lb	CG	Detonation	2
7/5/55	bomb	M47		Burning	17
7/5/55	Bomb (body)	E54	Ethylene glycol	Burning	3
7/5/55	Bomb (body), inert and fuse burned out	E104		Burning	35
7/5/55	Bomb (BW)		Ethylene glycol gel	Burning	12
7/5/55	Bomb, inert	M74		Detonation	12
7/5/55	Bomb without fuse	M74	PT	Burning	
7/5/55	Bomb	M74	WP cup	Detonation	600
7/5/55	Bomb, alive	M50		Detonation	99
7/5/55	Bomb	M69	Napalm	Burning	478
7/5/55	Bomb	M69	Napalm	Burning	74
7/5/55	Bomb	M69	Napalm	Burning	5
7/5/55	Bomb	M69		Detonation	700
7/5/55	Bomb	E54 R6		Detonation	12
7/5/55	Bomb	E76 R1		Detonation	16
7/5/55	Bomb	E49		Detonation	6
7/5/55	Bomb	E72 HC	Smoke	Detonation	30
7/5/55	Bomb	M60		Detonation	1,156
7/5/55	Bomb - M, 100-lb	M47	Napalm	Burning	37
7/5/55	Bomb - M, 100-lb	M47		Burning	25
7/5/55	Bomb (wood, floating)	E35		Burning	6
7/5/55	Bomb	M47	PWP	Burning	9
7/5/55	Bomb, 100-lb	M47	PWP, smoke	Detonation	57
7/5/55	Bomb, 100-lb	M47 AW PWP	Smoke	Burning	5
7/5/55	Bomb, alive	E80	Magnesium	Detonation	13
7/5/55	Booster		Tetryl	Detonation	8,225
7/5/55	Booster	M21A4		Detonation	10

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/55	Booster	T10		Detonation	9
7/5/55	Booster cup		Tetryl	Detonation	4,300
7/5/55	Booster		Tetryl	Burning	23
7/5/55	Booster	M4A1	Tetryl	Burning	10
7/5/55	Booster	Type 2		Burning	9
7/5/55	Booster		Tetryl	Burning	2,759
7/5/55	Booster			Burning	730
7/5/55	Booster		Tetryl	Burning	3,285
7/5/55	Booster			Detonation	3,283
7/5/55	Bulb and delay element		WD	Burning	4
7/5/55	Burster	M4		Burning	17
7/5/55	Burster	M4		Burning	17
7/5/55	Burster		Exp TNT	Detonation	10
7/5/55	Burster		Tetryl	Detonation	4
7/5/55	Burster (charge experience)		Tetryl	Detonation	6
7/5/55	Burster (charge special)	T2		Detonation	10
7/5/55	Burster (exp projectile)	155-mm, M110		Detonation	
7/5/55	Burster assembly rocket	2.36	Smoke	Detonation	76
7/5/55	Burster charge	T2		Detonation	10
7/5/55	Burster rocket	5.0 WP HUAR-TNT	Tetryl	Detonation	8
7/5/55	Burster rocket exper			Detonation	420
7/5/55	Burster shell	4.2 exp	Tetryl	Detonation	6
7/5/55	Burster	E12R1		Detonation	1,626
7/5/55	Burster charges	M24		Detonation	230
7/5/55	Burster F/grenade			Burning	321
7/5/55	Burster for 500-lb bomb		GP	Burning	8
7/5/55	Candles		Fuel	Detonation	90
7/5/55	Candles	M5	Smoke, gel	Detonation	81
7/5/55	Cap blasting, elec			Burning	30
7/5/55	Cap blasting, elec			Burning	16
7/5/55	Cap blasting, elec			Burning	30
7/5/55	Cap blasting, elec			Burning	16
7/5/55	Cap		Tetryl	Detonation	10,300

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/55	Cap blasting, elec			Detonation	80
7/5/55	Cap blasting, non-elec			Detonation	281,000
7/5/55	Cartridge	50-caliber		Detonation	6
7/5/55	Cartridge cal empty primed shell	38 spec		Detonation	278
7/5/55	Cartridge ignition	E11		Detonation	61
7/5/55	Cartridge case	T19E1B1		Burning	4
7/5/55	Casing w/primer for gun	T91 & T126 (76-mm)		Burning	4
7/5/55	Chemicals (inert)		Chemicals (inert)	Detonation	2,442
7/5/55	Chrome		Chloride (incendiary liquid)	Detonation	1
7/5/55	Cluster bomb			Detonation	54
7/5/55	Clusters	M12		Burning	10
7/5/55	Clusters	M12		Burning	50
7/5/55	Shell dud	4.2	CN	Burning	1
7/5/55	Composition block	C-3		Burning	7
7/5/55	Composition block	C-3		Burning	44
7/5/55	Composition block	C-3		Burning	7
7/5/55	Composition block	C-3		Burning	8
7/5/55	Composition Block	C-3		Burning	5
7/5/55	Container (1-ton)			Burning	12
7/5/55	Container (1-ton)			Burning	12
7/5/55	Container (ton)			Burning	36
7/5/55	Container (ton)		Contaminated w/O & PS	Burning	11
7/5/55	Container (ton)		H	Detonation	9
7/5/55	Cordite			Detonation	1
7/5/55	Cup		Tetryl lead	Burning	3,061
7/5/55	Cup for bomb	M74	WP	Burning	300
7/5/55	Canister		CW mix	Burning	36
7/5/55	Cylinder		Contaminated w/ mustard	Burning	2
7/5/55	Cylinder		Chlorine trifluoride	Detonation	1
7/5/55	Cylinder	M1A2	Portable chemical	Detonation	329
7/5/55	Cylinder ignition flame thrower	M1		Detonation	100
7/5/55	Cylinder portable			Burning	23
7/5/55	Cylinder		Toxic gas	Burning	16

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/55	Delay (body)	E10R1		Detonation	300
7/5/55	Detonator	M28		Burning	28,546
7/5/55	Detonator	CM2 and CM3		Burning	40
7/5/55	Detonator			Detonation	15
7/5/55	Detonator	MK 55		Burning	73
7/5/55	Drum		Gasoline	Burning	14
7/5/55	Drum, cap	55-gal	Napalm gel	Detonation	7
7/5/55	Drum, cap	55-gal	Contaminated w/HT-MT	Detonation	4
7/5/55	Drum, cap	55-gal	Contaminated w/HQ-MT	Detonation	16
7/5/55	Drum, cap	55-gal	Contaminated w/HN_3-MT	Detonation	4
7/5/55	Drum, cap	55-gal	Contaminated w/H-MT	Detonation	17
7/5/55	Drum.	55-gal	Contaminated with GA	Burning	43
7/5/55	Dye, carton		Marker dye	Detonation	20
7/5/55	Electric adaptor booster	T3		Burning	3,600
7/5/55	Empty can		CN/DM	Burning	300
7/5/55	Encendiary	M69	Napalm	Detonation	1,700
7/5/55	Exper bomb			Detonation	5
7/5/55	F/bomb	E 50		Burning	66
7/5/55	Fin primed w/cartridge	60-mm		Burning	10
7/5/55	Fire starters	E7R3		Detonation	14
7/5/55	Flame thrower igniter, portable			Detonation	300
7/5/55	Flame thrower igniter, portable	M1		Detonation	1,800
7/5/55	Flame thrower unit igniter, 1 shot	E10		Detonation	8
7/5/55	Flame thrower, 1 shot		Unit propellant	Detonation	95
7/5/55	Flare aircraft parachute w/o fuse	ANM 26		Detonation	4
7/5/55	Flash charge		Pentalite	Burning	5
7/5/55	Fuel block			Burning	46
7/5/55	Fuse	E7R6		Burning	204
7/5/55	Fuse	E27R1		Burning	2,124
7/5/55	Fuse	M103		Burning	3
7/5/55	Fuse	M08	w/Strikers	Burning	8
7/5/55	Fuse	M2		Detonation	380
7/5/55	Fuse	E39		Detonation	24

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/55	Fuse	M62A1	BD loaded A0P1-122	Detonation	5
7/5/55	Fuse	M55A3	Air burst TSQ	Detonation	11
7/5/55	Fuse	BD M66A1		Detonation	7
7/5/55	Fuse	MK50-2		Detonation	50
7/5/55	Fuse igniter grenade	M201		Detonation	25,000
7/5/55	Fuse (body)	E10		Detonation	100
7/5/55	Fuse (body), alive	M150		Detonation	1
7/5/55	Fuse (parts)		Scrap	Burning	200
7/5/55	Fuse (TSA), less burster	M77		Detonation	167
7/5/55	Fuse alive	E17		Detonation	40
7/5/55	Fuse aux detonator	MK55		Detonation	76
7/5/55	Fuse igniter grenade	M201		Detonation	21,750
7/5/55	Fuse PD	M5043A1		Burning	720
7/5/55	Fuse PD	M503A1		Burning	4
7/5/55	Fuse shell PD (Howitzer)	T76E9A 155-mm		Detonation	24
7/5/55	Fuse slides w/primer	4.2		Detonation	60
7/5/55	Fuse w/o strikers	M108		Detonation	189
7/5/55	Fuse, detonator	MK66-0		Detonation	50
7/5/55	Fuse, experimental alive	201A1		Burning	450
7/5/55	Fuse, lower det assembly	M46 or M47		Burning	133,000
7/5/55	Fuse, lower det assembly	M46 or M47		Burning	44,000
7/5/55	Fuse, TSQ	M77	Lead cup	Detonation	117
7/5/55	Fuse	M2		Detonation	162
7/5/55	Fuse	M50-1		Detonation	50
7/5/55	Grenade	M15	Smoke WP	Burning	14
7/5/55	Grenade		White smoke	Detonation	48
7/5/55	Grenade		Smoke CN & DM	Detonation	35
7/5/55	Grenade	T36	SWP	Detonation	93
7/5/55	Grenade (body)		Therm	Detonation	8
7/5/55	Grenade (complete)	AN 14		Detonation	45
7/5/55	Grenade (hand grenade)		Green	Burning	3
7/5/55	Grenade (hand grenade)	CB M7		Burning	341
7/5/55	Grenade (hand grenade)		Smoke white	Detonation	20

