WSRC-RP-95-1539, REV. 1

RCRA FACILITY INVESTIGATION/ REMEDIAL INVESTIGATION REPORT WITH BASELINE RISK ASSESSMENT

FOR THE

CENTRAL SHOPS BURNING/RUBBLE PIT (631-6G) (U)

VOLUME I

FINAL

APRIL 1996

Westinghouse Savannah River Company
Savannah River Site
Aiken, South Carolina 29808

SAFETY · RESPONSIBILITY · SECURITY
SRS
SAVANNAH RIVER SITE

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT DE-AC09-89-SR18035

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Revision 1

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ERRATA

The attached pages are provided in response to South Carolina Department of Health and Environmental Control (SCDHEC) comments on the RFI/RI/BRA for the Central Shops Burning/Rubble Pit (631-6G), WSRC-RP-95-1539 Rev. 1 April 1996. These pages should be inserted into the Central Shops Burning/Rubble Pit (631-6G), WSRC-RP-95-1539 Rev. 1 in the following manner:

Replace rev 1.0 cover page and spine with rev 1.1 cover page and spine.

Errata sheet to be inserted after the "Disclaimer" page.

Table of Contents Changes

Replace pages vii-x in the Table of Contents with the revised pages vii-x having the revised pages for the text.

Replace pages xv,xvi in the Table of Contents with the revised pages xv,xvi having the revised pages for the figures.

Replace pages xxi,xxii in the List of Appendices with the revised pages xxi,xxii having the revised contents for the Appendices.

Text Changes

Replace all three pages of the Executive Summary with the new three page Executive Summary, having all the revised text.

Replace pages 5-32 through 5-34 in Rev. 1. with the revised pages 5-32 through 5-35, having the revised text.

Figure 5-1 now appears on Page 5-35a, previously on page 5-35.

Replace page 5-36 and 5-37 with revised 5-36 and 5-37. Revisions are only on page 5-37 (Table 5.2).

Replace pages 7-8 through 7-12 with revised 7-8 through 7-13 having all the revised text.

Figure 7-1 now appears on Page 7-14, previously on page 7-11.

Appendix Changes

Delete Appendix G-2 from Appendix in Volume II; Calculations for the site specific SSLs are in Appendix L

Add Appendix L to the Volume II; Appendix L is new for this revision.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF PLATES

LIST OF APPENDICES

ACRONYMS AND GLOSSARY

<	Qualifier: Less than the detection limit specified in the results field.
//	Qualifier: Separation fields for the three types of data flags: result qualifiers, analysis qualifiers, and bias codes. In the event no data qualifiers are assigned to validated data, "//" will be displayed in the data qualifier field. Data which have not been validated will not display "//".
2,4-D	2,4-Dichlorophenoxyacetic Acid (EPTox, TCLP herbicide)
2,4,5-TP	2,4,5-Trichlorophenoxyacetic acid (Silvex) (EPTox, TCLP herbicide)
3	Qualifier: Analytical factor causing bias, the associated result may be of poor precision (high variability).
A	Analysis Qualifier: Relative Retention Time or mass spectra criteria not met for organics compound identification. Used with "U" or "UJ" for anomalies in pesticide identification.
ACGIH	American Conference of Governmental Industrial Hygienists
ACU	Above confining unit (drilling)
ADI	Allowable Daily Intake. The traditional practice for evaluating exposure to noncarcinogenic compounds has been to experimentally determine the No-Observable-Adverse-Effect-Level (NOAEL) on laboratory animals and then divide this dose rate by a safety factor in order to establish an acceptable dose rate or Allowable Daily Intake (ADI) (mg/kg body weight/day) for humans. The Fraction of ADI is determined by dividing the average daily dose rate by the ADI; as the units cancel out, the Fraction of ADI is dimensionless. A Fraction of ADI of 1.0 or less is a conservative exposure level which will result in no adverse chronic effect on the most sensitive segment of the human population.
AF	Adherence Factor
ARARs	Applicable or Relevant and Appropriate Requirements

ACRONYMS AND GLOSSARY (Continued)

Aroclor®	Trade name for Series 1016, 1221, 1232, 1242, 1248, 1254, 1260 PCB's (stable, fire-resistant compounds), produced by Monsanto (and others 1929-1977) for use in transformers; may yield PCDFs (and HCl) at temperatures of 600-650°C in the presence of excess oxygen, do not produce PCDDs; also Askarel™ and Therminol™; targets liver, lipophilic (bioaccumulation and biomagnification), 1300 victims in Yusho, Japan, 1968 (leaking heat exchanger in rice oil processing plant)
ATSDR	Agency for Toxic Substances and Disease Registry, branch of CDC
ATTA	Advanced Tactical Training Area, area in the northeast part of SRS used by Wackenhut for small unit tactics training
AWQC	EPA Ambient Water Quality Criteria
B	Qualifier: The result is below the contract required detection limit and above or equal to the instrument detection limit. Used with "J".
BAF	Bioaccumulation Factor
BC	Blow counts (drilling, while driving split spoon)
BCF	Bioconcentration Factors
BG	Background
BNA	Base/Neutral and Acid Extractables (Semi-volatile organics)
BRA	Baseline Risk Assessment
BRP	Burning/Rubble Pit
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
C	Qualifier: Calculated. Value reported was not measured directly, but was calculated from other data available.
CAB	Citizen's Advisory Board
CAGs	criteria, advisories, and guidance (ARAR's not codified in the law)
CAMU	Corrective Action Management Unit
CDC	Center for Disease Control

ACRONYMS AND GLOSSARY (Continued)

CEC	Cation Exchange Capacity
C&CH	Circulate and condition hole (drilling)
CEIL	Ceiling Limit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act, 1980; amended by SARA, 1986
CFC	Chlorofluorocarbons
CFR	Code of Federal Regulation
CLP	Contract Laboratory Program
COC	Chemical of Concern
COC	Constituent of Concern
COC	Chain of custody
COI	Constituent of Interest
COOH	Coming out of hole (drilling)
COPC	Constituent of Potential Concern
CPF	Cancer Potency Factor, also q1*
CPS	Carcinogenic Potency Slope
CRP	CERCLA Community Relations Plan
CSBRP	Central Shops Burning/Rubble Pit
CS&D	Contaminated Soil and Debris
CSM	Conceptual Site Model
CSWE	Central Services Works Engineering
DCG	Derived Concentration Guidelines for radionuclides in water (DOE Order 5400.5) radiation dose protection standards represent the concentration that under conditions of continuous exposure for one year would result in an effective dose equivalent of 100 mrem (the level recommended by ICRP).
p,p'-DDD	1,1-Dichloro-2,2-bis(p-chlorophenyl)-ethane insecticide

ACRONYMS AND GLOSSARY (Continued)

p,p'-DDT	1,1,1-Trichloro-2,2-bis(p-chlorophenyl)-ethane insecticide
DECA	Decachlorobiphenyl, used in water quality laboratory work as a surrogate spike for pesticides and herbicides
DHEC	(South Carolina) Department of Health and Environmental Control
DNAPL	dense non-aqueous phase liquid
DOE	Department of Energy
DP	Drill pipe
DQO	Data Quality Objectives, specify data needed to support decisions regarding remedial response activities
ECQ	Ecological (hazard) Quotient
Eh	Oxidation-Reduction (Redox) Potential
EHRAV	Electronic Handbook of Risk Assessment Values
EP	Extraction Procedure
EPA	Environmental Protection Agency (regions same for FDA) Region 3: DE, MD, PA, VA, WV, DC Region 4: AL, FL, GA, KY, MS, NC, SC, TN
EPCRA	Emergency Planning and Community Right-to-know Act
EPTox	Extraction Procedure Toxicity (established by 45 CFR 33119, 5-19-80)
FDS	Field Data Sheet
FFA	Federal Facility Agreement (EPA, SCDHEC, and DOE)
FID	Flame ionization detector
FONSI	Finding Of No Significant Impact
FR	Federal Register
FS	CERCLA Feasibility Study
GC/MS	Gas Chromatograph/Mass Spectrometer
GIH	Going in hole (drilling)

ACRONYMS AND GLOSSARY (Continued)

GPR	Ground Penetrating Radar
GS	Ground surface
H	Analysis Qualifier: Internal standards performance criteria not met. Bias code: Analytical factor causing bias. The associated result may overestimate the true value (i.e., is bias high).
HASP	Health and Safety Plan
HCFC	Hydrochlorofluorocarbon
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HNu	brand name, photoionization detector for total short alkanes and aromatics
HP	Health Protection (changed to Radiological Control Operations in 1994)
HpCDD	Heptachlorodibenzo-p-dioxin
HpCDF	Heptachlorodibenzo-furan
HQ	Hazard Quotient (for individual contaminant, estimated dose/RfD, summed to give HI)
HSWA	Hazardous and Solid Waste Amendments, 1984
HxCDD	Hexachlorodibenzo-p-dioxin
HxCDF	Hexachlorodibenzo-furan
HYP	Hydropunch^{TM} groundwater sampling technology
I	Analysis Qualifier: Matrix spike recovery is not within control limits.
ICRP	International Council on Radiation Protection
ID	Inside Diameter (piping)
IDLH	Immediately Dangerous to Life and Health
IRIS	Integrated Risk Information System
IRo	Ingestion Rate-oral
IRS	Ingestion Rate Soil

ACRONYMS AND GLOSSARY (Continued)

IRW	Ingestion Rate Water
J	Result Qualifier: The analytical result is an estimated quantity.
Kd	Partition Coefficient which relates the amount of a chemical species in the solid phase (soil) to that in the liquid phase (groundwater) at thermodynamic equilibrium
Koc	Soil adsorption (organic carbon partition) coefficient
Kow	Soil octanol/water partition coefficient
Kp	Partition coefficient (sediment/water)
L	Result Qualifier: Off scale high. The actual value is not known but is known to be greater than the value shown. Analysis Qualifier: Calibration criteria (initial or continuing) were not met. Used with "J" or "U". Bias Codes: Analytical factor causing bias. The associated result may underestimate the true value (i.e., is biased low).
LLD	Lower Limits of Detection
LOAEL	Lowest Observed Adverse Effect Level
M	Qualifier: Presence of material is verified but not quantified. The analytical result field should be blank. For analyses yielding a presence/absence result, the analyte is present.
M&E	Metcalf and Eddy
MCL	Maximum Contaminant Level established in SDWA, 1974
MCLG	Maximum Contaminant Level Goal, health-based, non-enforceable goal
MDL	Method Detection Limit
MSDS	Material Safety Data Sheet
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NARM	Naturally-occurring and accelerator-produced radioactive material
ND	Not Detected, less than detection limits

ACRONYMS AND GLOSSARY (Continued)

NDA	No Data Available
NEPA	National Environmental Policy Act, 1969, 10CFR1021
NOAEL	No Observed Adverse Effect Level
NORM	Diffuse naturally occurring radioactive materials
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NSDWR	National Secondary Drinking Water Regulations, 40CFR143.3, non-enforceable standards relating to the aesthetic properties (such as taste, odor, and color) of public drinking water supplies, which influence public acceptance of drinking water
NSDWS	National Secondary Drinking Water Standards, 40CFR143.3
O	Analysis Qualifier: Surrogate spike recoveries are out of specification.
OCDD	Octachlorodibenzo-p-dioxin
OCDF	Octachlorodibenzo-furan
OD	Outside Diameter (piping)
OSHA	Occupational Safety and Health Act, 1970
OU	Operable Unit
OVA	Organic vapor analyzer
PAH	Polycyclic Aromatic Hydrocarbon,
PCB	Polychlorinated Biphenyls, Aroclor^{TM} is trade name for Series 1016, 1221, 1232, 1242, 1248, 1254, 1260 PCB's (stable, fire-resistant compounds), produced by Monsanto (and others 1929-1977) for use in transformers; may yield PCDFs (and HCl) at temperatures of 600-650^{o}C in the presence of excess oxygen, do not produce PCDDs; also Askarel^{TM} and Therminol^{TM}; targets liver, lipophilic (bioaccumulation and biomagnification), 1300 victims in Yusho, Japan, 1968

ACRONYMS AND GLOSSARY (Continued)

PCDD	Pentachlorodibenzo-p-dioxin
PCDD	Polychlorinated dibenzo-p-dioxins
PCDD/PCDF	polychlorinated dibenzo-p-dioxins and dibenzofurans
PCDF	Pentachlorodibenzo-p-furan
PCE	Tetrachloroethylene (perchloroethylene)
pCi	PicoCurie (2.2 disintegrations per minute)
pH	Negative logarithm of effective hydrogen-ion concentration
PID	Photoionization Detector
PIP	Public Involvement Plan
POOH	Pulling out of hole (drilling)
PP	Proposed Plan
ppb	parts per billion
ppbv	parts per billion by volume
ppm	parts per million
ppmv	parts per million by volume
PRG	Preliminary Remediation Goals
PRGS	Preliminary Remediation Goals Statement (EPA, 1991)
PRAO	Preliminary Remedial Action Objectives
PU	Picked up (drilling)
q1*	Cancer potency factor, the lifetime cancer risk for each additional mg/kg body weight per day of exposure
Q	Analysis Qualifier: Sample held beyond normal holding time.
R	Result Qualifier: Rejected because performance requirements in the sample or associated quality control analysis were not met. The analyte may or may not be present. Analysis Qualifier: ICP interference check sample criteria are not met. Used with "J", "UJ", or "R".