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/55	Grenade (hand grenade)	CN		Detonation	30
7/5/55	Grenade (hand grenade)		Tear gas	Detonation	2,145
7/5/55	Grenade (stabilizers)	M23		Detonation	248
7/5/55	Grenade		WP	Burning	8
7/5/55	Grenade		WP	Burning	2
7/5/55	Grenade (hand grenade)		Smoke violet	Burning	2
7/5/55	Grenade (hand grenade)		Smoke red	Burning	2
7/5/55	Grenade		WP	Detonation	5
7/5/55	Grenade	C-12		Detonation	145,275
7/5/55	Grenade		Smoked	Detonation	29
7/5/55	Grenade	M23A1	Color	Detonation	92
7/5/55	Grenade (tear)	M7-CN		Detonation	2
7/5/55	Grenade		Smoke HC	Burning	6
7/5/55	Head rocket	2.36	WP Fill	Detonation	1
7/5/55	Igniter		WP special green	Detonation	1
7/5/55	Igniter cartridge motor	4.2		Detonation	8,527
7/5/55	Igniter		WP w/o explosive	Detonation	9
7/5/55	Igniter		WP	Burning	3
7/5/55	Igniter rifle grenade			Detonation	147,453
7/5/55	Igniter, grenade	M23		Detonation	248
7/5/55	Ignition			Burning	26
7/5/55	Ignition exp		WP	Detonation	1
7/5/55	Incendiary	ANM50		Burning	32
7/5/55	Incendiary	M69	Napalm	Detonation	400
7/5/55	Incendiary	M50	Incendiary	Burning	18
7/5/55	Incendiary	M69	Incendiary	Burning	764
7/5/55	Incendiary	M50	Incendiary	Detonation	160
7/5/55	Incendiary (alive)	M50	Incendiary	Detonation	30
7/5/55	Incendiary	M69	Napalm	Burning	490
7/5/55	Inert chemicals from C&RL			Detonation	281
7/5/55	Igniter	MK125		Burning	1
7/5/55	Initiator			Burning	30
7/5/55	Initiator burster	M1		Burning	7

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/55	Instructional bomb	M1A1	Incendiary	Burning	4
7/5/55	Lead cup		Tetryl	Detonation	2,000
7/5/55	Lead cup		Tetryl	Detonation	3,200
7/5/55	Live block	E21	Fuel	Burning	53
7/5/55	Live Navy burster			Detonation	17
7/5/55	Loaded smoke w/o fuse or burster	81-mm	Loaded smoke	Detonation	24
7/5/55	Magnesium (powdered, 250-g)		Magnesium	Detonation	11
7/5/55	Metal scrap		Contaminated with mustard	Burning	300
7/5/55	Metal scrap		Contaminated	Detonation	1,100
7/5/55	Mortar shell	M6 4.2	Smokeless charge powder	Detonation	49.5
7/5/55	Mortar shell		HE chemical	Burning	1
7/5/55	Mortar, complete	4.2-in.	CM	Burning	1
7/5/55	Mortar rocket	3.25, MK7 637-NFCN 45c Test		Detonation	17
7/5/55	Mortar rocket, complete w/tail	3.25, MK7		Detonation	12
7/5/55	Motor rocket, complete w/tail fin big ban & wire	3.25, MK7 6R MK13		Detonation	48
7/5/55	Motors for fuse w/primer	E40		Detonation	40
7/5/55	Napalm barrel		Napalm	Detonation	11
7/5/55	Napalm barrel		Napalm	Burning	2
7/5/55	Napalm gel		Napalm gel	Detonation	270
7/5/55	Napalm gel		Napalm gel	Detonation	75
7/5/55	Navy container shell		Pressurized FS	Burning	7
7/5/55	Nitro-cellulose		Nitro-cellulose	Burning	10
7/5/55	Nitro-cellulose		Nitro-cellulose	Burning	10
7/5/55	Nitro-cellulose		Nitro-cellulose	Detonation	10
7/5/55	One-shot flame thrower		Fuel	Detonation	125
7/5/55	Pellet		Tetryl	Detonation	
7/5/55	Pellet		Tetryl	Detonation	50,187
7/5/55	Plastic balls			Burning	16
7/5/55	Plate		Cellulose nitrate	Burning	900
7/5/55	Primer	L44		Burning	450
7/5/55	Primer	M58	Percussion	Burning	7
7/5/55	Primer	M51		Detonation	540

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/55	Primer bushed fuse	MK5 from M201		Burning	168
7/5/55	Primer cord			Burning	125
7/5/55	Primer detonator	M126		Detonation	37,440
7/5/55	Primer detonator	M28		Detonation	19,220
7/5/55	Primer detonator	M26AL		Burning	12,110
7/5/55	Primer percussion			Burning	500
7/5/55	Primer percussion	M49		Detonation	1,306
7/5/55	Primer with sleeve for fuse	M151		Burning	11
7/5/55	Primer and holders	209B		Detonation	300
7/5/55	Projectile 6-in. Navy shell		WP	Burning	1
7/5/55	Projectile		WP	Burning	15
7/5/55	Propellant shell	M8 for 81-mm M43A1	Powder	Detonation	90
7/5/55	Propellant, bundle paclincrement	4.2 CM 5	Powder	Detonation	5
7/5/55	Bomb	M47A2	PWP	Burning	1
7/5/55	Bomb	M47	PWP	Burning	19
7/5/55	Bomb	M47A2	PWP	Burning	1
7/5/55	Rocket	4.2	High explosive	Burning	1
7/5/55	Rocket motor	3.25 MK7		Burning	4
7/5/55	Rocket motor	4.25		Detonation	2
7/5/55	Rocket practive	T46, 4.5		Detonation	4
7/5/55	Rocket propellant	3.5-in.		Detonation	2
7/5/55	Rocket propellant	2.25-in.		Detonation	14
7/5/55	Rocket shell	57-mm	WP	Burning	3
7/5/55	Rocket, alive	Incendiary for 3.5 rocket	Incendiary	Burning	15
7/5/55	Rockets	2.25		Burning	4
7/5/55	Rockets	2.25		Detonation	4
7/5/55	Rockets heads	3.25		Burning	3
7/5/55	Rocket motor (Mod-0)	2.25 M15		Detonation	4
7/5/55	Rotor for fuse	M19		Burning	144
7/5/55	Rotor for fuse with detonator	M174		Burning	214
7/5/55	Rotor for fuse with detonator	E19		Burning	13

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/55	Rotor with primer for fuse	R20		Burning	176
7/5/55	Rubber gel, fortified			Detonation	16
7/5/55	Scrap WP		Contaminated	Burning	500
7/5/55	Solventless Russian furo			Detonation	41
7/5/55	Shell	60-mm	WP	Burning	57
7/5/55	Shell	57-mm	WP	Burning	51
7/5/55	Shell	M308A1	Smoke WP	Burning	4
7/5/55	Shell	4.2		Burning	4
7/5/55	Shell	75-mm	Mustard	Burning	12
7/5/55	Shell	90-mm		Burning	18
7/5/55	Shell	90-mm		Burning	8
7/5/55	Shell	155-mm	WP	Burning	1
7/5/55	Shell	60-mm M302	Smoke WP	Burning	60
7/5/55	Shell	4.2 CML	Mortar contaminated w/H	Detonation	2
7/5/55	Shell	57-mm	Smoke WP	Detonation	10
7/5/55	Shell	60-mm M302	Smoke WP	Detonation	60
7/5/55	Shell	40-mm	Complete w/water fill proj	Detonation	8
7/5/55	Shell	75-mm M311A	Smoke WP, WP	Detonation	19
7/5/55	Shell	WP 60-mm M302	Smoke	Burning	60
7/5/55	Shell	90-mm	PWP	Burning	8
7/5/55	Shell	90-mm	WP	Burning	3
7/5/55	Shell	76-mm	WP	Burning	1
7/5/55	Shell, Navy		WP	Burning	2
7/5/55	Shell	90-mm	PWP	Burning	8
7/5/55	Shell	90-mm	WP	Burning	49
7/5/55	Sleeve assembly	E18R1 M2		Burning	10
7/5/55	Sleeve assembly	M142A1		Detonation	30
7/5/55	Slider block w/detonator			Detonation	5,400
7/5/55	Slider block w/detonator			Burning	3,000
7/5/55	Slider with detonator			Burning	41,600
7/5/55	Slides bomb (block)		Tetryl	Burning	4,000
7/5/55	Smoke		Smoke	Detonation	191
7/5/55	Canister shell	155MM T72	Color smoke	Detonation	1

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/55	Smoke cannister (alive)	105	Smoke	Detonation	55
7/5/55	Smoke marker w/ fuse			Burning	58
7/5/55	Smoke mix, alive		Smoke mix	Detonation	60
7/5/55	Smoke pot	M4	Smoke	Burning	1
7/5/55	Smoke pot	M5	HC Smoke	Burning	1
7/5/55	Smokeless powder		Smokeless powder	Burning	50
7/5/55	Smokeless powder		Smokeless powder	Burning	750
7/5/55	Sodium nitrate in celluloid		Sodium nitrate in celluloid	Detonation	800
7/5/55	Special grenade	T-C		Detonation	13
7/5/55	Squibs		Cellulose nitrate	Burning	485
7/5/55	Stabilizers	T12		Burning	489
7/5/55	Sulfur monochloride		Sulfur monochloride	Detonation	17
7/5/55	Sulphuric acid		Sulphuric acid	Detonation	20
7/5/55	Test explosives			Detonation	25
7/5/55	Tetryl blocks			Detonation	8,400
7/5/55	Tetryl leads		Tetryl leads	Detonation	200
7/5/55	Tetryl, 15-lb			Burning	15
7/5/55	Tracer	M5AL		Burning	183
7/5/55	Tube igniter			Detonation	25,000
7/5/55	Tubes (primer only)	W209		Detonation	20
7/5/55	Unit live with detonator		WP	Burning	4
7/5/55	Cannister		WP	Detonation	4
10/5/55	Assembly match elec.			Burning	4
10/5/55	Ballistite, powder			Detonation	340
10/5/55	Black powder,-lb		Black powder	Burning	340
10/5/55	Blasting cap non-elec			Detonation	41
10/5/55	Bomb	M69	Incendiary	Burning	16,375
10/5/55	Bomb	M47	Incendiary	Burning	109
10/5/55	Bomb	M50X	Incendiary	Detonation	25
10/5/55	Bomb	AN50	Incendiary	Detonation	17
10/5/55	Bomb (body)	E50R1		Burning	129
10/5/55	Bomb, magnesium body		Black powder	Burning	400
10/5/55	Bomb, 30-lb, aeriel			Detonation	1

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
10/5/55	Bomb	E54R6	Sim	Burning	666
10/5/55	Bomb	M2A1	Incendiary	Burning	4
10/5/55	Bomb	E89		Burning	137
10/5/55	Bomb	E54R1		Burning	32
10/5/55	Bomb	E61		Burning	365
10/5/55	Bomb	E54	GB	Burning	10
10/5/55	Bomb	M69		Detonation	730
10/5/55	Bomb, w/&w/o fuse	E72, M150A1	HE	Burning	120
10/5/55	Booster			demilitarization	640
10/5/55	Booster		Tetryl	Detonation	7,300
10/5/55	Burster	C8R1		Burning	27,825
10/5/55	Burster (charge) for grenade	T36		Burning	10
10/5/55	Burster for bomb	M4E1		Detonation	12
10/5/55	Burster	M10		Burning	332
10/5/55	Burster	E12R1		Burning	97
10/5/55	Burster	E16		Burning	20
10/5/55	Burster	E10		Detonation	10,500
10/5/55	Burster	E12R1		Detonation	4,531
10/5/55	Burster	E10		Detonation	1,600
10/5/55	Burster	M10	Tetryl	Detonation	274
10/5/55	Burster	T15		Detonation	150
10/5/55	Burster	E2R1		Detonation	1,282
10/5/55	Burster assembly w/cap	C8R1		Detonation	27,825
10/5/55	Cap blasting elec			Detonation	202
10/5/55	Cartridge	90-mm		demilitarization	1
10/5/55	Cartridge	75-mm		demilitarization	20
10/5/55	Cartridege mortar	4.2 M2		Burning	1,755
10/5/55	Cartridge	M30M6		Detonation	50
10/5/55	Cartridge auxillary	M7		Detonation	50
10/5/55	Shell	4.2	CG	Burning	1
10/5/55	Shell	4.2	CG	Detonation	6
10/5/55	Cluster	M12 WP		Detonation	26
10/5/55	Composition block	C-3		Detonation	25

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
10/5/55	Container	CK 25		Burning	50
10/5/55	Container		CB	Detonation	1
10/5/55	Cup booster		Tetryl	Detonation	2,770
10/5/55	Cup		Tetryl lead	Detonation	14,732
10/5/55	Cup with sleeves		Tetryl	Detonation	200
10/5/55	Cylinder portable	M1A2		Burning	53
10/5/55	Delay - body	E13		Burning	1,299
10/5/55	Delay assembly PD fuse	M48A3		Burning	6,489
10/5/55	Delay body			Detonation	5,550
10/5/55	Delay	E10R1		Burning	3,550
10/5/55	Drum		Ashes magnesium	Burning	3
10/5/55	Drum		Contaminated w/H	Burning	31
10/5/55	Drum	55-gal	Silicon tetryl chloride	Burning	8
10/5/55	Flame thrower, portable	E16R1		Burning	1
10/5/55	Flash powder			Burning	194
10/5/55	Fuse	M8		Burning	288
10/5/55	Fuse	MTE 30		Burning	280
10/5/55	Fuse	M174		Burning	214
10/5/55	Fuse	E7		Burning	46
10/5/55	Fuse	M142		Burning	83
10/5/55	Fuse	M20		Burning	60
10/5/55	Fuse	E34		Burning	72
10/5/55	Fuse	M82		Demilitarization	44,274
10/5/55	Fuse	E10R3		Demilitarization	103
10/5/55	Fuse	173		Demilitarization	820
10/5/55	Fuse	M147		Demilitarization	11
10/5/55	Fuse	E24R1		Demilitarization	700
10/5/55	Fuse	M152		Demilitarization	59
10/5/55	Fuse	M146		Demilitarization	901
10/5/55	Fuse	M157		Demilitarization	150
10/5/55	Fuse	E58-Q63		Demilitarization	765
10/5/55	Fuse	M77		Demilitarization	8,375
10/5/55	Fuse	M201A1		Detonation	12,700

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
10/5/55	Fuse	E7R6		Detonation	3,000
10/5/55	Fuse	M108		Detonation	200
10/5/55	Fuse	M204A1		Detonation	275
10/5/55	Fuse	M48		Detonation	20
10/5/55	Fuse	M77		Detonation	17,145
10/5/55	Fuse (body)	E29		Detonation	50
10/5/55	Fuse (body)	M48		Burning	19
10/5/55	Fuse bomb noze	MT T39		Burning	48
10/5/55	Fuse, dud			Detonation	2
10/5/55	Fuse, hand grenade	M6A4D		Detonation	200
10/5/55	Fuse PD	82A1		Burning	3,600
10/5/55	Fuse PD	M48A3 for 76-mm		Burning	5
10/5/55	Fuse PD	M503A1		Burning	7
10/5/55	Fuse safety			Detonation	100
10/5/55	Fuse TSQ with lead cup	M77		Detonation	572
10/5/55	Fuse	E24R1		Burning	2,124
10/5/55	Fuse	M82		Burning	3,948
10/5/55	Fuse	M82A1		Demilitarization	50,190
10/5/55	Grenade		Smoke yellow	Burning	92
10/5/55	Grenade		Green smoke	Burning	8
10/5/55	Grenade (charge propelling)	T36		Burning	17
10/5/55	Grenade (hand)		CN	Burning	5
10/5/55	Grenade	M7	CN	Burning	41
10/5/55	Grenade (hand) w/out burster		Smoke WP	Burning	500
10/5/55	Grenade primer			Detonation	50
10/5/55	Grenade, red	M23A1		Burning	81
10/5/55	Grenade, rifle		Color smoke	Burning	2
10/5/55	Grenade	SWP T36	Smoke	Burning	7
10/5/55	Grenade	M15	WP	Burning	1
10/5/55	Grenade	M15	WP	Burning	1,638
10/5/55	Grenade		WP	Burning	1
10/5/55	Grenade	M8		Burning	235
10/5/55	Can		HC w/black powder	Burning	27

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
10/5/55	Head assembly			Burning	110
10/5/55	Igniter assembly			Burning	370
10/5/55	Igniter for smoke pot			Burning	15
10/5/55	Ignition unit			Burning	760
10/5/55	Incendiary	ANM 50		Burning	8
10/5/55	Initiater booster			Burning	6,720
10/5/55	Jato bottles			Detonation	1
10/5/55	Leads			Detonation	189,000
10/5/55	Napalm gel (gal)			Burning	260
10/5/55	Pellet		Tetryl	Detonation	17,017
10/5/55	Prima cord (ft)			Detonation	800
10/5/55	Primer	M49		Detonation	1
10/5/55	Primer	M69		Detonation	2
10/5/55	Primer percussion	M49		Burning	50
10/5/55	Primer with sleave			Burning	43
10/5/55	Primer detonator	M28		Burning	9,360
10/5/55	Primer with sleeve			Detonation	100
10/5/55	PWP	155-mm		Detonation	74
10/5/55	PWP	105-mm		Detonation	5
10/5/55	Rocket	2.36	HE	Detonation	4
10/5/55	Rocket mortar	4.2		Detonation	6
10/5/55	Rocket motor	2.25		Detonation	15
10/5/55	Rocket motor	3.5		Detonation	7
10/5/55	Rocket motor	2.75		Detonation	8
10/5/55	Rocket propellant			Detonation	13
10/5/55	Rocket propellent	2.25		Detonation	1
10/5/55	Rocket, 5-in assembly		GB	Burning	5
10/5/55	Roller for fuse	E19		Burning	157
10/5/55	Rotor with detonator	M115A2		Burning	104
10/5/55	SCAR motors			Detonation	2
10/5/55	Shell	105-mm		Demilitarization	718
10/5/55	Shell	4.2	H	Detonation	1
10/5/55	Shell	81-mm	FS	Detonation	51