ACRONYMS AND GLOSSARY (Continued)

RBC	Risk Based Concentration
RCO	Radiological Control Operations (Formerly Hp)
RCRA	Resource Conservation and Recovery Act, 1976
RD	Rigged down (drilling)
RDA	Recommended Daily Allowance
Rem	Roentgen equivalent man
RfD	Reference Dose, estimate of a daily exposure to the human population that is likely to be without appreciable risk of deleterious effects during a lifetime
RFI	RCRA Facility Investigation
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study.
RME	Reasonable Maximum Exposure
RP	Rubble Pit
RU	Rigged up (drilling)
S	Analysis Qualifier: The reported value was determined by the method of standard additions.
SAP	Sampling and Analysis Plan
SBLK	Soil Blank (Laboratory QC)
SCDHEC	South Carolina Department of Health and Environmental Control
SCHWMR	South Carolina Hazardous Waste Management Regulations
SDWA	Safe Drinking Water Act, 1974, Title 42 USC 300
SF	Slope Factors
Silvex	2,4,5-Trichlorophenoxyacetic acid (2,4,5-TP) (EPTox, TCLP herbicide)
SRS	Savannah River Site
SS	Split spoon
SWMU	Solid Waste Management Unit

ACRONYMS AND GLOSSARY (Continued)

T	Analysis Qualifier: Peak height (instead of peak area) was used to quantitate the analyte, and all other identification criteria were met; or, a signal to noise ratio of the confirmation ion is below 2.5, but the GC/MS analyst determined that the peak was positive.
TAL	Target Analyte List
TCDD	Tetrachlorodibenzo-p-dioxin
TCE	Trichloroethene (trichloroethylene)
TCLP	Toxicity Characteristic Leaching Procedure, 40CFR264.24 (RCRA) test for characteristically toxic hazardous wastes developed using a subsurface fate and transport model, replaced EPTox on September 25, 1990
TD	Total Depth
TEF	Toxicity Equivalency Factor
TIC	Tentatively Identified Compounds
TIH	Tripping in hole (drilling)
TOOH	Tripping out of hole (drilling)
TSCA	Toxic Substances Control Act, 1976
U	Result Qualifier: The analyte was not detected. Value reported is the sample quanitification limit.
ug/L	Micrograms per Liter (ppb)
UL95	95% Upper Confidence Limit on the Mean
USEPA	United States Environmental Protection Agency
USFS	U. S. Forest Service
USGS	United States Geological Survey

ACRONYMS AND GLOSSARY (Continued)

V	Analysis Qualifier: The analyte was detected in an associated method blank. Used with "J" for non radionuclide analyses when the result is less than five times the amount in the associated blank (less than ten times for the common laboratory contaminants acetone, methyl chloride, 2-butanone, and phthalates). For radionuclide analyses, used with "J" when the result is less than five times the amount in the associated blank or "UJ" when the result is less than the detection limit.
VOC	Volatile Organic Compound
WIH	Went in hole (drilling)
WL	Water Level
WO	Waiting on (drilling)
WSRC	Westinghouse Savannah River Company
WT	Water Table
WU	Waste unit
Y	Analysis Qualifier: Sample was unpreserved or improperly preserved.

CERTIFICATION PAGE

Revision 1

EPA/SCDHEC Comment Response Resolution to the

RCRA Facility Investigation/ Remedial Investigation/ Baseline Risk Assessment
for the
Central Shops Burning/Rubble Pit (631-6G), Revision 0 (U)

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

Date: 4/1/96
Signature:
Title: A. M. Schwartzman, Program Manager
Environmental Restoration Department
Westinghouse Savannah River Company
Contractor for the U.S. Department of Energy
Savannah River Operations

Date: 4/3/96
Signature: Cynthia V. Ande
Title: C. V. Anderson, Director
Environmental Restoration Division
U.S. Department of Energy
Savannah River Field Office

EXECUTIVE SUMMARY

The Burning/Rubble Pits at the Savannah River Site (SRS) were usually shallow excavations approximately 3 to 4 meters in depth. Operations at the pits consisted of collecting waste on a continuous basis and burning on a monthly basis. The Central Shops Burning/Rubble Pit 631-6G (BRP6G) was constructed in 1951 as an unlined earthen pit in surficial sediments for disposal of paper, lumber, cans and empty galvanized steel drums. The unit may have received other materials such as plastics, rubber, rags, cardboard, oil, degreasers, or drummed solvents. The BRP6G was operated from 1951 until 1955. After disposal activities ceased, the area was covered with soil. Hazardous substances, if present, may have migrated into the surrounding soil and/or groundwater. Because of this possibility, the United States Environmental Protection Agency (EPA) has designated the BRP6G as a Solid Waste Management Unit (SWMU) subject to the Resource Conservation Recovery Act/Comprehensive Environmental Response, Compensation and Liability Act (RCRA/CERCLA) process.

The investigation of the BRP6G site was conducted during two (2) time frames. The initial field sampling activities were performed from March 25 through April 5, 1994. A total of ten soil borings were installed for the unit assessment activities per the Central Shops 631-6G RFI/RI Work Plan, Rev. 2. Preliminary results from this characterization indicated contamination is present in the RCRA Facility Investigation/Remedial Investigation (RFI/RI) unit soils.

Preliminary results from this investigation and a review of historical aerial photographs implied that the waste unit was actually larger than previously marked and investigated. Therefore, further characterization was deemed necessary. An additional sampling plan and monitor well installation plan was devised to incorporate the required groundwater monitoring well installation, surface water and sediment sampling, and further soil boring investigation. This additional sampling characterized the full extent of the pit as shown on the historical photographs.

The second phase of the investigation included the installation of twelve soil borings, collection of six surficial soil samples, and collection of surface water/sediment samples. Three temporary groundwater monitoring wells were also installed (one to the west, one to the south, and one to the southeast). Water level data from all the wells was incorporated in determining the hydraulic gradient of the groundwater. All wells were sampled for contaminants, and this data is included in this report.

As proposed in the Central Shops 631-6G RFI/RI Work Plan, Additional Sampling and Monitor Well Installation Plan, additional field activities were performed from November 2, 1994 through December 28, 1994 under Subcontract AA46326P, Task Order 72. All monitoring well installations were performed in accordance with SCDHEC 1985, South Carolina Well Standards and Regulations, R. 61-71, June 1985. An additional twelve (12) borings were taken and three (3) temporary groundwater monitoring wells were installed and sampled. Soil samples were collected from the twelve borings during drilling operations. The soil sample tables have deleted duplicates, replicates, and the applicable "V" qualified data. Surficial soil samples were collected at six (6) locations within the ditch located along the railroad, south of the unit. Also, five surface water/sediment samples were collected from the drainage ditch southeast of the unit. Slug tests were performed at each well and the data was reduced by the Bouwer-Rice method to calculate hydraulic conductivity.

Analysis of the surface soils, subsurface soils, groundwater and sediment indicate contamination by metals, semi-volatiles, and volatile organics. Radionuclides, pesticides, PCB's, dioxins and furans exhibit minor contamination of these media. The predominance of contamination is present from below four feet to the base of the pit, however the data shows little or no migration beyond pit boundaries.

A BRA was conducted on the data compiled from the analysis of the sampling described above. The purpose of the BRA is to help determine whether additional response action is necessary at the Central Shops Burning/Rubble Pit 631-6G. The BRA noted only potential contaminants of concern, none of which had a risk which was in excess of 10^{-4}, and were only slightly in excess of 10^{-6}. The future use of this area is proposed to be industrial. The risk drivers are arsenic, beryllium, bis (2-ethylhexyl) phthalate, chloromethane, and chloroform in groundwater and arsenic in the shallow subsurface soil. The manner of groundwater sample acquisition, bailing of sample, lends uncertainty to the results obtained from this method, particularly in the results for the metals.

As part of the RFI/RI/BRA for the Central Shops Burning/Rubble Pit, analysis of leachability to groundwater of soil contaminants was done for five chemicals of potential concern (COPC)s that failed a generic soil screening process. The five chemicals consist of two metals, chromium and barium, and three organic compounds, benzo(a)pyrene, benzo(b)fluoranthrene, and dieldrin. Spreadsheet calculations were made to estimate groundwater concentrations for the chemicals of concern. The modeled groundwater concentrations were used to determine the risk or hazard in both future adult/child and future industrial worker.

The hazard index for chromium (using the geochemically prevalent trivalent (III) state) and barium are significantly less than 1.0 for the adult/child (0.04) and for the future industrial worker (0.006). The soil leachability results for dieldrin and the two PAHs indicate they will not reach the groundwater.

The recommended remedial action objectives are for no further action. The BRA demonstrated that no contaminant exceeded levels of unacceptable risk for receptors, under the proposed future use scenario.

1.0 INTRODUCTION

1.1 Purpose of the RCRA Facility Investigation/Remedial Investigation

1.1.1 RCRA Facility Investigation (RFI) Program

The Savannah River Site (SRS), Aiken, South Carolina, of the U.S. Department of Energy (DOE) manages certain waste materials which are regulated under the 1976 Resource Conservation and Recovery Act (RCRA). RCRA is a comprehensive law requiring stringent management of hazardous wastes or constituents. The Hazardous and Solid Waste Amendments (HSWA) were passed in 1984 to further augment the 1976 RCRA requirements.

Units covered under RCRA are classified as either regulated or non-regulated. Regulated units are those surface impoundments, landfills, and waste piles (collectively termed "land disposal units") which have received hazardous waste since November 19, 1980 and require RCRA operating or post-closure permits.

The 1984 HSWA regulations require investigation and corrective action for non-regulated units at permitted facilities. These non-regulated units have been termed Solid Waste Management Units (SWMU) and may include any facility where hazardous constituents are potentially uncontrolled and may be released to the environment. Investigation and corrective action at these non-regulated units are mandated by RCRA Section 3004(u) and are managed under the SRS RCRA Facility Investigation (RFI) Program. The Central Shops Burning/Rubble 631-6G (hereafter referred to as the BRP6G) is a non-regulated unit which must be addressed under RCRA Section 3004 (u).

1.1.2 CERCLA Remedial Investigation (RI) Program

On December 21, 1989, SRS was included on the National Priorities List (NPL). A site included on the NPL falls under the jurisdiction of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In accordance with Section 120 of CERCLA, the DOE has negotiated a Federal Facility Agreement (FFA) with the U.S. Environmental Protection Agency (EPA) and the South Carolina Department of Health and Environmental Control (SCDHEC) to coordinate cleanup activities at SRS into one comprehensive strategy. Public participation requirements are listed in Sections 113 and 117 of CERCLA. These requirements include the establishment of an Administrative Record file that documents the selection of cleanup alternatives and provides for review and comment by the public on those alternatives. An SRS Public Involvement Plan (PIP) WSRC-RP-91-445, Rev. 2, is designed to facilitate public involvement in the decision-making processes for permitting, closure, and the selection of remedial alternatives. The PIP will address the requirements of CERCLA, RCRA, and the National Environmental Policy Act (NEPA).

The PIP is available to the public in information repositories located in communities near the SRS. In addition to the PIP, the public will have access to the Administrative Record through these repositories.

RCRA Facility Investigation/Remedial Investigation (RFI/RI) Reports, such as this one, will be a part of the Administrative Record and will be available to the public. Information repositories have been established at DOE's Public Reading Room located at the University of South Carolina campus in Aiken, South Carolina and the Thomas Cooper Library located at the University of South Carolina in Columbia, South Carolina. A notice will be published in local newspapers when information is being compiled regarding the investigation and cleanup of the BRP6G. Additional repositories may be added and/or locations changed to better meet the needs of the public.

This RFI/RI Report contains the results of the investigations conducted at the BRP6G from March 1994 through April 1994 and November through December 1994. This RFI/RI Report also provides a summary of previous investigation results. This investigation included soil boring and soil sampling, the installation of groundwater monitoring wells, groundwater sampling using monitoring wells and surface water and sediment sampling. Additionally the RFI/RI Report presents an evaluation of the results and recommendations for future action.

The primary objectives of this investigation of the BRP6G were to investigate and evaluate the sources of contamination, and pathways of contaminant movement as identified in the conceptual site model, (see Figure 2-1a). This investigation includes: .

1. Characterization of the potential source(s) of contamination;
2. Delineation of the extent of hazardous substance release to the soil;
3. Enhancement and refinement of the hydrogeologic characterization of the subsurface in the vicinity of the RCRA/CERCLA unit; and
4. Defining the vertical and horizontal extent of possible hazardous substances in the water table aquifer.

1.2 Unit Background

1.2.1 Unit Location and Description

The Central Shops Burning/Rubble Pit 631-6G (BRP6G) is located in the Central Shops Area near the center of the SRS (Plate 1-1). Figure 1-2 shows the relative location of the BRP6G with respect to Central Shops Area facilities. The BRP6G Solid Waste Management Unit (SWMU) is on the southeastern side of a divide that separates the drainage basins of the Pen Branch Creek [approximately 1.6 km (1 mi) to the southeast] and Fourmile Branch [approximately 4 km (2.5 mi) to the northwest] (Figure 1-2). The ground elevation is approximately 88.4 m [290 feet (ft)] above mean sea level (msl) (Gordon et al., 1987). Surface drainage is southward to an unnamed tributary of Pen Branch.

The BRP6G was constructed as an unlined earthen pit, or pits, dug into surficial sediments that were then filled with various waste materials. The location of the BRP6G is shown in relation to major SRS facilities on Plate 1-1. The region around the BRP6G is shown on Figure 1-2 and on two aerial photographs, Plates 1-2 and 1-3. A map of the BRP6G area is shown on Figure 1-3.

The BRP6G operated from 1951 through 1955 for disposal and burning of waste materials. The unit consisted of a shallow excavation, approximately 3 m (10 ft) deep. Materials believed to be disposed of in the pit include waste oils, rags, paper, cardboard, plastics, degreasers, wood, rubber, and drummed organic solvents were disposed of in the pit and periodically burned. The volume of waste disposed of at BRP6G was not reported. After disposal activities ceased, the area was covered with soil. The materials incinerated in the burning/rubble pit included potentially hazardous substances, such as organic solvents. Some of the hazardous substances, if present, may have migrated into the surrounding soil, and/or groundwater. Because of this possibility, the United States Environmental Protection Agency (EPA) has designated the BRP6G as a SWMU subject to the Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act (RCRA/CERCLA) process.