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
10/5/55	Shell	90-mm	H	Detonation	1
10/5/55	Shell	105-mm	H	Burning	1
10/5/55	Shell	76-mm	PSP	Detonation	110
10/5/55	Shell	75-mm	PWP	Burning	5
10/5/55	Shell	57-mm	PWP	Detonation	120
10/5/55	Simulated bomb		G	Burning	156
10/5/55	Slider blocks and tetryl cup			Detonation	122,132
10/5/55	Smoke pot	M5	HC	Detonation	44
10/5/55	Smoke pot floating			Burning	2
10/5/55	Smoke powder (lb)		HC	Burning	150
10/5/55	Smokeless powder			Burning	725
10/5/55	Squib electric			Burning	2
10/5/55	Stabilizer - assembly with igniter	RD2-12, ED2-15		Detonation	4,600
10/5/55	Stabilizer assembly			Detonation	4,600
10/5/55	Stabilizers			Burning	31,124
10/5/55	Stablizers for grenade	M25		Burning	74
10/5/55	Stick of ballistite			Detonation	7
10/5/55	Stroke mortar rounds			Detonation	6
10/5/55	Tube body			Burning	20
1/5/56	Adapter		Aluminum w/squib	Burning	2
1/5/56	Adapter			Burning	20
1/5/56	Adapter		Aluminum with squib	Burning	13
1/5/56	Blasting cap			Burning	9
1/5/56	Bomb	E54R6		Burning	720
1/5/56	Bomb	E49		Burning	144
1/5/56	Bomb	M47	Napalm	Burning	46
1/5/56	Bomb	M69	Napalm	Detonation	3,204
1/5/56	Bomb	AN50A3		Detonation	865
1/5/56	Bomb	ANM 50	Incendiaries	Burning	80
1/5/56	Bomb, instructional		Incendiary	Detonation	891
1/5/56	Bomblet	E2P	Inert	Burning	169
1/5/56	Bomb	M69	Napalm	Burning	37,125
1/5/56	Burster		Black powder	Burning	1,140

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
1/5/56	Burster	M13		Detonation	96
1/5/56	Burster	M4		Detonation	16
1/5/56	Burster	M4		Detonation	18
1/5/56	Canisters, empty			Burning	9
1/5/56	Cap, blasting	T36		Detonation	24
1/5/56	Cap, blasting non-electric			Detonation	3,000
1/5/56	Cap, blasting electric			Detonation	5,000
1/5/56	CN (lb)			Burning	4
1/5/56	Cylinder		Chlorine	Detonation	53
1/5/56	Cylinder		HC	Detonation	127
1/5/56	Delay	E10R1		Burning	100
1/5/56	Delay detonator	M17		Burning	17
1/5/56	Delay	M48		Burning	42,638
1/5/56	Delay assembly			Burning	10,260
1/5/56	Detonator, fire-type			Burning	6
1/5/56	Detonator	#6		Detonation	27,965
1/5/56	Detonator	E24R1		Detonation	5,617
1/5/56	Detonator rocket	T36		Detonation	42
1/5/56	Drum	55-gal	FS	Burning	1
1/5/56	Fin	60-mm		Detonation	5,850
1/5/56	Fin	60-mm		Detonation	8,450
1/5/56	Fin	60-mm		Detonation	6,120
1/5/56	Fuel block			Burning	99
1/5/56	Fuse	E30		Burning	1,140
1/5/56	Fuse	E24R1		Demilitarization	10,584
1/5/56	Fuse	PD M48A3		Detonation	1
1/5/56	Fuse body		Black Powder	Burning	77
1/5/56	Fuse head			Burning	443
1/5/56	Fuse			Burning	95
1/5/56	Fuse	M206		Burning	16
1/5/56	Fuse	M206A1		Burning	2
1/5/56	Fuse	M26 M1		Burning	6
1/5/56	Fuse	MK26 Mod 1		Burning	6

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
1/5/56	Fuse	MK26 Mod 0		Burning	6
1/5/56	Fuse	M201		Detonation	3,632
1/5/56	Grenade	T36	SWP	Detonation	1
1/5/56	Grenade		Smoke (colored)	Burning	2,372
1/5/56	Grenade	M7	CN	Burning	921
1/5/56	Grenade	M6	CN-DM	Burning	224
1/5/56	Grenade, rifle		Empty	Burning	200
1/5/56	Grenade		WP	Burning	16
1/5/56	Igniter	M201		Detonation	1,100
1/5/56	Pellet		Tetryl	Detonation	2,070
1/5/56	Plastic spheres			Burning	4
1/5/56	Primer cord			Burning	100
1/5/56	Primer	M26		Burning	500,000
1/5/56	Primer	M68		Detonation	3
1/5/56	Primer, percussion	M48		Burning	49
1/5/56	Projectile, artillery rounds			Demilitarization	110
1/5/56	Rocket heads		Empty	Burning	5
1/5/56	Shell	4.2	H	Detonation	2
1/5/56	Shell	75-mm	H	Detonation	6
1/5/56	Shell	155-mm	H	Detonation	2
1/5/56	Shell	57-mm	PWP	Detonation	35
1/5/56	Shell	90-mm		Burning	3
1/5/56	Shell	75-mm	Empty	Burning	3
1/5/56	Shell	75-mm	PWP	Detonation	22
1/5/56	Shell	90-mm	PWP	Detonation	2
1/5/56	Sphere fuse			Burning	14
1/5/56	Slider			Detonation	7,700
1/5/56	Smokeless powder (lb)			Burning	18
1/5/56	Sphere			Burning	15
1/5/56	Sphere (composite)			Burning	3
1/5/56	Squibs			Burning	200
1/5/56	Tetryl (lb)			Burning	3
1/5/56	Tube			Burning	50

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
4/5/56	Ammo - carbine	30-caliber		Detonation	2,800
4/5/56	ammo - practice, blank	30-cal		Detonation	50
4/5/56	Ammo crimped, blank	M1, 30-cal		Detonation	150
4/5/56	ammo, rounds	50-cal		Detonation	35
4/5/56	Ammunition (pistol)	45-cal		Detonation	50
4/5/56	Ammunition, mortar rounds	4.2-in.	H	Burning	15
4/5/56	Ammunition, round	155-mm	WP	Detonation	2
4/5/56	Ammunition, round	76-mm	WP	Detonation	16
4/5/56	Ammunition, round	90-mm	WP	Detonation	13
4/5/56	Ammunition, round	105-mm	TNT	Detonation	12
4/5/56	Ammunition, short rounds		22 cal	Burning	7
4/5/56	Ammunition, rounds	T90	WP	Detonation	17
4/5/56	Assembly fin	M4		Burning	42
4/5/56	Blasting cap - nonelectric	#8		Detonation	7
4/5/56	Block - CML, 500-lb		Contaminated w/WP	Detonation	1
4/5/56	Bomb	M76	GP	Detonation	7
4/5/56	Bomb (chemical)	M70	G	Burning	2
4/5/56	Bomb, cluster	M69		Burning	20,094
4/5/56	Bomblet		GB	Burning	4
4/5/56	Bomb	M69	Incendiary	Burning	4,214
4/5/56	Bomb	M47	Incendiary	Burning	136
4/5/56	Bomb	ANM50X	Incendiary	Burning	15
4/5/56	Bomb	E54R6		Detonation	1,292
4/5/56	Bomb	M47	Napalm	Detonation	2
4/5/56	Bomb	AN-M47A4	PWP	Detonation	13
4/5/56	Bomb	E50R1		Detonation	11
4/5/56	Bomb	ANM50	Incendiary	Detonation	14
4/5/56	Bomb		PWPV	Detonation	15
4/5/56	Bomb	M70	G	Detonation	10
4/5/56	Bomb CMB, 250-kg		Inert	Burning	11
4/5/56	Bomb, body		WP	Detonation	6
4/5/56	Bomb, body	AP2-87-Lot 2	WP	Detonation	3
4/5/56	Bomb cluster	M12	Napalm	Detonation	138

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
4/5/56	Bomb	M1AL	Incendiary	Burning	13
4/5/56	Bomb, 115-lb	M70	G	Burning	5
4/5/56	Bomb, 550-lb	E201R2	Incendiary	Burning	3
4/5/56	Bomb, armable cluster	M20		Detonation	2
4/5/56	Booster		Tetryl	Detonation	50
4/5/56	Burster (charge)	M23		Detonation	1
4/5/56	Burster (charge)	M23		Detonation	1
4/5/56	Burster	E12R1	Tetryl	Detonation	1,063
4/5/56	Burster	M3		Detonation	35
4/5/56	Burster	M4	Tetryl	Detonation	20
4/5/56	Burster	M3		Detonation	20
4/5/56	Cap blasting electric			Detonation	23
4/5/56	Cap blasting eng spec elec			Detonation	2
4/5/56	Cartridge	105-mm T54	WP	Detonation	1
4/5/56	Chloractapheonone (lb)			Burning	14,858
4/5/56	Cluster bomb	M12		Burning	1,121
4/5/56	Cluster bomb	M12	Incendiary	Burning	106
4/5/56	CN (lb)		CN tear gas	Burning	55
4/5/56	Composition block (1-lb)	C-2		Detonation	74
4/5/56	Composition block	C-2		Detonation	3
4/5/56	Container		Cylinder poison gas	Burning	6
4/5/56	Cylinder		Hydrogen fluoride	Burning	3
4/5/56	Cylinder		Methyl chloride	Burning	1
4/5/56	Cylinder	H2S04	Hydrogen sulfide	Burning	1
4/5/56	Cylinder, JATO		FS	Detonation	4
4/5/56	Delay	E10R1		Detonation	24
4/5/56	Detonator w/sleeves	M12A2		Detonation	125
4/5/56	DMO-TNT, 1/2-lb block			Detonation	1
4/5/56	Drum, contaminated	55-gal		Burning	75
4/5/56	Fuse (safety time)			Detonation	78
4/5/56	Fuse	T31B		Detonation	1
4/5/56	Fuse	M48 A3		Detonation	8
4/5/56	Fuse, detonating (ft)			Detonation	900

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
4/5/56	Fuse grenade	M201 A1		Detonation	4,600
4/5/56	Fuse lighter	MK2		Burning	2
4/5/56	Fuse, grenade	M26A1		Burning	2,648
4/5/56	Fuse	E-19		Detonation	28
4/5/56	Fuse, base AP shell	90-mm		Detonation	6
4/5/56	Fuse, complete	E24R1		Detonation	24
4/5/56	Fuse, delay	M48		Burning	9,600
4/5/56	Fuse for hand grenade			Detonation	10
4/5/56	Grenade	T36	Propellant charge	Detonation	25
4/5/56	Grenade (hand grenade)	M15	WP	Burning	2
4/5/56	Grenade (rifle)	M18		Burning	2,237
4/5/56	Grenade	M15	WP	Burning	3
4/5/56	Grenade	M15	WP	Detonation	6
4/5/56	Grenade	M18	Smoke	Burning	8,084
4/5/56	Grenade	M15	WP	Burning	2
4/5/56	Grenade		CN-DM	Burning	2,963
4/5/56	H		Mustard	Burning	50
4/5/56	Head assembly, unfired	M48A3		Burning	175
4/5/56	Igniter burster	M2		Detonation	11
4/5/56	Igniter	777-9	WP	Detonation	930
4/5/56	Incendiaries, training	M2		Burning	2
4/5/56	Incendiary magnesium			Detonation	21
4/5/56	Initiator burster	M2		Detonation	1
4/5/56	Initiator buster	T73		Detonation	1
4/5/56	Instructional grenade		Incendiary	Detonation	10
4/5/56	Lighter fuse			Burning	4
4/5/56	Lighter fuse	M2		Detonation	10
4/5/56	Drum	55-gal	Menthanol (G-contaminated)	Burning	1
4/5/56	ML thermite		Incendiary	Burning	8
4/5/56	Mortar round	60-mm		Detonation	1
4/5/56	Motor round	4.2 CONL	TNT (1 only)	Detonation	2
4/5/56	Nitro starch (lb)			Detonation	4
4/5/56	Non electric blasting cap	#8		Detonation	5

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
4/5/56	Particulate burster	E10		Detonation	27
4/5/56	Primer, percussion	M68		Detonation	9
4/5/56	Primer	M68		Burning	7
4/5/56	Primer	M26		Detonation	26
4/5/56	Primer, percussion	M49		Burning	980
4/5/56	Primer, percussion	M68		Detonation	17
4/5/56	Primer, percussion	M49		Detonation	17
4/5/56	Primer w/sleeves			Burning	67
4/5/56	Primer, percussion	M20		Burning	69,850
4/5/56	Rocket heads	4.5		Detonation	25
4/5/56	Rocket motors	2 ind		Detonation	7
4/5/56	Shell	90-mm AP-T		Detonation	13
4/5/56	Shell	M64 75-mm	PWPV	Detonation	179
4/5/56	Shell	155-mm	Sand	Detonation	43
4/5/56	Shell	76-mm	Smoke	Detonation	156
4/5/56	Shell, illuminating	M83A1		Detonation	39
4/5/56	Shell, mortar round	105-mm M325	WP	Detonation	2
4/5/56	Shell, police spec rounds	32-cal		Burning	25
4/5/56	Shell, shotgun	10-gauge		Burning	22
4/5/56	Container (gal)		Silicone-contaminated	Burning	10
4/5/56	Smoke canisters	E-26	Smoke	Burning	356
4/5/56	Smoke grenade	M15	WP	Detonation	4
4/5/56	Squibs, electric			Burning	113
4/5/56	Steel container, contaminated			Burning	5
4/5/56	T/fin	60-mm		Detonation	37,151
4/5/56	T/fin assembly w/cartridge mortar round	105-mm		Detonation	1
4/5/56	T/fin for mortar rounds	60-mm		Burning	23,416
4/5/56	Canisters	M15	WP	Detonation	3
7/5/56	Ammunition	M1, 30-cal		Burning	1,200
7/5/56	Ammunition	Ball, .50-cal.		Burning	70
7/5/56	Ammunition	30-caliber	Carbine tracers	Burning	400
7/5/56	Bomb	AN-M50X-A3		Burning	1,730
7/5/56	Bomb (body)		Incendiary PT1	Burning	25

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/56	Bomb	AN-M50X A3		Burning	10,560
7/5/56	Bomb	AN-M50X A3		Burning	9,696
7/5/56	Bomb	M74	Incendiary	Burning	119
7/5/56	Bomb	AN-M50-A2		Burning	581
7/5/56	Bomb	M12		Burning	229
7/5/56	Bomb	M74	PT1	Burning	150
7/5/56	Bomb	M47	Incendiary Napalm	Burning	22
7/5/56	Bomb	AN-M50		Burning	10
7/5/56	Bomb	M47	Napalm	Burning	3
7/5/56	Bomb	M47	Napalm	Burning	2
7/5/56	Bomb	AN-M50X-A3		Detonation	1,320
7/5/56	Bomb	AN-M50X		Detonation	968
7/5/56	Bomb	M74		Detonation	16
7/5/56	Bomb	E54R1	Simulant	Detonation	7
7/5/56	Bomb burster	E54R6 w/E24R1 & E12R1		Detonation	6
7/5/56	Bomb, instructional		Incendiary	Burning	6
7/5/56	Bomb, instructional		Incendiary	Detonation	2
7/5/56	Box, 500-lb	M220		Burning	1
7/5/56	Burster	M3		Detonation	548
7/5/56	Burster	E12R1		Detonation	181
7/5/56	Burster	M3		Detonation	68
7/5/56	Burster	E12R1		Detonation	65
7/5/56	Burster	155-mm		Detonation	43
7/5/56	Burster	M4		Detonation	19
7/5/56	Burster	M4	Tetryl	Detonation	79
7/5/56	Burster	M4		Detonation	53
7/5/56	Burster	155-mm		Detonation	32
7/5/56	Burster	105-mm		Detonation	17
7/5/56	Burster, bomb	E10		Detonation	5
7/5/56	Burster for CML land mines	M3		Detonation	15
7/5/56	Burster for CML shell	105-mm		Burning	20
7/5/56	Burster shell	155-mm		Detonation	16

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/56	Canister		DM	Burning	5
7/5/56	Canister	E15		Burning	7
7/5/56	Cap, blasting nonelectric			Detonation	3
7/5/56	Cap blasting electric			Detonation	10
7/5/56	Cap, blasting electric			Detonation	71
7/5/56	Cap, blasting nonelectric			Detonation	4
7/5/56	Cap, blasting nonelectric			Detonation	3
7/5/56	Cap, blasting special electric			Detonation	50
7/5/56	Caustic soda mix (lb)			Detonation	2,765
7/5/56	Pot		CN	Burning	48
7/5/56	Composition block	C-3		Detonation	12
7/5/56	Composition block	C-2		Detonation	58
7/5/56	Composition (lb)	C-2		Detonation	22
7/5/56	Container (ton)		CG	Burning	1
7/5/56	Container (ton)		CK	Burning	5
7/5/56	Container (ton)		GA	Burning	2
7/5/56	Cylinder		G-contaminated	Detonation	1
7/5/56	Cylinder		Contaminated w/anhydrous-ammonia	Burning	12
7/5/56	Delay	E10		Burning	1,550
7/5/56	Detonating cord			Burning	525
7/5/56	Detonating cord (ft)			Detonation	107
7/5/56	Detonator sleeves for fuse	E24R1		Burning	1,000
7/5/56	Drum		DM-contaminated	Burning	2
7/5/56	Drum		Napalm	Burning	1
7/5/56	Fuse, safety time (ft)			Burning	16
7/5/56	Fuse, (safety time (ft)			Detonation	40
7/5/56	Fuse, safety time (ft)			Detonation	18
7/5/56	Fuse parts	M201		Burning	225
7/5/56	Fuse primer for fuse	E24R1		Burning	300
7/5/56	Fuse slider for fuse	E24R1		Burning	300
7/5/56	Fuse	E24R1		Burning	25
7/5/56	Fuse	M200A1		Burning	14

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/56	Fuse	M206		Detonation	2,657
7/5/56	Fuse (grenade)	M206A1		Detonation	1,200
7/5/56	Fuse of detonation			Detonation	2
7/5/56	Grenade	M1A1	Incendiary	Detonation	1
7/5/56	Grenade	M15		Detonation	1
7/5/56	Grenade	ANM8	Smoke HC	Burning	1,624
7/5/56	Grenade	M18		Burning	58
7/5/56	Grenade	HC-M18		Burning	22
7/5/56	Grenade	M18	Smoke	Burning	20
7/5/56	Grenade	M15	Smoke WP	Burning	4
7/5/56	Grenade	M7		Detonation	445
7/5/56	Grenade	M15		Detonation	1
7/5/56	Grenade, hand		Smoke yellow	Burning	16
7/5/56	Grenade, hand		Smoke green	Burning	16
7/5/56	Grenade, hand		Smoke white HC	Burning	16
7/5/56	Grenade smoke colored	M6, M8, M18		Burning	2,430
7/5/56	Grenade		WP	Detonation	2
7/5/56	Igniter	M16		Detonation	1
7/5/56	Igniter mix (lb)			Burning	65
7/5/56	Igniter	M5		Detonation	296
7/5/56	Igniter	E3R1		Detonation	95
7/5/56	Igniter	M9		Detonation	10
7/5/56	Igniter for ALM		WP	Detonation	31
7/5/56	Incendiaries training	M2		Burning	20
7/5/56	Initiator burster	751E1 90mm		Detonation	587
7/5/56	Instructional incendiaries			Burning	10
7/5/56	Leads fuse	E23R1		Detonation	1,350
7/5/56	Motor oil (gal)			Burning	50
7/5/56	Napalm gel (gal)			Burning	130
7/5/56	Nitro starch (lb)			Detonation	4
7/5/56	Prima cord			Burning	2,150
7/5/56	Prima cord			Burning	1,000
7/5/56	Prima cord			Burning	500