1.2.1.1 Geology of SRS

The following three distinct geologic and hydrologic systems occur in the subsurface beneath the SRS:

- Igneous and metamorphic rocks of Paleozoic age
- Lithified mudstones, sandstones, and conglomerates of Triassic age
- Unconsolidated to semi-consolidated Coastal Plain sediments of Late Cretaceous and Tertiary ages

Igneous and metamorphic rocks of the Piedmont and Blue Ridge Provinces were the source of the Coastal Plain sediments. Precambrian and Paleozoic slates, phyllites, schists, gneisses, volcanics and metavolcanics, granites, and mafics were formed under the influence of several orogenic episodes in the Appalachians. Similar Paleozoic igneous and metamorphic rocks outcrop in the Piedmont Province north of the Fall Line, which is approximately 30 miles northwest of the SRS. The rocks are generally rich in feldspar, providing a source for the kaolinite which is abundant in much of the updip Coastal Plain section.

The southeastern part of the SRS is underlain by poorly sorted mudstones, quartz sands, and conglomerates of the Triassic Newark Supergroup in the Dunbarton Basin. The Dunbarton Basin is a fault-bounded sedimentary basin in Paleozoic metamorphic rock, overlain by approximately 1200 ft of coastal plain sediments in the southeastern part of the SRS.

Both the Paleozoic and Triassic rocks were leveled by erosion and are unconformably overlain by unconsolidated to semi-consolidated Coastal Plain sediments. The Late Cretaceous to Recent Coastal Plain sediments comprise a clastic wedge that thickens and dips toward the southeast. In the vicinity of the SRS these sediments consist predominantly of sandy clays and clayey sands, although occasional beds of clean sand or clay also occur. Two bioclastic limestone zones occur discontinuously within the Eocene strata. These calcareous zones vary in thickness, where present, from about 1 foot to approximately 80 ft. They appear to be lens-like bodies that pinch out laterally into sand or clay facies. This erosional surface dips approximately 35 ft/mile to the southeast.

Known faults beneath the SRS are shown in Figure 1-4 and include the Pen Branch Fault; the Steel Creek Fault, located southeast of the Pen Branch Fault and parallel to it; the Ellenton and ATTA Faults that trend northwest and may intersect the Pen Branch Fault; and the northeast trending Crackerneck Fault in the northernmost part of the SRS.

The most recent stratigraphic interpretation, by Fallaw and Price, 1994, is shown in Figure 1-5. For a picture of the regional stratigraphy through the SRS, see Figure 1-6. Approximately two-thirds of the Coastal Plain section consists of Cretaceous quartz sands and clays which have characteristics of fluvial and deltaic deposits. These sediments have been assigned to the Cape Fear Formation, the Middendorf Formation, the Black Creek Group, and the Steel Creek Formation. Paleocene deposits are composed of quartz sands and clays of the lower Paleocene Sawdust Landing Formation and the upper Paleocene Lang Syne and Snapp Formations.

1.2.1.1.1 Cretaceous Sediments. The Cape Fear Formation is composed of poorly sorted, medium- to coarse-grained, muddy quartz sands and interbedded clays. Gray, yellow, orange, red, brown, tan, and blue colors are common. The sands are arkosic in places. Muscovite and iron sulfides also occur. Pebbly sands and gravel layers are common. Sands typically fine upward into clays and appear to be composed of two crudely upward fining supersequences of equal thickness. The Cape Fear Formation is more indurated than other Cretaceous formations because of high clay content and the abundance of low temperature silicate minerals in the matrix. Bedding is irregular and marine fossils are rare. This, in addition to the poor sorting and the high degree of oxidation, indicates that the sediments were deposited in fluvial and delta plain environments. The Cape Fear thickens across the SRS, ranging from 30 ft at the northwest SRS site boundary to about 200 ft at the southeast SRS site boundary.

The Middendorf Formation is composed mostly of tan, gray, and yellow, medium- and coarse-grained quartz sand. Sorting is generally moderate to good. Pebbly zones are common within the sand, and clay clasts occur in places. Parts of the unit are feldspathic, micaceous, and lignitic. Cross-bedding is well-developed in the lower section. A kaolinitic clay or a clay-and-interbedded-sand zone forms the top of the unit. The lower contact between the Middendorf and the Cape Fear Formations is marked by a pebbly zone. Wood fragments, spores, pollen, and rare dinoflagellates occur in the unit. The scarcity of marine fossils, the presence of wood fragments, and the discontinuous bedding indicate that most of the Middendorf was probably deposited in fluvial and deltaic environments. The Middendorf is approximately 100 ft thick near the northwestern boundary of the SRS and thickens to more than 180 ft near the southeastern boundary.

The Black Creek Group is generally comprised of interbedded quartz sands, silts, and clays. The Black Creek Group is generally darker, more micaceous, and more lignitic than the other Cretaceous units. The lower part of the unit is tan and light-gray, fine- to coarse-grained sand with moderate to poor sorting. The sand is micaceous and becomes lignitic in the central and southeastern parts of the SRS. Layers of pebbles and clay clasts are common and feldspathic zones occur locally. In the central and downdip parts of the SRS, a southeasterly-thickening wedge of dark, fissile, lignitic, pyritic, micaceous clay with dark, interbedded sands and silts occurs in the middle (McQueen Branch Confining Unit) and upper parts of the formation. The upper part of the formation consists mostly of tan and light gray sands (lower Crouch Branch Aquifer). In general, the Black Creek contains more dark clays, lignite, and muscovite than the Middendorf. Light-colored sands and large, oxidized clay lenses suggest delta plain conditions in the lower Black Creek in the northwestern part of the SRS. The dark clays and sands abundant in the southeastern part of the Site suggest delta front and prodelta environments. The Black Creek Group is about 200 ft thick at the northwestern boundary of the SRS and thickens to more than 300 ft near the southeastern boundary.

The Steel Creek Formation contains poorly to well-sorted, fine- to coarse-grained quartz sand and silty sand in the lower section. It is tan, light- to dark-gray, orange, and yellow in color. Concentrations of feldspar and lignite occur. Pebbly zones are common, as are layers with clay clasts. The upper part of the Steel Creek in most places at the SRS is oxidized, kaolinitic clay, with orange, red, gray, purple, and yellow coloring, interbedded with sands in places. In general, the Steel Creek has more oxidized clays, fewer and much thinner dark clays, and less lignite than the Black Creek. The Steel Creek grades into the calcareous siliciclastics of the Pee Dee Formation to the northeast and southeast. To the southwest it grades into the calcareous sands of western Georgia. The lateral limits of the Steel Creek have been arbitrarily set where the calcium carbonate content of the sediments is 5%. Wood fragments, spores, pollen, and rare dinoflagellates have been found. Scarce marine fossils, irregular bedding, and large bodies of oxidized clay suggest that the sediments were probably deposited in fluvial and delta plain environments. The Steel Creek Formation is about 60 ft thick at the northwestern SRS boundary and 140 ft thick at the southeastern boundary.

1.2.1.1.2 Paleocene Sediments. The Sawdust Landing is composed of gray, poorly and moderately sorted, micaceous, silty and clayey quartz sands and pebbly sands with interbedded, dark gray clays. In the northwestern part of the SRS it consists of yellow, orange, tan, moderately to poorly sorted, micaceous quartz sands. Locally feldspathic, iron sulfides and lignite are common in the darker parts of the section. Clays are fissile in places and contain micaceous silt and fine sand laminae. In general, the Sawdust Landing has more feldspar and iron sulfide than the Steel Creek, is darker, and sorting is poorer. The clays of the Sawdust Landing are more fissile than those of the Steel Creek. The Sawdust Landing is about 10 ft thick near the northwestern boundary of the SRS and thickens to about 40 ft near the southeastern boundary. The term "Sawdust Landing" rather than "Rhems" is used by Fallaw and Price (1994) because the lithology at the SRS is more similar to the type Sawdust Landing in central eastern South Carolina than it is to the type Rhems in eastern South Carolina. Light-colored, moderately to poorly sorted, micaceous quartz sands, feldspathic in places, which, interpreted by Fallaw and Price (1994) as upper delta plain deposits, are common in the northwestern part of the SRS, with darker, poorly sorted, micaceous lower delta plain facies becoming dominant in the southeastern part.

The Lang Syne Formation consists of dark-gray and black, lignitic clays and poorly and moderately sorted, micaceous, lignitic, muddy quartz sands and pebbly sands. Both sands and clays are glauconitic with a greensand at the base in places. Deposits composed of yellow, orange, tan, moderately to poorly sorted, micaceous quartz sands are common in the northwestern part of the SRS, with darker, poorly sorted, micaceous facies becoming dominant to the southeast. Basal sands lie on dark clays or dark sands of the Sawdust Landing, with a pebbly zone common at the contact. In general, the Lang Syne contains more glauconite, muscovite, lignite, and iron sulfide than the Sawdust Landing and the clay beds are much thicker. Light-colored, moderately to poorly sorted, micaceous quartz sands are common in the northwestern part of the SRS and are interpreted by Fallaw and Price (1994) as upper delta plain sediments. The thick dark clays probably accumulated in lagoons or bays. Darker, poorly sorted, micaceous lower delta plain and prodelta facies become dominant in the southeastern part of the SRS. The unit appears to be sporadic in the northwestern part of the SRS and thickens to about 80 ft near the southeastern boundary where it is calcareous.

The Snapp sediments, also referred to as the "Williamsburg Formation", are typically light-gray, tan, orange, and yellow, silty, micaceous, medium- to coarse-grained quartz sands and pebbly sands interbedded with kaolinitic clays. Sorting in the sands is generally poor. The Snapp is well-developed at the southeastern boundary where there are two upward fining sequences but appears to pinch out updip near Upper Three Runs. The Snapp Formation is about 70 ft thick near the southeastern boundary. The Snapp was designated by Fallaw and Price (1994) as a new formation name because the lithology is not similar to that of the type Williamsburg and Black Mingo in eastern South Carolina. The type section of the Snapp Formation is described from the core from SRS well P 22TA in southern Barnwell County, South Carolina. Snapp sands are usually lighter in color than Lang Syne sands, containing less lignite, iron sulfide, and glauconite. The Snapp probably grades into siliciclastics and limestones of the upper part of the Williamsburg Formation. The boundary has been arbitrarily placed where the section is 5% calcium carbonate (Fallaw and Price, 1994). The near absence of marine fossils, the generally poorly sorted sands, and the oxidized clays indicate that the environment of deposition was probably mostly upper delta plain.

1.2.1.1.3 Early-Middle Eocene. The Fourmile Branch Formation is composed of quartz sand with some interbedded clays. The Formation is mostly orange, green, gray, yellow, and tan, moderately to well sorted, fine- to coarse-grained quartz sand with green and gray clays a few feet thick in the middle and at the top. Dark clays rich in organic matter tend to be more abundant in the northwestern part of the SRS and glauconitic clays more common to the southeast. The unit is about 30 ft thick in the northwestern part of the SRS and appears to thin to the southeast and toward the Savannah River from the center of the SRS. A new formation name is used by Fallaw and Price (1994) to refer to a sand and interbedded clay unit deposited during a sedimentary cycle which preceded the one which deposited the Congaree. The type section is described from core from well MWD 3A in northwestern Barnwell County, South Carolina. In general, going upward across the Lang Syne/Fourmile Branch contact in the northwestern part of the SRS, the sands become cleaner, iron sulfide and lignite content decreases, colors become lighter, and clay bed thickness decreases. Going upward across the Snapp/Fourmile Branch contact to the southeast, sands become cleaner, glauconite increases, and clay bed thickness decreases. Downdip, the Fourmile Branch grades into the Fishburne Formation, a limestone. The contact is defined by Fallaw and Price (1994) where 25% of the section is composed of calcium carbonate. The only well-preserved fossils recovered from the Fourmile Branch are palynomorphs. The glauconite, the abundant dinoflagellates, and the moderate to good sorting indicate that the environment of deposition was shallow marine, with dark clays in the northwestern part of the SRS probably forming in bays or lagoons, and glauconitic clays in the southeastern part being deposited in neritic conditions.

The Congaree Formation consists of yellow, orange, tan, gray, and greenish-gray, moderately and well-sorted, fine- to coarse-grained quartz sands with thin clay laminae, pebbly layers, clay clasts, and glauconite. Quartz grains tend to be more well rounded than in the rest of the stratigraphic column. The top section of the Congaree Formation is cemented with silica in many areas of the SRS, slightly calcareous in other areas, and consistently calcareous near the southeastern boundary. The Congaree is similar to the Fourmile Branch but glauconite decreases, muscovite decreases, clay beds and laminae become less common, sorting becomes better, pebble content decreases, and colors become lighter above the contact in the Congaree. The Congaree Formation is approximately 60 ft thick at the northwestern SRS boundary and thickens to approximately 85 ft near the southeastern SRS boundary. Molluscan shell fragments, usually silicified, have been found in the Congaree at the SRS. Dinoflagellates were found in the lower and middle parts of the Congaree for age determinations. The well-sorted sands, the occurrence of glauconite, and the dinoflagellate assemblages indicate a shallow marine environment.

The Warley Hill is a fine- to medium-grained, poorly to well-sorted quartz sand and muddy quartz sand, glauconitic in places and thickens from a few inches to about 15 ft above the Congaree. The sand fines upward with a clay occurring at the top. Common colors are brown, green, gray, yellow, tan, and orange. The top of the Congaree is picked at the top of a clean sand sequence. The Warley Hill is difficult to identify and appears to be missing from the northwestern part of the SRS. Dinoflagellates, spores, and pollen have been recovered from the unit at the SRS. Glauconite and dinoflagellates suggest marine conditions, with the muddier sands indicating lower energy levels than those prevailing when the Congaree was deposited. The high mud content could have also caused by flocculation at the fresh water/salt water interface.

Most of the middle Eocene section consists of three laterally gradational units: the Santee Limestone, the Tinker Formation, and the informally named "Blue Bluff" unit.

Much of the Santee is composed of cream-colored, slightly to moderately indurated calcarenite and calcilutite with well-indurated calcareous nodules lying on top of the quartz sands and clays of the Warley Hill. Better developed in a northeasterly trend across the middle of the SRS, the Santee is sporadic in the vicinity of the Upper Three Runs and rare to the northwest. To the southeast it interfingers with and grades into the "Blue Bluff" unit. The name "McBean" has been applied to these sediments. Because the "McBean" is not defined as a lithologically homogenous unit and because of confusion involved in the use of the term, Fallaw and Price (1994) conclude that the carbonate below the lowest quartz sands in the section should be assigned a name (Santee) different from that applied to the sands. The carbonates are more similar to those in the type area of the Santee. Microfossils and megafossils are abundant in the Santee. The environment of deposition was probably mostly inner to middle neritic, judging from the abundant fossils and calcareous sediments.