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/56	Prima cord (ft)			Detonation	1,000
7/5/56	Primer for blast driven-earth rod			Burning	15
7/5/56	Propellant		Powder	Burning	276
7/5/56	Propellant (charge)	T-119		Burning	160
7/5/56	Propellant (ballestite for JATO bottles)			Burning	67
7/5/56	Rocket mortar	2.25		Detonation	9
7/5/56	Rocket motor	2.25		Detonation	9
7/5/56	Rocket tail fin assembly			Burning	2,500
7/5/56	Rocket motor	2.25		Detonation	5
7/5/56	Scrap		Tetryl & TNT	Detonation	70
7/5/56	Shapes, experimental			Detonation	80
7/5/56	Shell	105-mm		Detonation	2
7/5/56	Shell	75-mm		Detonation	1
7/5/56	Shell	T-92	WP	Burning	260
7/5/56	Shell	155-mm	PWP	Burning	14
7/5/56	Shell	155-mm	PWPV	Detonation	50
7/5/56	Shell	T-92		Detonation	17
7/5/56	Shell	155-mm	PWPV	Detonation	74
7/5/56	Shell	76-mm	Smoke	Detonation	12
7/5/56	Shell	155-mm		Detonation	72
7/5/56	Shell	155-mm	WP	Detonation	2
7/5/56	Shell	75-mm	WP	Detonation	5
7/5/56	Shell	75	HC WP	Detonation	3
7/5/56	Shell	76-mm	WP	Detonation	2
7/5/56	Shell	90-mm	HE	Detonation	2
7/5/56	Shell, mortar	4.2-in.		Detonation	19
7/5/56	Shell, mortar	81-mm	WP	Detonation	11
7/5/56	Slider, fuse	E24R1		Detonation	1,350
7/5/56	Smoke (color) canister			Detonation	16
7/5/56	Smoke canister	E26	Smoke	Detonation	488
7/5/56	Smoke canister	E28	Smoke	Detonation	411
7/5/56	Smoke pot	M1		Burning	4
7/5/56	Smoke pot	M1		Detonation	45

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/56	Sodium nitrate (lb)			Burning	57
7/5/56	Squibs electric			Burning	125
7/5/56	Starter mix			Detonation	50
7/5/56	T/fin	60-mm		Detonation	2,890
7/5/56	Thermate and first-fire mix			Detonation	5,250
7/5/56	Thermate and first-fire mix (lb)			Burning	22,410
7/5/56	Thermate and first-fire mix (lb)			Burning	16,380
7/5/56	Thermate and first-fire mix (lb)			Burning	7,920
7/5/56	Training incendiary	M1A1		Burning	2
7/5/56	Canister	75-mm	WP	Detonation	5
10/5/56	Bomb	M47A3	PWPV	Detonation	1
10/5/56	Bomblet	E54		Burning	30
10/5/56	Bomb	AN-M50X-A3		Burning	38,259
10/5/56	Bomb	N47	Napalm	Burning	65
10/5/56	Bomb	M74		Burning	8
10/5/56	Bomb	M47	Napalm	Detonation	10
10/5/56	Booster	M21A4		Detonation	53
10/5/56	Burster	M4		Detonation	2
10/5/56	Burster	E12R1		Detonation	76
10/5/56	Burster	M10		Detonation	20
10/5/56	Burster	E10R1		Detonation	5
10/5/56	Burster for CML land mine	M3		Detonation	81
10/5/56	Burster for shell	105-mm		Detonation	1
10/5/56	Burster for shell	155-mm		Detonation	8
10/5/56	Cap, blasting electric			Detonation	61
10/5/56	Cap, nonelectric			Detonation	9
10/5/56	Cartridge, ignition	M2		Burning	5,414
10/5/56	Cartridge ignition, mortar	4.2		Burning	2,188
10/5/56	Casing burster aluminum	T92		Burning	9,074
10/5/56	Composition block	C-3		Detonation	21
10/5/56	Composition block	C-3		Detonation	44
10/5/56	Container		CG	Burning	8
10/5/56	Contaminated wood (ft)			Burning	600

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
10/5/56	Cylinder		Nitrate	Burning	36
10/5/56	Cylinder equition for PFT			Burning	19
10/5/56	Detonating cord (ft)			Detonation	99
10/5/56	Drum	55-gal	FS	Detonation	1
10/5/56	Dynamite stick			Detonation	12
10/5/56	Fuse, safety time (ft)			Burning	36
10/5/56	Fuse	M210		Burning	650
10/5/56	Fuse	M46A1		Burning	15
10/5/56	Grenade		WP	Burning	1
10/5/56	Grenade, colored	M18		Burning	166
10/5/56	Grenade, HC	M18		Burning	22
10/5/56	Hexachlorethane (lb)			Burning	40
10/5/56	Incendaries, training			Burning	36
10/5/56	Instructional bomb		Incendiaries	Burning	5
10/5/56	Magnesium and black powder (lb)			Burning	60
10/5/56	Motar shell	57-mm	WP	Detonation	12
10/5/56	Prima cord (ft)			Burning	7,500
10/5/56	Prima cord (ft)			Detonation	50
10/5/56	Prima cord (ft)			Detonation	100
10/5/56	Primer stabalizers			Burning	198,900
10/5/56	Rocket head	2.25	HE	Detonation	8
10/5/56	Rocket motor SCAR	2.25		Detonation	1
10/5/56	Shell burster	T17		Detonation	149
10/5/56	Shell, recoiless	57-mm	WP	Detonation	50
10/5/56	Shell	155-mm	H	Burning	2
10/5/56	Shell	155-mm	PWPV	Detonation	136
10/5/56	Shell	T92	WP	Detonation	60
10/5/56	Shell	155-mm	WP	Detonation	20
10/5/56	Shell	60-mm		Detonation	38
10/5/56	Shell	75-mm	WP	Detonation	9
10/5/56	Shell	105-mm	WP	Detonation	8
10/5/56	Thermate and first-fire mix			Burning	82,400
10/5/56	TNT (lb)			Detonation	2

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
10/5/56	Sludge		WP	Burning	3,420
1/7/57	Ammunition, bullets	50-cal	CN	Burning	120
1/7/57	Ball ammunition	30-cal		Detonation	1,028
1/7/57	Bomblets (BW)			Burning	8
1/7/57	Bomb	AN-50X-A3		Burning	9,038
1/7/57	Bomb	M47	Napalm	Burning	108
1/7/57	Bomb	E54R6	G-simulant	Burning	30
1/7/57	Bomb	E50	PT3	Burning	3
1/7/57	Bomb	E54R6	Simulant	Detonation	28
1/7/57	Bomb	M78	CK	Detonation	4
1/7/57	Bomb	M47	Napalm	Detonation	3
1/7/57	Bomb cluster, armable, 500-lb	M19		Burning	66
1/7/57	Bomb cluster, 1,000-lb	E101R3	Simulant	Burning	4
1/7/57	Bomb w/o fuse	M69	Napalm	Burning	71
1/7/57	Bomb, cluster	M19		Burning	840
1/7/57	Burster	M3		Burning	4,300
1/7/57	Burster	M4		Burning	1,221
1/7/57	Burster	M4		Detonation	1,245
1/7/57	Burster	M10		Detonation	800
1/7/57	Burster	E12R1		Detonation	167
1/7/57	Burster	155-mm		Detonation	20
1/7/57	Burster for CML land mine	M3		Detonation	20
1/7/57	Candles		CN	Burning	5
1/7/57	Canisters	HC72R1		Detonation	11
1/7/57	Cap blasting electric			Detonation	23
1/7/57	Cap blasting nonelectric			Detonation	8,724
1/7/57	Composition block, 1/2-lb	C-3		Detonation	37
1/7/57	Container		L	Detonation	1
1/7/57	Container		G	Burning	10
1/7/57	Container		H	Detonation	1
1/7/57	Contaminated material			Burning	1,300
1/7/57	Cylinder, commercial		G	Detonation	1
1/7/57	Cylinder		AC	Detonation	7

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
1/7/57	Cylinder		CK	Detonation	2
1/7/57	Cylinder, commercial		CG	Detonation	1
1/7/57	Cylinder, portable		CK	Detonation	4
1/7/57	Cylinder, commercial		CK	Detonation	2
1/7/57	Drum		G-contaminated material	Burning	6
1/7/57	Field identification sets			Burning	28
1/7/57	FS			Detonation	100
1/7/57	Fuse	AN-M100A1		Detonation	1
1/7/57	Fuse, artillery	M77		Detonation	1
1/7/57	Fuse, bomb	Mt-M152E1		Detonation	4
1/7/57	Fuse, bomb	T55A1		Detonation	1
1/7/57	Fuse, butterfly bomb, inert			Detonation	10
1/7/57	Fuse, grenade	M206A1		Detonation	900
1/7/57	Fuse, grenade	M201		Detonation	600
1/7/57	Fuse, w/booster	M503A1		Detonation	2
1/7/57	GB			Detonation	1
1/7/57	Grenade		Incendiary	Burning	2
1/7/57	Grenade (hand grenade)	M14	Smoke thermate	Burning	2
1/7/57	Grenade (hand grenade)	M18	Smoke red	Burning	688
1/7/57	Grenade (hand grenade)	M18	Smoke green	Burning	576
1/7/57	Grenade (hand grenade)	M18	Smoke yellow	Burning	336
1/7/57	Grenade	E-15-2	Colored	Burning	24
1/7/57	Grenade	M7A1	CN	Burning	176
1/7/57	Grenade	M8	HC	Burning	200
1/7/57	Igniter, grenade			Burning	300
1/7/57	Igniter, sodium-fused			Detonation	49
1/7/57	Incendiary, training			Burning	22
1/7/57	Kit, CML field identification			Detonation	5
1/7/57	Larvacide (lb)			Detonation	44
1/7/57	Nitro starch (lb)			Detonation	150
1/7/57	Prima cord (ft)			Burning	1,932
1/7/57	Prima cord (ft)			Detonation	186
1/7/57	Primer, percussion	M34		Burning	372

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
1/7/57	Primer, percussion			Detonation	2
1/7/57	Primer, percussion	M32		Burning	646
1/7/57	Rocket	4.5	G	Detonation	8
1/7/57	Rocket		GA	Detonation	1
1/7/57	Rocket	3.5	HE	Detonation	5
1/7/57	Rocket head	7.2	WP	Detonation	6
1/7/57	Rocket motor	2.25-in.		Burning	521
1/7/57	Shell	155-mm	GA	Detonation	4
1/7/57	Shell mortar	4.2	G	Detonation	4
1/7/57	Shell	105-mm	WP	Burning	214
1/7/57	Shell	T92	WP	Burning	12
1/7/57	Shell	76-mm	WP	Burning	12
1/7/57	Shell	T92	WP	Burning	11
1/7/57	Shell	75-mm	WP	Burning	7
1/7/57	Shell	90-mm		Detonation	11
1/7/57	Shell	75-mm	WP	Detonation	10
1/7/57	Shell	T64 105-mm		Detonation	11
1/7/57	Shell	90-mm	WP	Detonation	2
1/7/57	Shell mortar	T.6, 60-mm	WP	Detonation	38
1/7/57	Smoke pot	M1		Burning	4
1/7/57	Solution-fission product, 120-gal bottles		Fuming nitric acid	Detonation	11
1/7/57	Thermate and first-fire mix			Burning	23,795
1/7/57	Time fuse			Burning	12
5/1/57	Blowing primer	120-mm		Detonation	21
5/1/57	Blowing primer	90-mm		Detonation	1
5/1/57	Bomb		Black powder	Burning	1,100
5/1/57	Bomb	M69		Detonation	129
5/1/57	Bomb	ANM50XA3		Burning	28,728
5/1/57	Bomb	M50X		Burning	1,100
5/1/57	Bomb	ANM50A3		Burning	142
5/1/57	Bomb	ANM50		Burning	476
5/1/57	Bomb	M47	Napalm	Burning	311
5/1/57	Bomb	250-kg	G	Burning	15

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
5/1/57	Bomb	M47		Burning	40
5/1/57	Bomb	M69	Napalm	Detonation	18
5/1/57	Bomb	ANM50XA3		Detonation and burning	9,944
5/1/57	Bomb		Incendiary napalm	Detonation and burning	216
5/1/57	Bomb, 100-lb	M47A3	Incendiary	Detonation and burning	148
5/1/57	Bomb	ANM50XA2		Detonation and burning	80
5/1/57	Bomb		black powder	Detonation and burning	44
5/1/57	Bomb	ANM50A3		Detonation and burning	20
5/1/57	Bomb (500-lb PT)	M78		Detonation	2
5/1/57	Bomb aimable clusters	M19		Burning	30
5/1/57	Bomb contaminated case, 250-kg			Burning	22
5/1/57	Bomb incend, instr			Burning	15
5/1/57	Bomb incend, instr	M1A1		Burning	7
5/1/57	Bomb, 250-kg			Detonation and burning	330
5/1/57	Bomb, 500-lb	M76	PT1	Burning	92
5/1/57	Bomb, 500-lb	M76	PTL	Detonation	12
5/1/57	Burster	M14		Detonation	1,865
5/1/57	Burster	M4		Detonation	300
5/1/57	Burster	M2		Detonation	2
5/1/57	Burster	M17		Detonation	1
5/1/57	Burster	M14		Detonation	12
5/1/57	Cap, blasting electric special			Detonation and burning	305
5/1/57	Cap, blasting nonelectric			Detonation	11
5/1/57	Cap, electric			Detonation	211
5/1/57	Cap, nonelectric			Detonation	9
5/1/57	Cartridge case for fuse	M2	Black powder	Burning	60,040
5/1/57	Clusters	M19		Burning	25
5/1/57	Composition block, 1/2-lb	C-3		Detonation and burning	30
5/1/57	Composition (lb)	C-3		Detonation	4
5/1/57	Container		H	Burning	1
5/1/57	Container		G	Burning	22
5/1/57	Contaminated material		G, M	Burning	2,000
5/1/57	Cylinder		H, S	Venting	1

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
5/1/57	Cylinder		Oxygen	Venting	1
5/1/57	Detonating cord (ft)			Burning	1,645
5/1/57	Detonating cord (ft)			Detonation	5,670
5/1/57	Mix (lb)		DM	Burning	26
5/1/57	Drum, contaminated	PCL-3		Burning	4
5/1/57	Drum, red fuming		Nitric acid	Venting	2
5/1/57	Duds	E24R1		Detonation	13
5/1/57	Duds	E10R1		Detonation	48
5/1/57	Fuse	M48A3		Detonation	1
5/1/57	Fuses	M174		Burning	154
5/1/57	Fuses	M206		Detonation	1,627
5/1/57	Fuses	M206A1		Detonation	800
5/1/57	Fuses, mech	SQM500		Detonation	3
5/1/57	Fuse, safety time (ft)			Burning	6
5/1/57	Grenade, hand		WP	Detonation and burning	8
5/1/57	Ignition cylinder, flame thrower			Burning	202,670
5/1/57	Incendiary			Burning	8
5/1/57	Lead-ins			Burning	13
5/1/57	Lead-ins			Detonation	349
5/1/57	Prima cord (ft)			Burning	4,550
5/1/57	Prima cord (ft)			Detonation	350
5/1/57	Propellant charge			Burning	21
5/1/57	Propellant charge	T26		Detonation	2
5/1/57	Shell	T92	WP	Burning	425
5/1/57	Shell	76-mm	WP	Burning	18
5/1/57	Shell	155-mm	H	Burning	3
5/1/57	Shell	75-mm	WP	Detonation	19
5/1/57	Sleeves loaded w/primer det			Burning	60,659
5/1/57	Slides	N24R1		Burning	13
5/1/57	Slides from fuses	E21R1		Detonation	649
5/1/57	Can, anti-dim		Colored smoke	Burning	32
5/1/57	Smoke grenade			Burning	225
5/1/57	Smoke mix salvage (lb)			Burning	30

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
5/1/57	Tetryl (lb)			Burning	23
5/1/57	Tetrytol and pentolite (lb)			Detonation	20
5/1/57	Thermate (lb)			Burning	67,000
5/1/57	TNT (lb)			Detonation	19
5/1/57	TNT (lb)			Detonation	2
5/1/57	Tracers	M502B1		Detonation	4
7/5/57	Assembly igniting for rifle	75-mm		Burning	406
7/5/57	Assembly igniting rifle	75-mm		Detonation	630
7/5/57	Bomb	M50XA2		Burning	21,780
7/5/57	Bomb	M50A2		Burning	3,881
7/5/57	Bomb	M69	Napalm	Burning	2,878
7/5/57	Bomb	M50KA1		Burning	2,000
7/5/57	Bomb	250-kg		Burning	125
7/5/57	Bomb	M50K		Burning	2
7/5/57	Bomb	M50X		Detonation	17
7/5/57	Bomb	M50A2		Detonation and burning	1,140
7/5/57	Bomb	M76		Detonation and burning	39
7/5/57	Bomb	M47		Detonation and burning	17
7/5/57	Bomb	M69		Destroyed by Demilitarization	500
7/5/57	Bomb	M1A1	Incendiary	Burning	55
7/5/57	Bomb	M76	PTI	Detonation	88
7/5/57	Bomb	M47	WP	Burning	1
7/5/57	Bomb, 100-lb	M47	Incendiary napalm	Burning	185
7/5/57	Bomb, 250-kg			Detonation and burning	500
7/5/57	Bomb	M69	Napalm	Burning	200
7/5/57	Boron aluminum hydride (lb)			Burning	15
7/5/57	Burster (charge)	M6		Burning	7
7/5/57	Burster igniter	M15-M16		Detonation	10,300
7/5/57	Burster	M14		Detonation	9,042
7/5/57	Burster	M6		Detonation	17
7/5/57	Burster	120-mm		Detonation	1
7/5/57	Burster	M8	TNT	Detonation	32
7/5/57	Burster bomb	AMM14, M76	500-lb incendiary	Detonation	360