Calcareous strata along the Savannah River valley in the same stratigraphic position as the Santee Limestone occurs with sufficient areal extent, thickness, and distinct lithology to warrant recognition as a separate unit, informally named the "Blue Bluff" unit by Fallaw and Price (1994). The "Blue Bluff" is gray and green, clayey, laminated calcilutite, calcarenite, and calcareous silt and clay, with shell layers, indurated nodules, thin indurated limestone lenses, calcareous muds, and quartz sand laminae in places. The sediments are widespread in the southern part of the SRS interfingering and grading into the cream-colored Santee facies and, in general, tend to be more common in the lower part of the section than the lighter-colored carbonates. The "Blue Bluff" sediments lie on poorly sorted quartz sands and clays, calcareous in places, of the Warley Hill. The "Blue Bluff" is about 90 ft thick at the southeastern boundary of the SRS. "Blue Bluff" sediments have been assigned to the "McBean Formation" or Santee Limestone by most workers in the area, but because of the extent and thickness of the unit, Fallaw and Price (1994) believe that when it is formally named, it should be on the formation level. A benthic foraminiferal species appears to be a marker for the Santee and "Blue Bluff" in this area with numerous molluscan taxa present. The fine grain size, the lamination, and fragile molluscan shells in the "Blue Bluff" suggest a lower energy environment than that of the Santee, probably farther out in the neritic zone.

The Tinker Formation consists of quartz sands, silts, and clays which, in general, occur updip from the Santee. The sands are typically finer grained than the ones above and below, contain more heavy minerals, and are more likely to contain glauconite, although glauconite is often found in the Warley Hill. Yellow, tan, and white sands are common with pale green sands occurring in the center of the SRS. Clay beds and laminae are more abundant in the Tinker than in underlying and overlying units. Tan clays are prominent in the overlying Dry Branch Formation, while green clays are more common in the Tinker (among them the "Green Clay") and contain less sand than the clays of the Warley Hill. The Tinker Formation grades downdip into the carbonates of the Santee and the "Blue Bluff." The Tinker Formation is about 40 ft thick at the northwestern boundary of the SRS and the "Blue Bluff" is about 90 ft thick at the southeastern boundary. Fallaw and Price (1994) propose a new name for siliciclastic sediments which occur, in general, updip from the carbonates of the Santee and "Blue Bluff." The Tinker is most of the siliciclastic parts of the "McBean Formation" as used by many workers. The type section is described from core from well MWD 5A in northwestern Barnwell County, South Carolina. The boundary between the Santee and "Blue Bluff" carbonates and the Tinker siliciclastics is defined by Fallaw and Price (1994) as where 25% of the section is composed of calcium carbonate. Where the Warley Hill is missing and the Tinker overlies the Congaree, colors become darker, grain size decreases, sorting becomes poorer, green clay or glauconitic sand become more common, and heavy minerals become more abundant upward in the section. Where the Tinker overlies the Warley Hill, Tinker sands tend to be finer and cleaner than the underlying sand, and the clays have a lower sand content. Palynomorphs and silicified shells and molds of mollusks have been found in the Tinker. Most of the Tinker sands probably formed in barrier and inner neritic environments and the silts and clays formed in bays, lagoons, and low energy shelf areas.

The Clinchfield consists of quartz sand and clay, calcareous in places, and carbonates. The sands are tan and yellow, poorly to well-sorted, and fine- to coarse-grained. The Utley Limestone Member is an indurated, bioclastic and biomoldic, glauconitic limestone in some places, and in others a calcareous sand and calcarenite. The lower contact of the Clinchfield may be marked by a change from calcareous sediments of the Santee and "Blue Bluff" to poorly to well-sorted sands. The Utley Limestone tends to be more indurated and coarsely glauconitic than the underlying carbonates, and it contains abundant sand dollar specimens. The Clinchfield is exposed along the Savannah River opposite the SRS. Approximately 30 ft thick in the southeastern part of the SRS, the Clinchfield pinches out or becomes difficult to identify updip in the middle of the SRS. The quartz sand of the Clinchfield at the SRS may be the Riggins Mill Member, as defined by Huddlestun and Hetrick, 1986. The concentrations of sand dollars in the carbonates and the sorting of the sands suggest a littoral and inner neritic environment.

1.2.1.1.4 Late Eocene.

The Dry Branch Formation includes quartz sands, clays, calcareous siliciclastics, and carbonates. Calcilutite, calcarenite, bioclastic and biomoldic limestone, calcareous sand, and shelly, calcareous clay occur in the Griffins Landing Member. The Griffins Landing is less glauconitic than the carbonates of the underlying Utley, Santee, and "Blue Bluff." The Griffins Landing is known to be present northwest of Upper Three Runs within the SRS boundary but is at least 50 ft thick in the southeastern part of the SRS. The rest of the Dry Branch Formation is divided into tan clays (Twiggs Clay lithofacies), and the Irwinton Sand Member.

The Irwinton Sand Member contains tan, yellow, and orange, moderately sorted quartz sand with interlaminated and interbedded clays typically tan. Glauconite is rare. Irwinton sands are generally coarser than those of the underlying Tinker Formation. Tan clays are more common above, and green and gray clays are more common below the contact. This clay lithofacies, which is tan, light gray, and brown, varies in thickness up to 12 ft at the SRS, but is not laterally continuous. The Dry Branch Formation is about 50 ft thick near the northwestern SRS boundary and about 80 ft thick near the southeastern boundary. Fossils such as foraminifers, barnacles, crabs, starfish, crinoids, shark and ray teeth, and fish bones have been found in the Griffins Landing Member. Palynomorphs and silicified fossils have also been found in the Irwinton Sand Member. Common planktonic Foraminifera from the Griffins Landing indicate some open ocean influence. Calcareous clay beds containing foraminiferal genera indicate bay or lagoonal environments. Irwinton sands are probably inner neritic and barrier deposits; the clays probably formed in lagoons or bays.

The Tobacco Road Formation, which overlies the Dry Branch Formation, consists of red, brown, tan, purple, and orange quartz sands and clayey quartz sands. These sands are fine- to coarse-grained, moderately to poorly sorted, with minor clay laminae. In general, the sands of the Tobacco Road are muddier, more micaceous, and more highly colored than those of the Dry Branch. The base of the Tobacco Road is marked in places by a coarse layer that contains flat quartz pebbles. No datable fossils have been recovered from the Tobacco Road at the SRS, but Ophiomorpha burrows can be seen and silicified shell fragments are common indicating a marine or transitional marine environment. Clay laminae in the upper part of the Tobacco Road suggest that some of the unit was deposited in a transitional, low energy environment, such as a tidal flat. The Tobacco Road outcrops at the surface at many locations throughout the site and ranges in thickness from 20 to 30 ft.

1.2.1.1.5 Altamaha Formation (Upland Unit). The Altamaha Formation is composed of poorly sorted, clayey and silty sands, with lenses and layers of pebbly and cobbly quartz sand with extreme lateral and vertical variation. The presence of the Altamaha Formation in this area is inconsistent, occurring predominantly at higher elevations around the SRS. Sediments are red, purple, gray, orange, yellow, and tan, with a fine- to coarse-grain size. Cross-bedding is prominent in places; muscovite flecks and weathered feldspar are locally abundant. In general, the Altamaha has poorer sorting, larger and more common weathered feldspar grains, more abundant and thicker clay beds, more argillaceous and indurated sands, larger pebbles, and in places, more muscovite than the underlying Tobacco Road. The Altamaha Formation is up to 70 ft. thick in parts of the SRS. Very few fossils have been reported from the Altamaha and its equivalents. The conglomerates, poorly sorted sands, and clay lenses have the characteristics of fluvial sediments. Possible Ophiomorpha and Foraminifera (Siple, 1967) suggests an occasional transitional marine influence.

1.2.1.2 Unit Geology

Figures 1-7 and 1-8 depict the local lithology and hydrostratigraphy. See Figure 1-9 for lithostratigraphic and hydrostratigraphic equivalents. For a detailed discussion of unit geology, see Section 3.4.

1.2.1.3 Hydrostratigraphy of SRS

The SRS is located approximately 48.3 km (30 miles) southeast of the Fall Line, where sediments of the Coastal Plain Physiographic Province pinch-out, exposing crystalline rocks of the Piedmont Physiographic Province. The recharge zone for the SRS includes surface streams, the surface area of the site as well as the upgradient land extending northwestward to the Fall Line. Normal annual rainfall for the SRS area is 121.2 cm (47.7 in.). The Savannah River and its tributaries, Upper Three Runs Creek, Four Mile Creek, Steel Creek, Pen Branch Creek, and Lower Three Runs Creek, provide the main surface water drainage system at the SRS.

A multi-layer hydrologic system exists in the Coastal Plain sediments at the SRS. Confining units within the system are interspersed with more transmissive units. Aadland et al (1995) redefined the hydrostratigraphic nomenclature system for SRS (Figure 1-9). The reader is referred to Aadland et al (1995) for the most recent description of SRS hydrogeology. Within this nomenclature, the basement complex underlying the Coastal Plain deposits is referred to as the

Paleozoic-Triassic Basement Hydrogeologic System. This system is overlain by three aquifer systems of Coastal Plain deposits. The lower two aquifer systems are the Dublin and Midville Aquifer Systems which are separated by the Allendale Confining System. Above these lower two is the Flordan Aquifer System, which is underlain by the Myers Branch Confining System. These Aquifer systems are separated from the lower Piedmont Hydrogeologic System by the Appleton Confining System. The Appleton Confining System is composed of poorly sorted, clayey sediments of the Cape Fear Formation. Confining clay sediments of the middle Black Creek Formation comprise the McQueen Branch Confining Unit which separates the McQueen Branch Aquifer Unit from the Crouch Branch Aquifer Unit. The Midville-Dublin Aquifer System is composed of sands of the Middendorf Formation and the lower sands of the Black Creek and lower Peedee Formations. The Upper Three Runs Aquifer includes the shallow Water Table Aquifer at the SRS, which is composted of sediments from the Tobacco Road, Dry Branch, and McBean Formations. The sediments of the Upper Three Runs Aquifer typically exhibit a wide variation in lithologic composition both vertically and laterally. Local hydrostratigraphy of the shallow Water Table Aquifer is discussed in Section 3.6.

Below the Water Table Aquifer (previously Aquifer Unit IIB) is the Gordon Confining Unit. This confining unit is referred to as the "Green Clay". At well cluster P-18 (Figure 1-10), located approximately 2.4 km (1.5 mi) west of the BRP6G (Figure 1-2) the "Green Clay" is an orange clayey sand with clay seams (Bledsoe et al., 1990). A head difference of 15.6 m (51.1 ft) has been observed between wells P-18D and P-18B, screened above and below the Gordon Confining Unit. A downward vertical gradient of 1.1 m/m (0.35 ft/ft) is calculated using this head difference. Vertical flow through the clay is not estimated because lithologies in addition to the clay are present between the screened intervals.

The Congaree Aquifer underlies the Gordon Confining Unit (locally the "Green Clay"). At P-18, the Congaree Aquifer consists of a very fine to fine, tan sand with a thickness of approximately 25.9 m (85 ft). The horizontal and vertical gradients within the aquifer are not known in the vicinity of the BRP6G. A regional calibrated flow model (Haselow and Taylor, 1989) used a horizontal hydraulic conductivity of 4.6m/day (15.1 ft/day) and a vertical hydraulic conductivity of 0.3 cm/day (0.01 ft/day) in the Congaree Aquifer for the regional SRS area. In the vicinity of the BRP6G, regional flow in the aquifer is to the southwest toward the Savannah River (Figure 1-11).

Underlying the Congaree Aquifer is the Myers Branch Confining System. The Myers Branch Confining System is locally referred to as the Ellenton Confining Unit. As indicated by the P-18 well cluster, the Myers Branch Confining System is actually a sequence of interbedded silts, sands and clays. It is approximately 21.3 m (70 ft) thick in the vicinity of the BRP6G. Undisturbed samples of the Myers Branch Confining System collected at the P-18 well cluster yielded a range of horizontal hydraulic conductivity values of 0.03 to 26.8 cm/day (0.00010 to 0.88 ft/day) and a range of vertical hydraulic conductivity values from 0.0267 to 12.2 cm/day (0.0009 to 0.40 ft/day) (Bledsoe et al., 1990). The downward vertical gradient across the Myers Branch Confining System, as measured at the P-18 well cluster, is 0.013. Using an effective porosity of 0.10 for sandy clay (Todd, 1959), the vertical flow velocity of the Myers Branch Confining System at C Area ranges from approximately 0.0037 to 1.58 cm/day (0.00012 to 0.052 ft/day) or 1.46 to 578.51 cm/year (0.043 to 18.98 ft/year).

The Dublin-Midville Aquifer System underlies Myers Branch Confining System. The Dublin-Midville Aquifer System is divided into the Crouch Branch and McQueen Branch Aquifer Units. The Crouch Branch Aquifer Unit includes the Steel Creek (formerly Pee Dee) and upper Black Creek Formations. Figure 1-11 is a regional potentiometric map of the Gordon (Congaree) Aquifer Unit. The map shows that groundwater flow in the aquifer is to the southwest toward the Savannah River.

The McQueen Branch Confining Unit separates the Crouch Branch and McQueen Branch Aquifer Units and includes the lower Black Creek Formation. The McQueen Branch Aquifer Unit is composed of the Middendorf Formation. Figure 1-12 is a regional potentiometric map for this aquifer unit. Figures 1-13 and 1-14 are regional potentiometric maps for the upper and lower members of the Crouch Branch Aquifer Unit. These maps indicate that groundwater flow within the aquifer unit is to the southwest toward the Savannah River.

The Midville-Dublin Aquifer System supplies drinking water throughout the SRS. Two existing water supply wells in C Area, 905-90C and 905-91CC, are screened in the lower Steel Creek (Pee Dee) and upper Black Creek Formations of the Midville-Dublin Aquifer System. At C Area, four wells within the P-18 well cluster are screened in the Midville-Dublin Aquifer System. Hydraulic heads measured in these screened zones during 1Q91 indicate the following:

- an upward vertical gradient of 0.019 from P-18A to P-18TD [Crouch Branch Confining Unit to the Crouch Branch Aquifer Unit]
- a downward vertical gradient of 0.003 from P-18TD to P-18TC [upper member of the Crouch Branch Aquifer Unit to lower member of the Crouch Branch Aquifer Unit]
- an upward vertical gradient of 0.005 from P-18TC to P-18TB [lower member of the Crouch Branch Aquifer Unit to the upper member of the McQueen Branch Aquifer Unit]
- An upward vertical gradient of 0.002 from P-18TB to P-18TA [upper member of the McQueen Branch Aquifer Unit to the lower member of the McQueen Branch Aquifer Unit]

In N Area, a reversal in the vertical hydraulic head between the overlying Crouch Branch Aquifer Unit and the deeper McQueen Branch Aquifer Unit is indicated at the P-18 well cluster. A reversal in hydraulic head also occurs between the overlying Crouch Branch Confining Unit and Crouch Branch Aquifer Unit. These head reversals inhibit vertical flow of groundwater from the Gordon (Congaree) Aquifer Unit into Crouch Branch Aquifer Unit, and from Crouch Branch Aquifer Unit to McQueen Branch Aquifer Unit, limiting the potential for downward migration of contaminants.

1.2.1.4 Local Hydrostratigraphy

Figure 1-15 shows the location of water table monitoring wells in the vicinity of Central Shop. Figure 1-16 is a potentiometric surface map of the water table (previously Aquifer Unit IIB) at the BBP6G. For a more detailed discussion, see Section 3.6.

1.2.2 Unit History of Central Shops Burning/Rubble Pit

Waste disposal activities at the BRP6G RCRA/CERCLA unit were initiated in 1951. The unit consisted of a shallow excavation, approximately 3 meters (m) (10 ft) deep, in which burnable waste was deposited. Materials believed to be disposed of include, waste oils, rags, paper, cardboard, plastics, degreasers, wood, rubber, and drummed organic solvents which were deposited in the pit and burned periodically, usually monthly. The volume of waste disposed of at BRP6G was not reported.

Based upon historical aerial photographs, (Plates 1-2 and 1-3), the BRP6G operated from 1951-1955. By 1955, the pit had been covered with soil and closed.

According to historical accounts, the disposal area at BRP6G was initially considered to be within a rectangular area approximately 83.8 m (275 ft) long and 9.1 m (30 ft) to 13.7 m (45 ft) wide (Figure 1-17). Data from a ground penetrating radar (GPR) survey indicated that soil in most of the area defined by the RCRA/CERCLA unit marker balls was undisturbed. Based upon the GPR, it was unlikely that the marked area accurately defined a waste disposal trench or pit. However, the GPR survey detected two areas of disturbed soil which may represent waste disposal sites (which are labeled Zones 1 and 2 on Figure 1-17). The largest area of disturbed soil (Zone 1) is southwest of the original marked area. This suspected pit forms a rectangle approximately 6.1 m (20 ft) wide and 54.86 m (180 ft) long. A second area of disturbed soil (Zone 2) exists around the southwestern HP marker. This second suspected waste pit forms an ellipse approximately 6.1 m (20 ft) wide and 12.2 m (40 ft) long. By comparison with elliptically shaped disturbed-soil areas at other rubble pits, the smaller disturbed soil zone at BRP6G may represent a borrow area for waste cover.

An embankment separates BRP6G from a shallow dry ditch and railroad right-of-way, (see Figure 1-3 and 1-17). The top of the embankment is approximately 7.62 m (25 ft) south of the southern edge of the suspected rectangular pit. The embankment is approximately 1.52 m (5 ft) high. Soils exposed in the embankment are undisturbed. The shallow dry ditch, which serves to contain drainage from the railroad right-of-way, contains no obvious evidence of contamination. Water has not been observed in the ditch during any unit reconnaissance.

1.2.3 Previous Investigations

1.2.3.1 Soil Gas Survey

A reconnaissance soil gas survey was performed at the BRP6G during the period of October 1990 through November 1991. The survey monitored the presence and distribution of C1-C4 hydrocarbons, BTEX, selected chlorinated hydrocarbons, and mercury. In general, samples for hydrocarbons and BTEX were collected at depths ranging from 0.91 m (3 ft) to 1.21 m (4 ft). Soil samples for mercury analyses were taken from a depth of 12 to 18 inches.

Only four isolated, and very low, observations of volatile organics were made at the BRP6G. Ethyl benzene was detected at 0.10 ppmv; toluene was detected at 0.33 ppmv; o-xylene was detected at 0.20 ppmv and m & p-xylenes were detected at 0.10 ppmv. Levels of observed methane were elevated in the southeast end of the unit. Other light hydrocarbons were detected at low concentrations and their presence was fairly uniformly distributed across the unit.

The results of the soil gas survey are presented in Appendix A.

1.2.3.2 Ground Penetrating Radar Survey

A ground penetrating radar (GPR) survey was conducted at the BRP6G during August of 1992. The purpose of this survey was to located areas of disturbed soils which might indicate trenches and/or trench boundaries. Areas of disturbed soils were determined from the survey. These area are illustrated on Figure 1-17. The GPR survey did not detect any anomalies characteristic of buried debris. The maximum observed depth of the disturbed soil was approximately 1.21 m (4 ft).

1.2.3.3 Groundwater Monitoring Program

Three groundwater monitoring wells (CBR-1D, CBR-2D, and CBR-3D) were installed at the BRP6G in January/February of 1990. The locations of these wells are shown on Figure 1-3. The analytical data available for the CBR-series wells indicate that sporadic occurrences of contaminants such as 2,4-dichlorophenoxyacetic acid, 1,1,2,2-tetrachloroethane, beryllium, bis(2-ethylhexyl)phthalate (a common laboratory contaminant), chromium, gross alpha, mercury, silver, tetrachloroethylene, toluene, and trichloroethylene were detected. These occurrences were not confirmed by subsequent sampling and were often contradicted by duplicate sample results. The data suggest a potential increase in concentration from the upgradient to the downgradient wells for chloride, iron, magnesium, nitrate, potassium, and tritium.

Dichloromethane (methylene chloride), a common laboratory contaminant, was detected in 14 of 52 samples. Of the 14 results above the detection limit, only samples collected from CBR-2D during the first quarter of 1991 exceeded the Maximum Contaminant Level (MCL) for dichloromethane.

1.2.3.4 Results/Conclusions of Previous Investigations

Based upon the Soil Gas Survey and data obtained from the Groundwater Monitoring Wells, there is sufficient evidence to believe hazardous substances are present in the BRP6G. Also, there are insufficient records to prove that no hazardous substances were received at the Solid Waste Management Unit. In addition, other rubble disposal areas at SRS have been found to contain hazardous substances. Therefore, the BRP6G RCRA/CERCLA unit warrants further investigation based on the evaluation of the preliminary data presented.

1.3 Report Organization

This RFI/RI Report consists of seven chapters describing the rationale for the investigation, activities conducted, data evaluation, risk assessment, and data assessment. Chapter 1 provides background information. Included in this chapter is a brief summary of the history of the unit, and the purpose and objectives of the investigation. Chapter 2 describes the objectives of each type of field activity and presents details of the procedures used. Chapter 3 contains an evaluation of the physical characteristics of the unit including surface topography, geology, hydrogeology, soil types, demography and land use, and ecology. Chapter 4 contains an evaluation of the nature and extent of contamination present at the Central Shops BRP6G. Chapter 5 contains an evaluation of the fate and transport mechanisms applicable to the contaminants detected at the CS BRP. Chapter 6 presents the human health and ecological baseline risk assessment. Chapter 7 presents a summary of the results of the RFI/RI Investigation and recommends additional action, if required.

1.4 Approved Standardized Corrective Action Design (ASCAD)

The purpose of the ASCAD process at SRS is to focus data collection on remedial technologies, eliminate/reduce redundant documentation, obtain/facilitate pre-approved remedial decisions, and standardize remedial designs. The ASCAD approach reduces the time and costs for remediating waste units by grouping similar waste units, focusing characterization and technology development on waste unit groups, and providing standardized designs which are based on unit specific requirements.

Waste units are grouped based on similarities such as waste category, media, unit specifics, and generic remedies. Waste categories focus on the manner in which waste was applied to the environment (i.e., basins, pits, piles, process lines). Media similarities address the environmental media that have been impacted. Examples are soil, vegetation, debris, sediment, and groundwater. Unit specifics include soil classification, lithology, and waste area/volume. Generic remedies identify the potential for similar waste units to apply the same or similar remediation strategy.

ASCAD is being applied to the Burning/Rubble Pits waste unit group in an effort to develop primary and secondary documentation models for SRS. This effort focuses on combining the remedial investigation with the baseline risk assessment, and the feasibility studies with the proposed plan and record of decision for the Burning/Rubble Pits. ASCAD provides for streamlining the design development process and projects focused technologies for remedial action for the Burning/Rubble Pits, based on the BRP6G as one of the primary sites. ASCAD Summary sections are included throughout this document to denote common unit characteristics.

FIGURES

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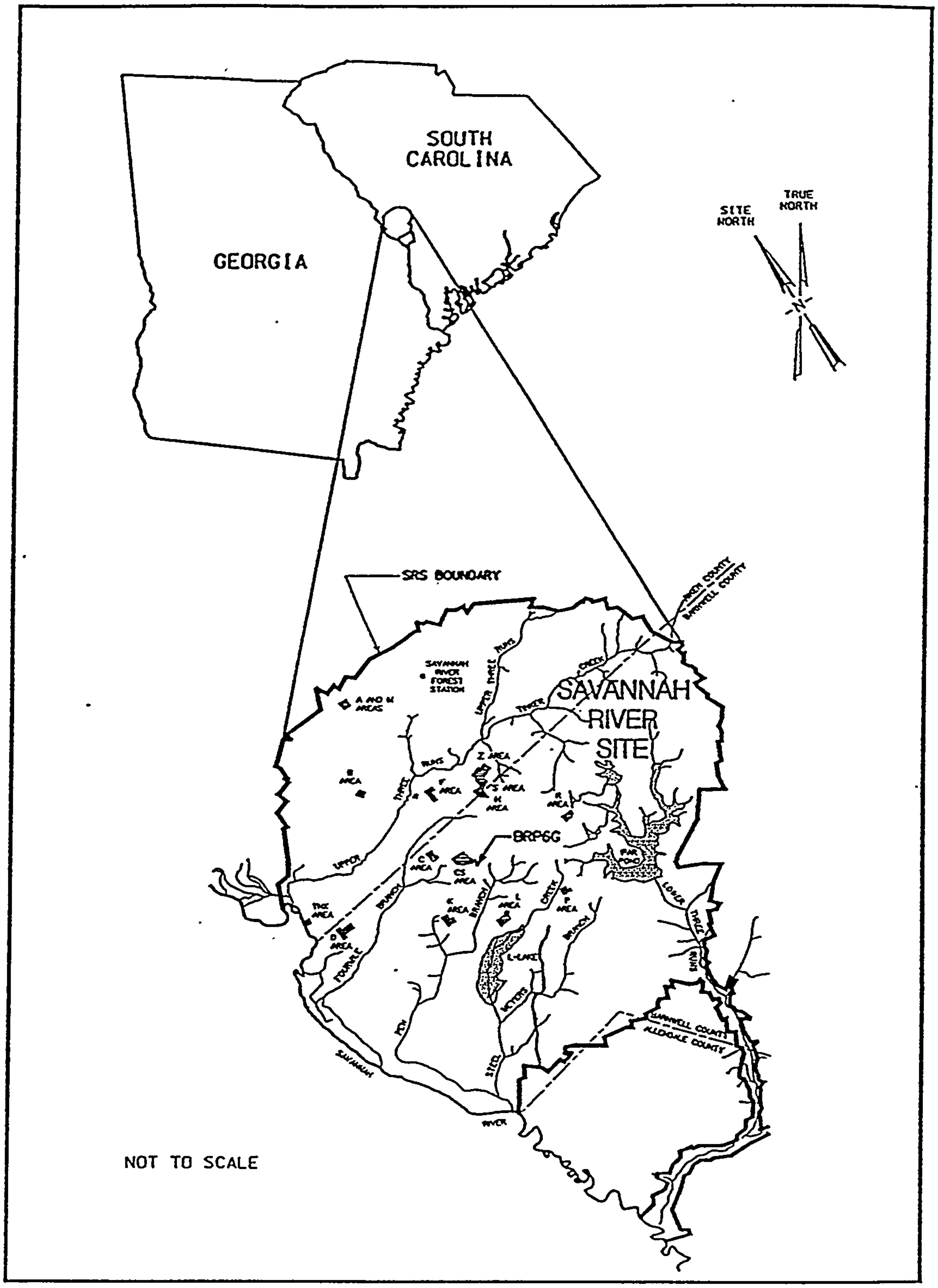