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/57	Canisters	M2		Burning	773
7/5/57	Canisters	M1 & M2		Burning	158
7/5/57	Cap adapter burster	M21		Detonation	36
7/5/57	Cap, blasting	#4		Detonation	2,180
7/5/57	Cap, blasting	#6		Detonation	2,400
7/5/57	Cap, blasting nonelectric			Detonation	188
7/5/57	Cap, blasting spec electric			Detonation	363
7/5/57	Cap, nonelectric			Detonation	30
7/5/57	Cartridge case	90-mm		Detonation	2
7/5/57	Charge prop gun	T21 for 120-mm		Burning	2
7/5/57	Clusters	M12		Destroyed	18
7/5/57	Mix (lb)		CN	Burning	450
7/5/57	Mix		Comp B and pentolite	Burning	14
7/5/57	Composition block	C-3		Detonation	68
7/5/57	Composition block	C-3		Detonation	38
7/5/57	Container		Red nitric acid	Burning, flushing, and cleaning	14
7/5/57	Scrap material		Contaminated with WP	Burning	150
7/5/57	Cylinder		Chlorine	Detonation	16
7/5/57	Detonating cord			Detonation	1,700
7/5/57	Detonating cord			Detonation	40
7/5/57	Mix (lb)		DM	Burning	50
7/5/57	Drum, latex scrap			Burning	3
7/5/57	Fuse, safety time (ft)			Burning	100
7/5/57	Fuse cup		Tetryl	Detonation	456
7/5/57	Fuse cup w/starter mix			Detonation	40
7/5/57	Fuse lighter			Detonation	14
7/5/57	Fuse safety			Detonation	331
7/5/57	Fuse	M49A3		Burning	4,225
7/5/57	Fuse	M2		Burning	6,800
7/5/57	Fuse	E24R1		Burning	500
7/5/57	Fuse	M6A3		Detonation	75
7/5/57	Fuse	M157		Demilitarization	5,805
7/5/57	Fuse	E10R3		Demilitarization	1,500

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/57	Fuse	M69		Demilitarization	100
7/5/57	Fuse bomb	M1 from M69		Burning	200
7/5/57	Fuse w/burster, assorted			Detonation	47
7/5/57	Grenade	M16		Burning	924
7/5/57	Grenade	M25 CW		Burning	1
7/5/57	Grenade w/tank rifle comp		B	Detonation	9
7/5/57	Grenade, hand		Smoke	Burning	2,000
7/5/57	KD (gal)			Burning	55
7/5/57	Lighter fuse	M2		Detonation	2
7/5/57	Loose condemned TNT			Detonation	75
7/5/57	Magnesium ethyl chloride (qt)			Burning	8
7/5/57	Picric acid			Detonation	15
7/5/57	Prima cord (ft)			Detonation	4
7/5/57	Primer	M26		Detonation	46
7/5/57	Primer, elec	T28		Detonation	210
7/5/57	Primer MKV			Detonation	100
7/5/57	Primer, percussion elec	T8503		Detonation	2
7/5/57	Projectors - living, 65-lb		Chlorine	Detonation and burning	3
7/5/57	Prop for earth rod	M2	Powder	Burning	495
7/5/57	Prop gun	M6 for 76-mm	Powder	Burning	105
7/5/57	Perchloric acid			Burning	40
7/5/57	Rocket head	7.2	WP	Detonation and burning	1
7/5/57	Rocket head	2.25		Detonation	20
7/5/57	Rocket head	6.5	Comp B	Detonation	4
7/5/57	Rocket motor, complete	6.5	Liquid form	Burning	4
7/5/57	Rocket motor, complete	2.7		Burning	2
7/5/57	Rocket	70-mm T264		Detonation	12
7/5/57	Rocket motor, complete	2.5		Detonation	2
7/5/57	Shell	37-mm	WP	Detonation	2
7/5/57	Shell gun	120-mm	WP	Detonation and burning	1
7/5/57	Shell	75-mm H		Burning	7
7/5/57	Shell	4.2		Detonation	6
7/5/57	Shell	4.2	CM, FS	Detonation	4

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
7/5/57	Shell	57-mm	Incendiary	Detonation	2
7/5/57	Shell	4.2	CM, WP	Detonation	3
7/5/57	Mix		Smoke, colored	Burning	300
7/5/57	Sodium amide			Burning	50
7/5/57	Starter mix (lb)			Burning	25
7/5/57	Tank		Napalm	Detonation	2
7/5/57	Therm (lb)	64C		Burning	94,500
7/5/57	Thermate and first-fire mix (lb)			Burning	31,200
7/5/57	TNT, 1/2-lb blocks			Detonation	165
7/5/57	TNT blocks, 1/2-lb			Detonation	18
10/10/57	Agent (gal)		HD	Detonation and burning	100
10/10/57	Agent (lb)		L	Detonation and burning	100
10/10/57	Bomb, 1,000-lb		CK	Detonation	2
10/10/57	Bomb, 250-lb		GA	Detonation and burning	82
10/10/57	Bomb, 1,000-lb		Sap HE	Detonation	1
10/10/57	Bomb	M50		Detonation and burning	1,115
10/10/57	Bomb	M70	GA	Detonation and burning	20
10/10/57	Bomb	M70	GA	Detonation and burning	388
10/10/57	Bomb, dud	M70		Detonation	5
10/10/57	Bomb, dud	M69		Detonation and burning	100
10/10/57	Bomb, 250-kg			Detonation and burning	880
10/10/57	Burster	M14		Detonation	11,151
10/10/57	Burster	E12R1		Detonation	323
10/10/57	Burster	M6		Detonation	2
10/10/57	Burster	E12R1		Detonation and burning	300
10/10/57	Cap, detonating electric			Burning	400
10/10/57	Cap, detonating electric			Detonation	121
10/10/57	Cap, detonating electric			Detonation and burning	10
10/10/57	Cap, detonating nonelectric			Detonation	45
10/10/57	Cap, spec elec			Detonation	1,632
10/10/57	Cluster	M12		Burning	788
10/10/57	Cluster	M19		Burning	2,640
10/10/57	Cluster	M69		Detonation	7

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
10/10/57	Cluster	M12		Detonation	7
10/10/57	CML M	4.2	FS	Detonation	4
10/10/57	Comp (lb)	C-3		Detonation	14
10/10/57	Comp (lb)	C-3		Detonation and burning	4
10/10/57	Comp, 1/2-lb block	C-3		Detonation	4.3
10/10/57	Composition, block	C-3		Burning	44
10/10/57	Container	M3	Rocket fuel	Burning	3
10/10/57	Container (1 ton)		H	Burning	4
10/10/57	Container (1 ton)		GA	Detonation and burning	2
10/10/57	Cup from bomb	M69	WP	Detonation	2
10/10/57	Cylinder		PTI	Detonation and burning	1
10/10/57	Cylinder		CL	Detonation	4
10/10/57	Delay	E-10		Detonation	234
10/10/57	Delay element			Detonation	328
10/10/57	Detonating cord (ft)			Detonation	5,690
10/10/57	Detonating cord (ft)			Detonation	285
10/10/57	Detonating cord			Detonation and burning	10
10/10/57	Drum	50-gal	HD	Detonation and burning	2
10/10/57	Drum	55-gal	HD	Detonation and burning	8
10/10/57	Fuse	M13A1		Detonation	1
10/10/57	Fuse, safety time (ft)			Burning	32
10/10/57	Fuse, safety (ft)			Detonation	38
10/10/57	Fuse, safety (ft)			Detonation and burning	11
10/10/57	Fuse, safety (ft)			Burning	5
10/10/57	Fuse, safety (ft)			Burning	36
10/10/57	Fuse floating smoke pot	M208		Detonation and burning	16,595
10/10/57	Fuse lighters	M2		Burning	2
10/10/57	Fuse lighters			Detonation	5
10/10/57	Fuse	M206		Burning	145,480
10/10/57	Fuse	M206A1		Burning	4,800
10/10/57	Fuse	E24R1		Detonation	78
10/10/57	Fuse	M150		Detonation	5
10/10/57	Fuse	M2		Demilitarization	32,000

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
10/10/57	Fuse	M126A1		Demilitarization	5,100
10/10/57	Fuse all types			Burning	210
10/10/57	Gas indent, set			Detonation and burning	5
10/10/57	Gasoline (gal)			Burning	1,500
10/10/57	Gasoline (gal)			Burning	301
10/10/57	Grenade		Colored smoke	Burning	1,807
10/10/57	Grenade		WP	Detonation	2
10/10/57	Holders w/primer			Detonation	100
10/10/57	ID set	M1		Detonation and burning	35
10/10/57	Lead cap		Tetryl	Detonation	300
10/10/57	Misc munition (lb)			Detonation	50
10/10/57	Mortar round	4.2	WP	Detonation	35
10/10/57	Napalm (lb)			Burning	183
10/10/57	Napalm (lb)			Burning	45
10/10/57	Prima cord (ft)			Detonation	126
10/10/57	Prima cord (ft)			Burning	600
10/10/57	Prima cord (ft)			Detonation	10
10/10/57	Primer	T70		Burning	9
10/10/57	Projectile	37-mm	WP	Detonation	1
10/10/57	Projectile	90-mm	WP	Detonation	1
10/10/57	Projectile	155-mm		Detonation	5
10/10/57	Projectile	9-mm T92		Detonation	2
10/10/57	Projectile (charge)	T21E1		Detonation	20
10/10/57	Projectile, live		FS	Detonation	5
10/10/57	Projectile		HE	Detonation	13
10/10/57	Propelling (charge)			Burning	47
10/10/57	Rocket	2.36		Detonation	1
10/10/57	Drum	M3	Rocket fuel	Detonation	5
10/10/57	Rocket head	3.5		Detonation	1
10/10/57	Rocket	2.75		Detonation	3
10/10/57	Rocket	5	FS	Detonation	5
10/10/57	Rocket head			Detonation	21
10/10/57	Shell, dud	4.2	FS	Detonation	1

TABLE B.1 (Cont.)

Time	Item	Type	Content	Destruction Process	Quantity
10/10/57	Shell	120-mm		Detonation	6
10/10/57	Shell	60-mm		Detonation	6
10/10/57	Shell	90-mm		Detonation	5
10/10/57	Smoke pot	M7		Detonation and burning	6
10/10/57	Smoke pot, floating			Burning	46
10/10/57	Tetrol (lb)			Detonation	110
10/10/57	TNT, 1/2-lb blocks			Detonation and burning	5
10/10/57	TNT, 1/2-lb			Detonation	217
10/10/57	TNT (lb)			Detonation	11