Figure 1-1. Location of BRP6G at the Savannah River Site

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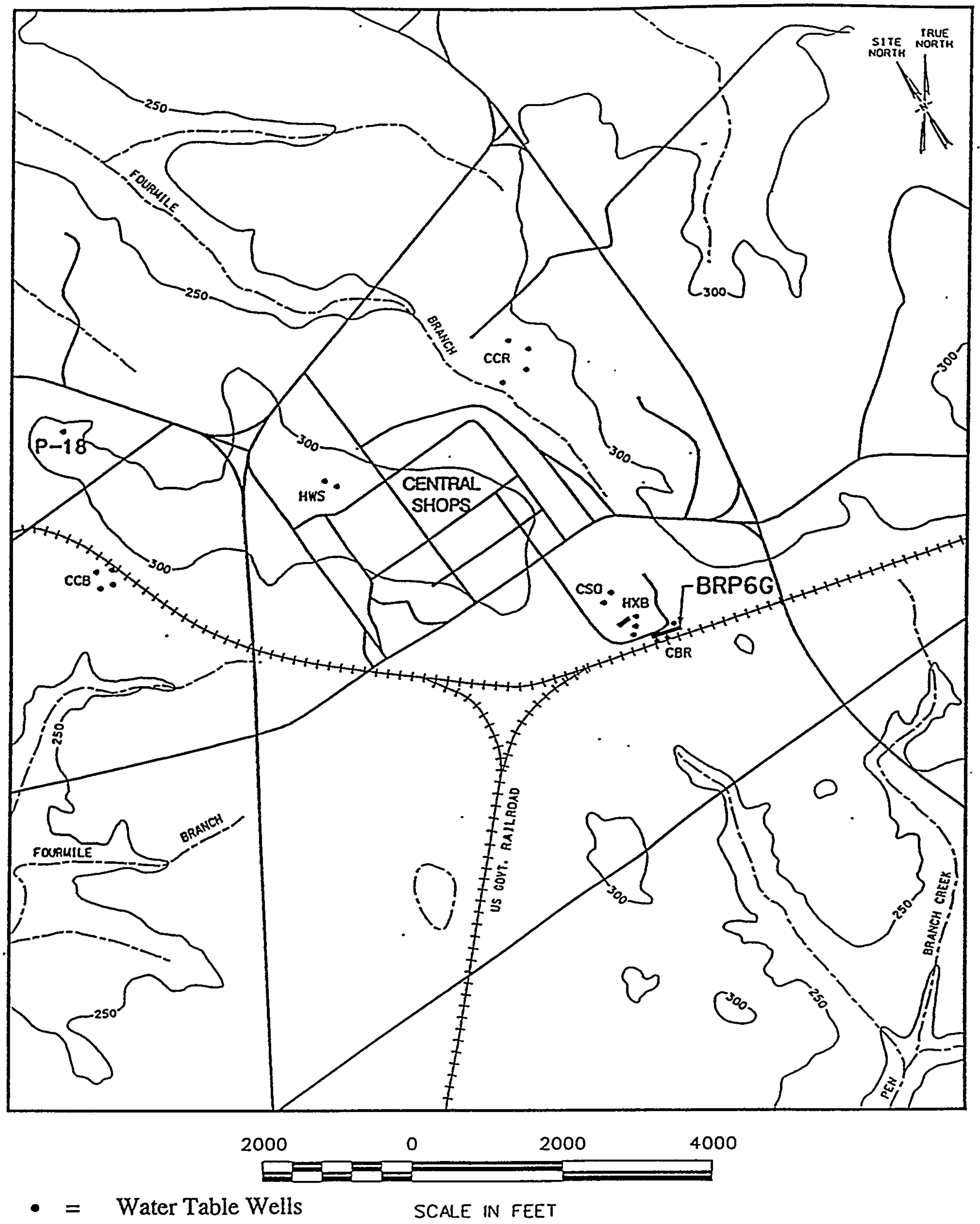

Figure 1-2. Location of the BRP6G in the Central Shops Area of SRS

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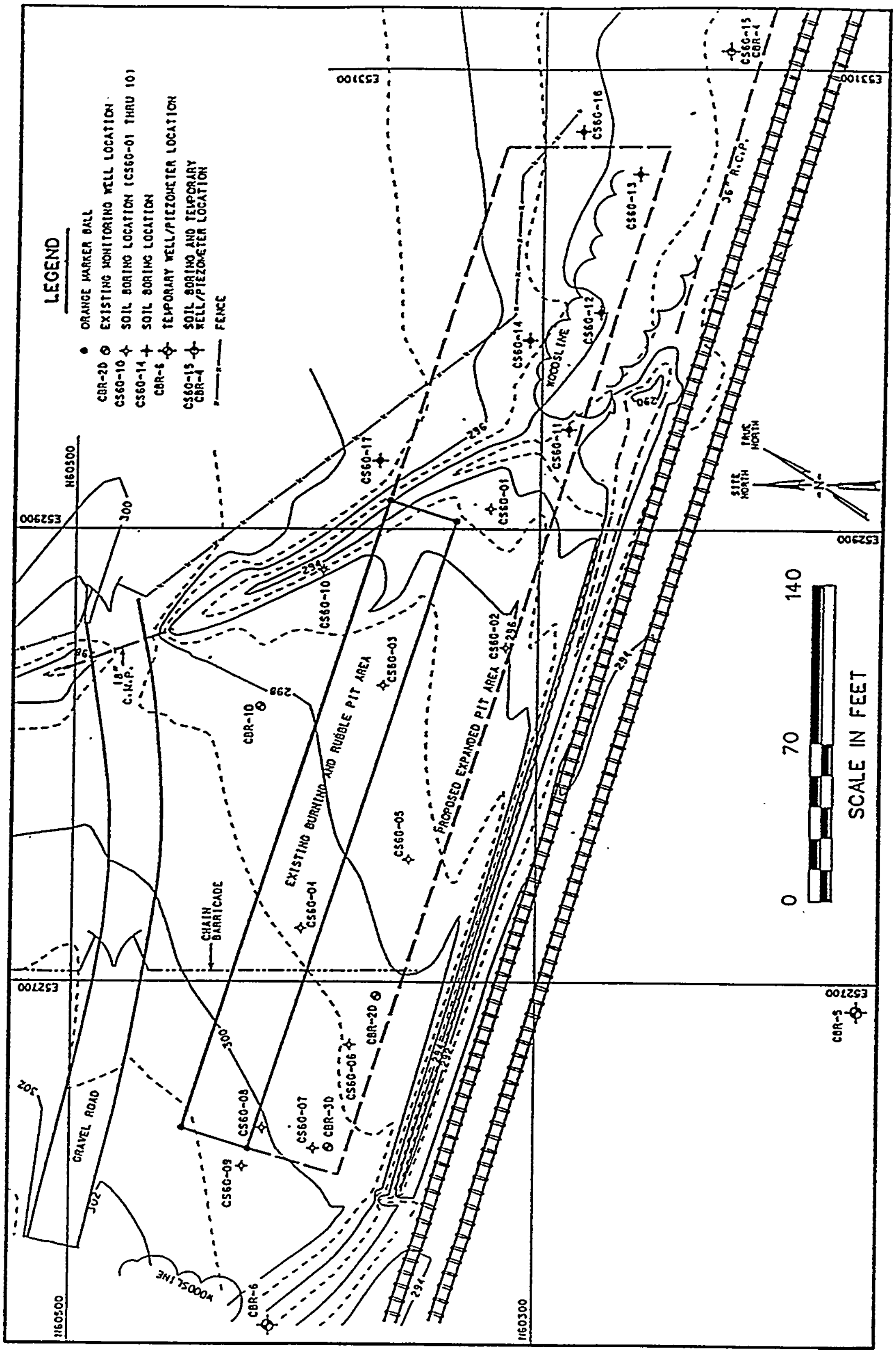

Figure 1-3. Map of the Central Shops Burning/Rubble Pit

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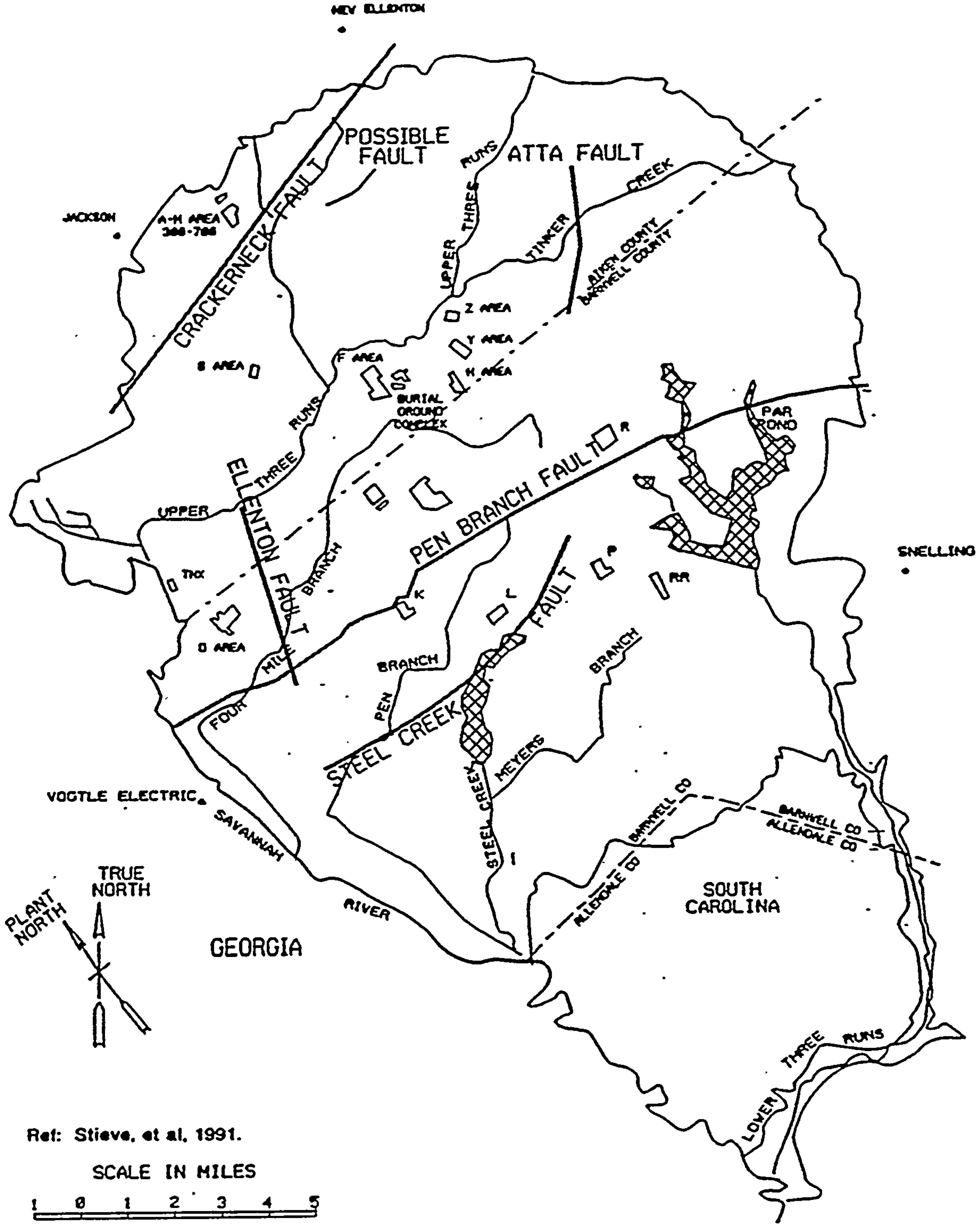

Location Map of Basement Faults Beneath the Savannah River Site.

Figure 1-4. Map of Known Faults at SRS

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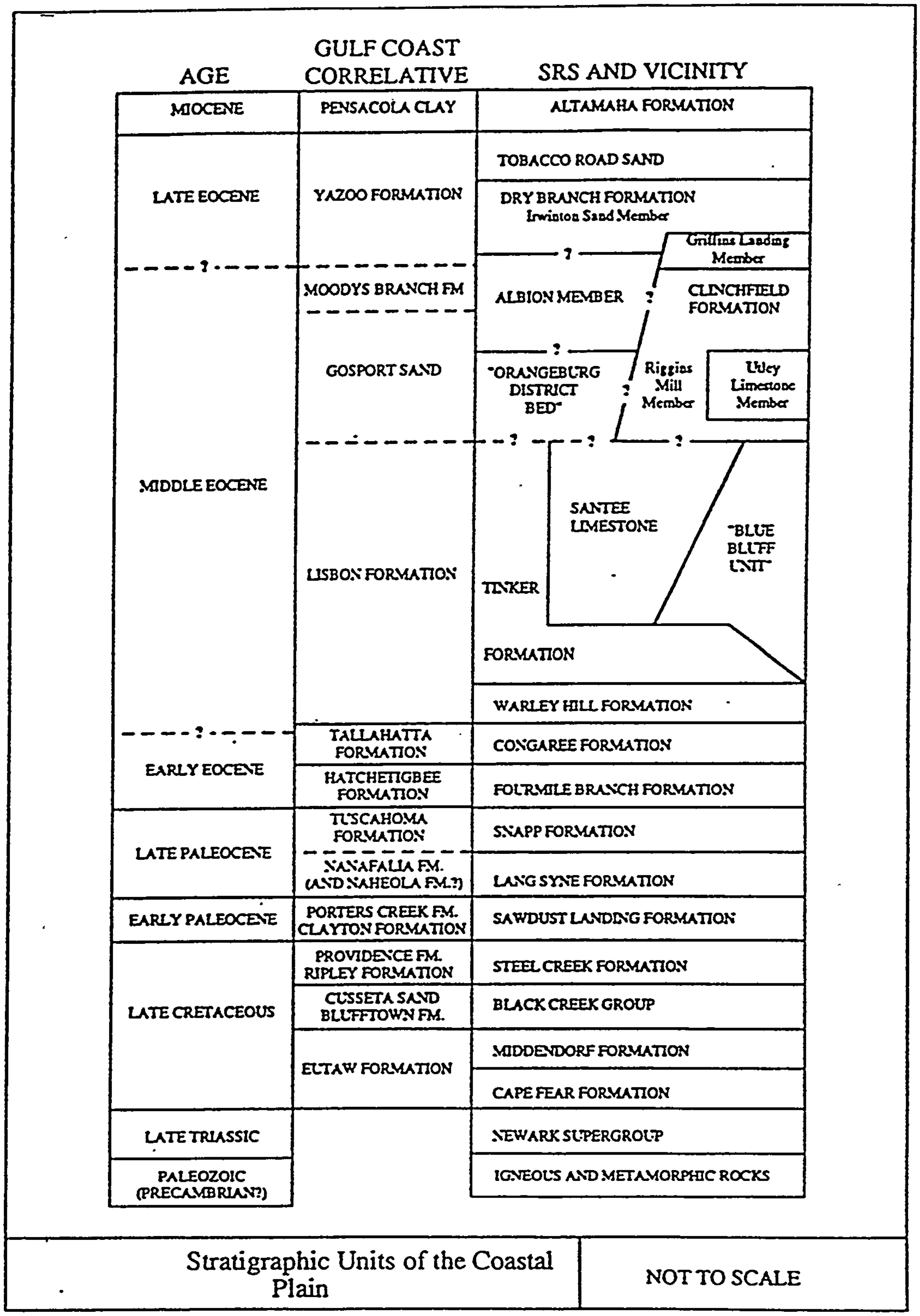

Figure 1-5. Stratigraphic Units of the Coastal Plain by Fallaw and Price, 1994

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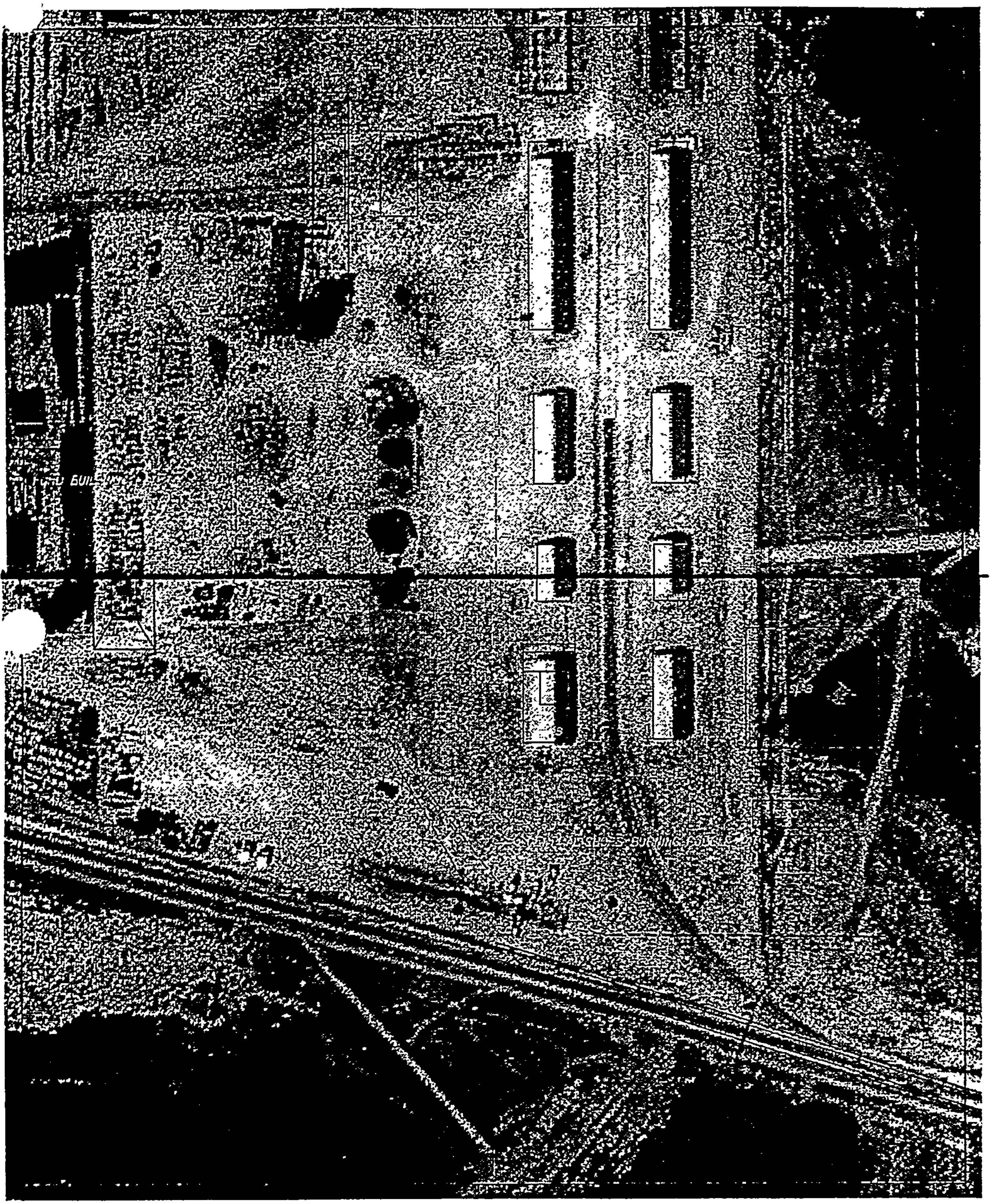


PLATE I-1
CENTRAL SHOPS BURNING RUBBLE PIT
AERIAL PHOTOGRAPH VINTAGE 1951

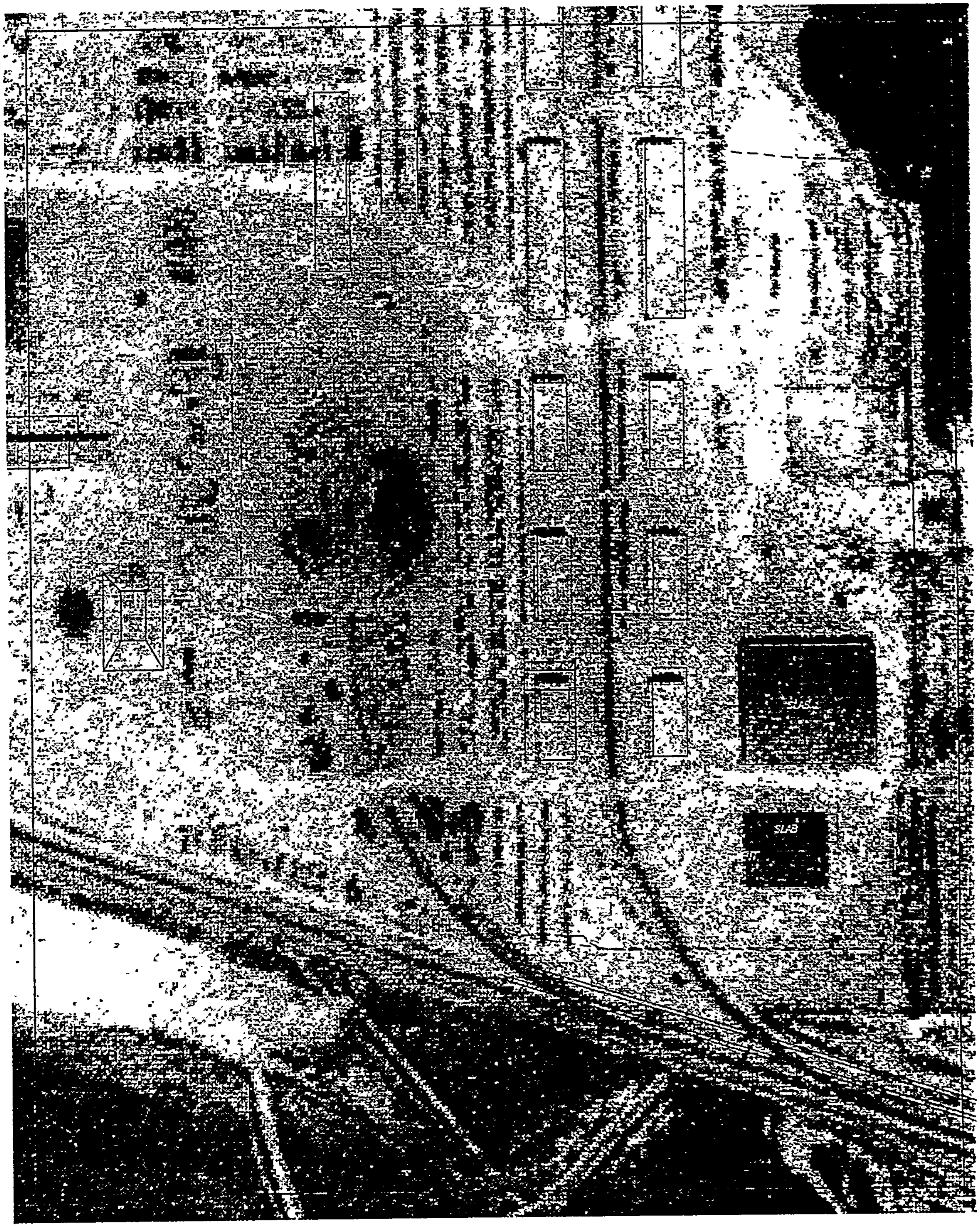


PLATE 1-2
CENTRAL SHOPS BURNING RUBBLE PIT
AERIAL PHOTOGRAPH VINTAGE 1955

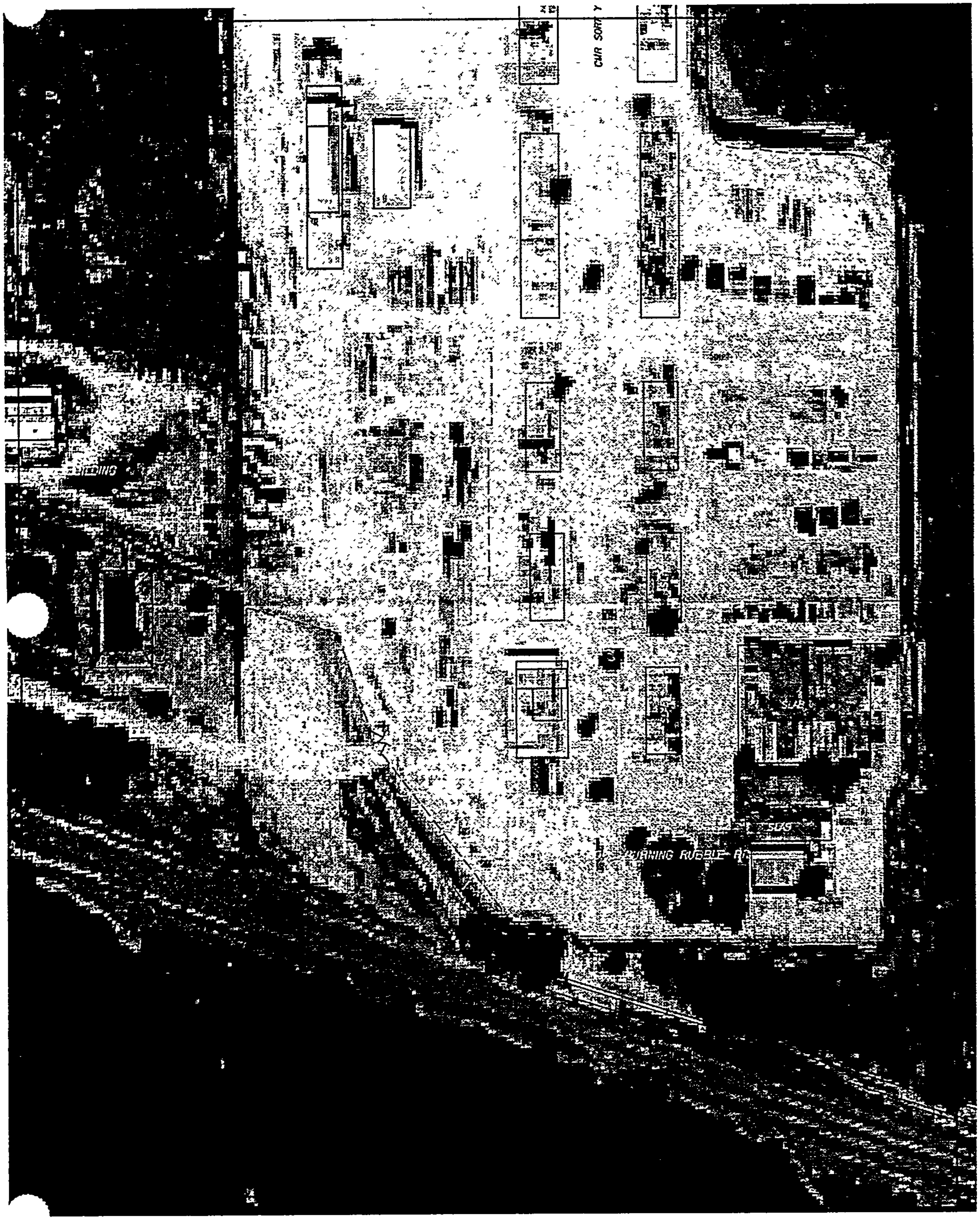
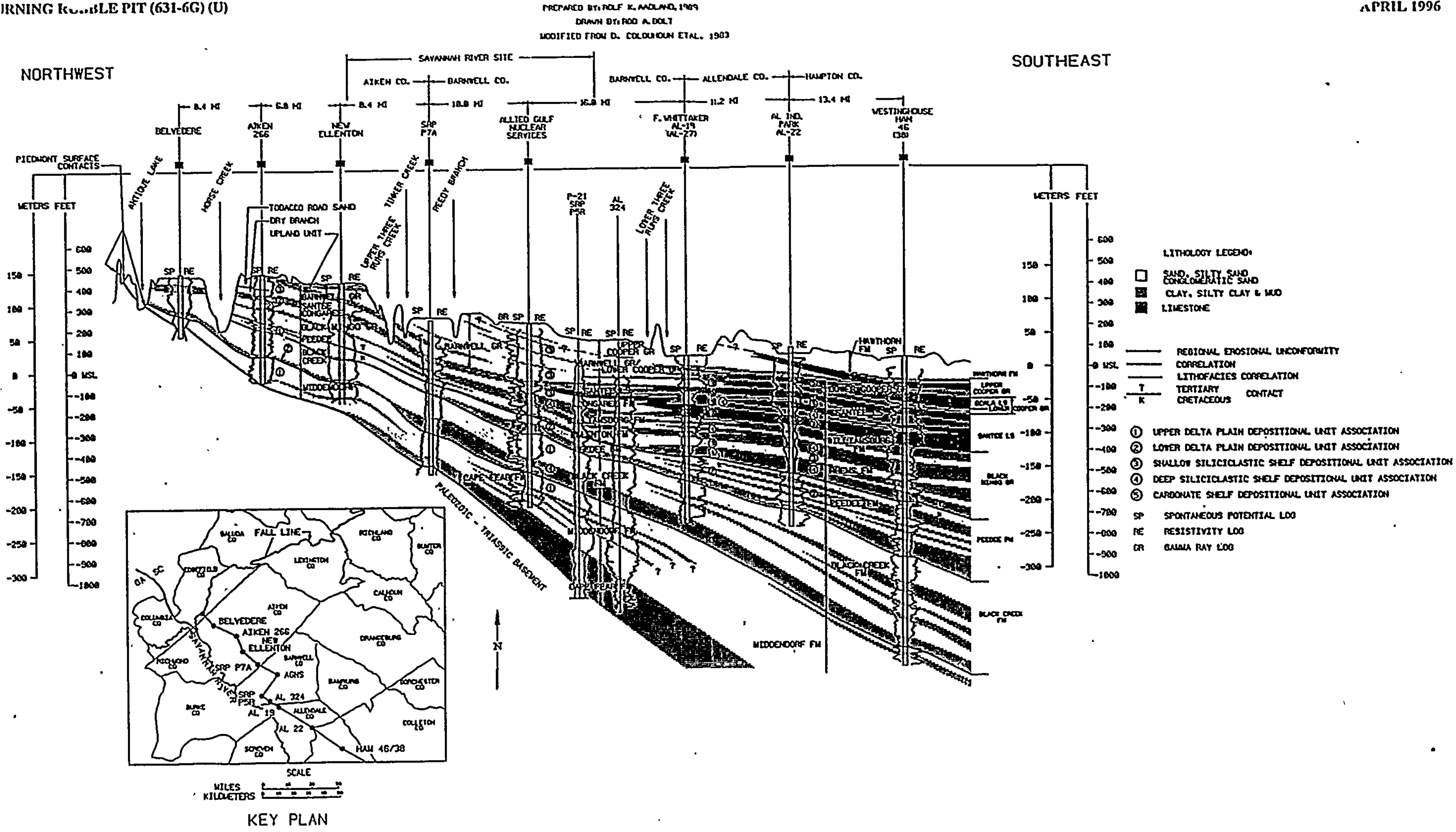


PLATE 1-3
CENTRAL SHOPS BURNING RUBBLE PIT
AERIAL PHOTOGRAPH VINTAGE 1990



Source: Aadland and Bledsoe, 1990

Figure 1-6. Regional Stratigraphic Cross-Section through SRS

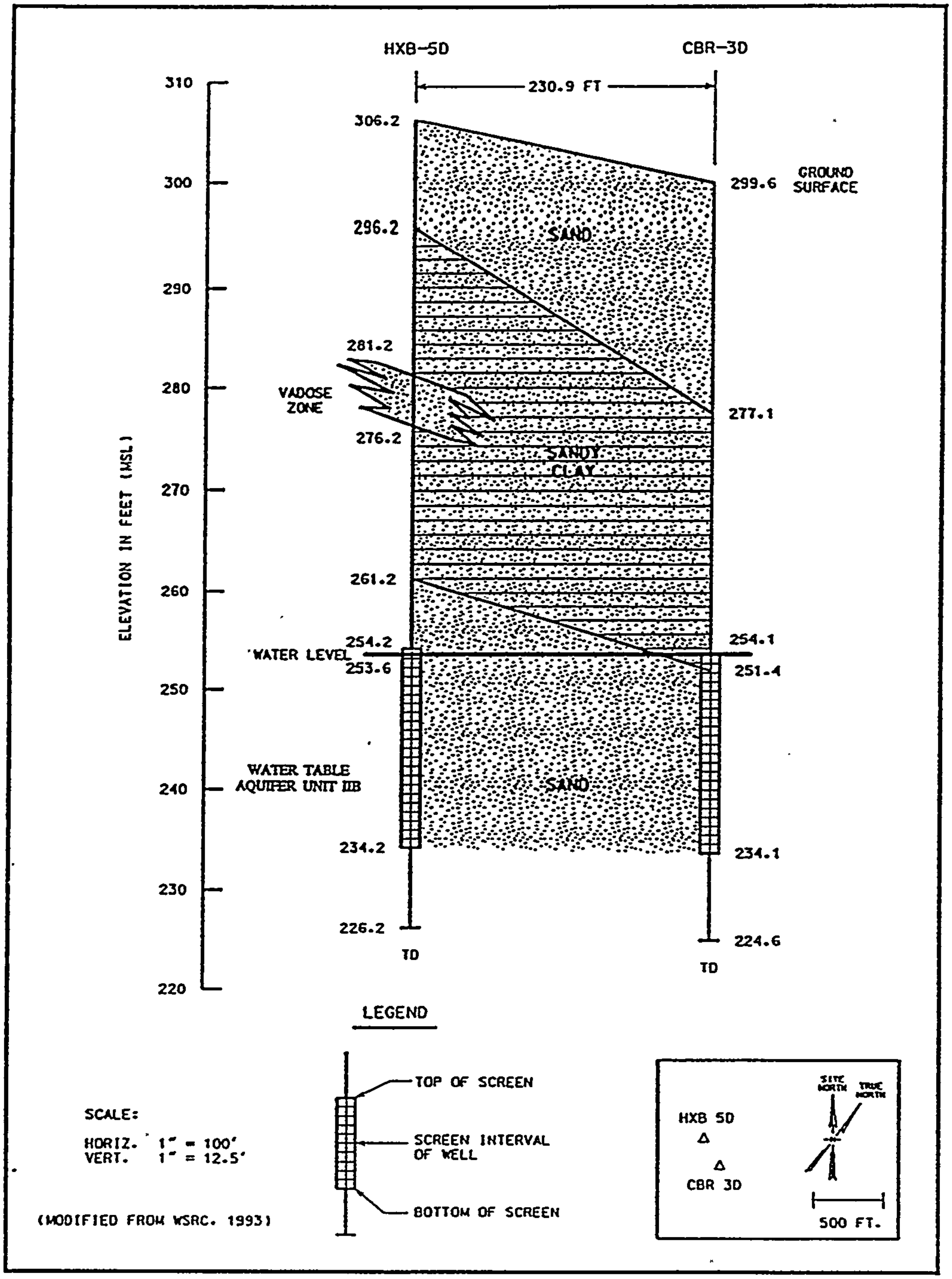


Figure 1-7. Lithologic and Hydrologic Cross Section HXB-5D to CBR-3D

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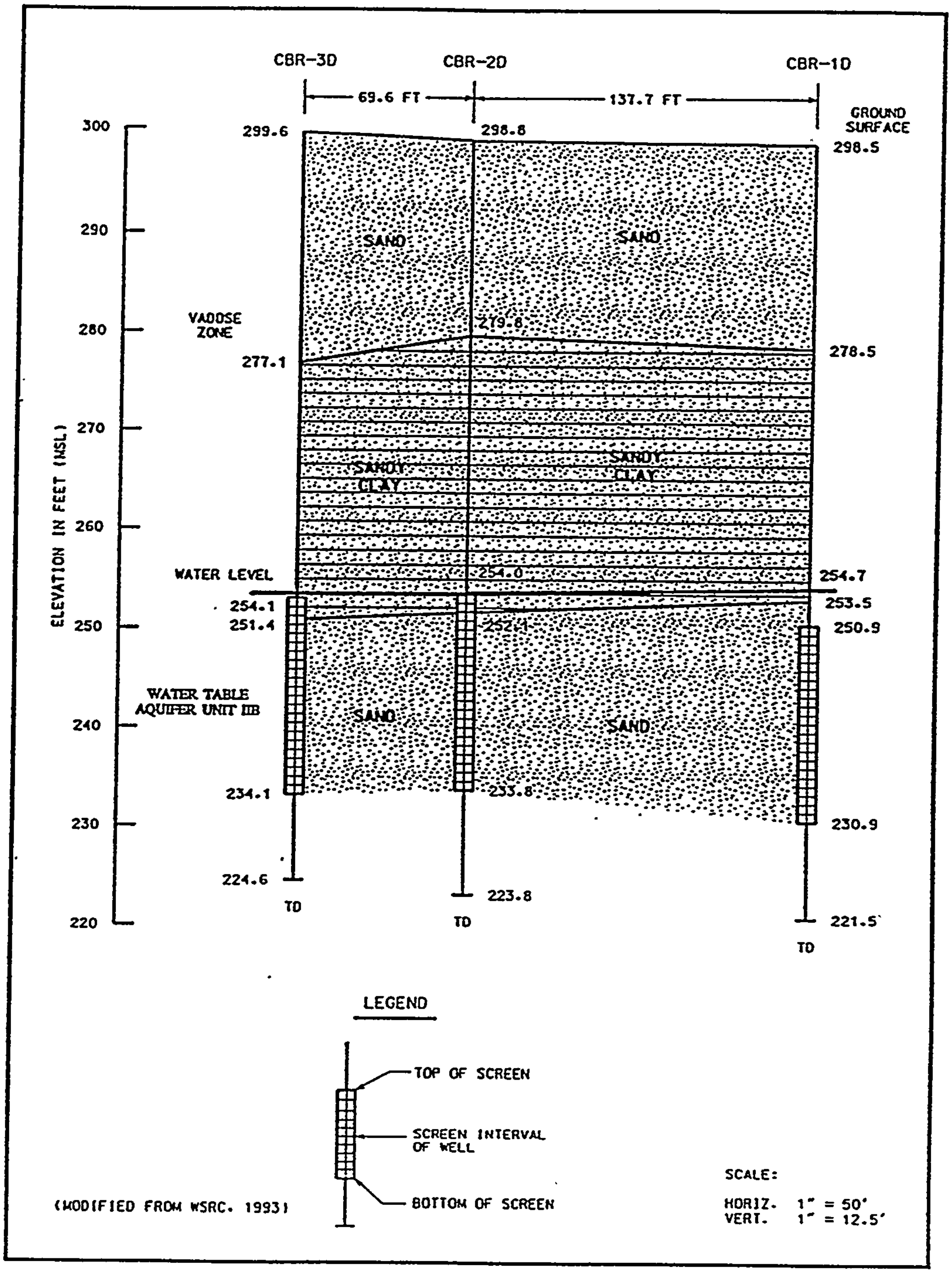

Figure 1-8. Lithologic and Hydrologic Cross Section CBR-3D, CBR-2D, and CBR-1D

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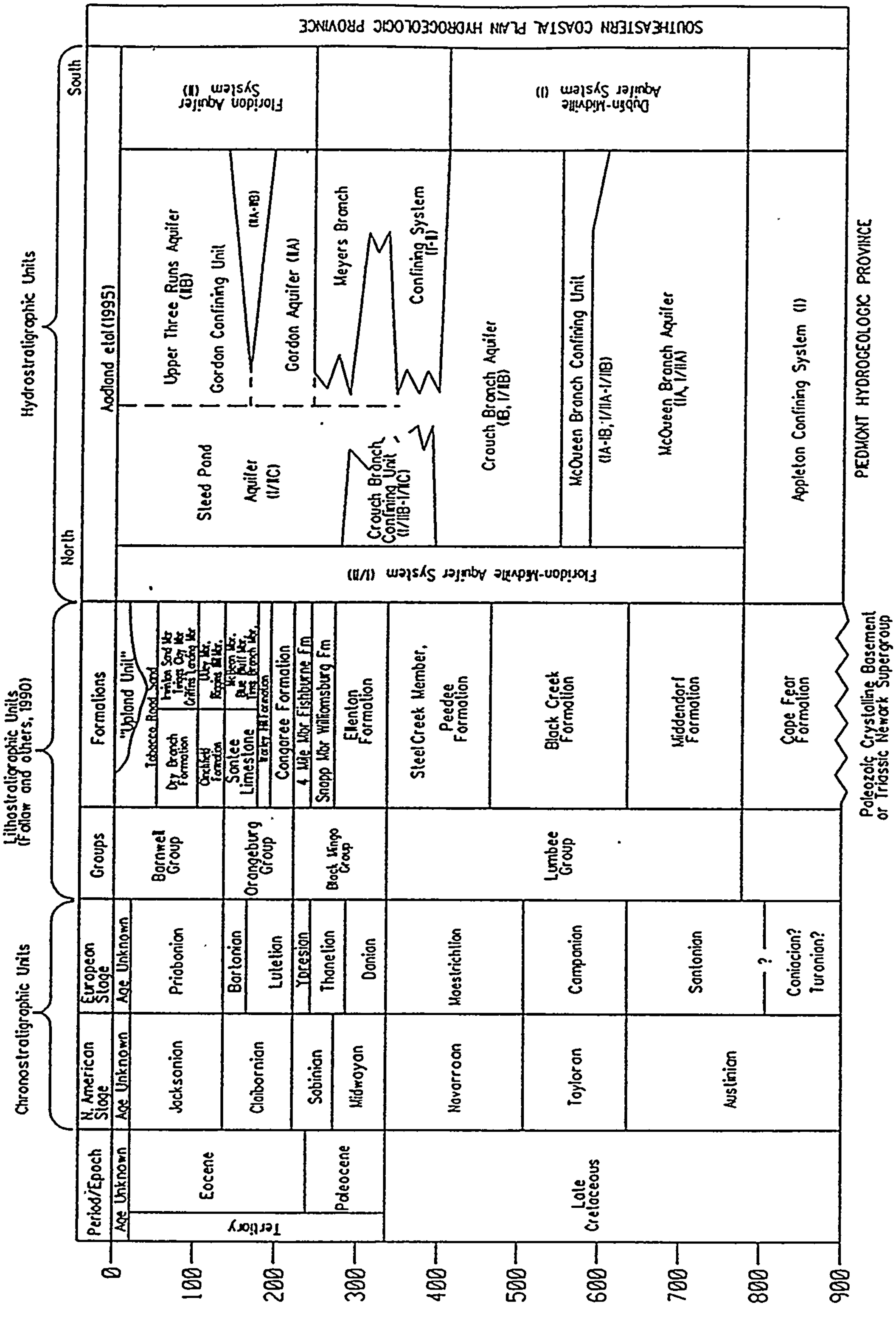

Figure 1-9. Stratigraphic Column of the SRS Area with Hydrologic Nomenclature

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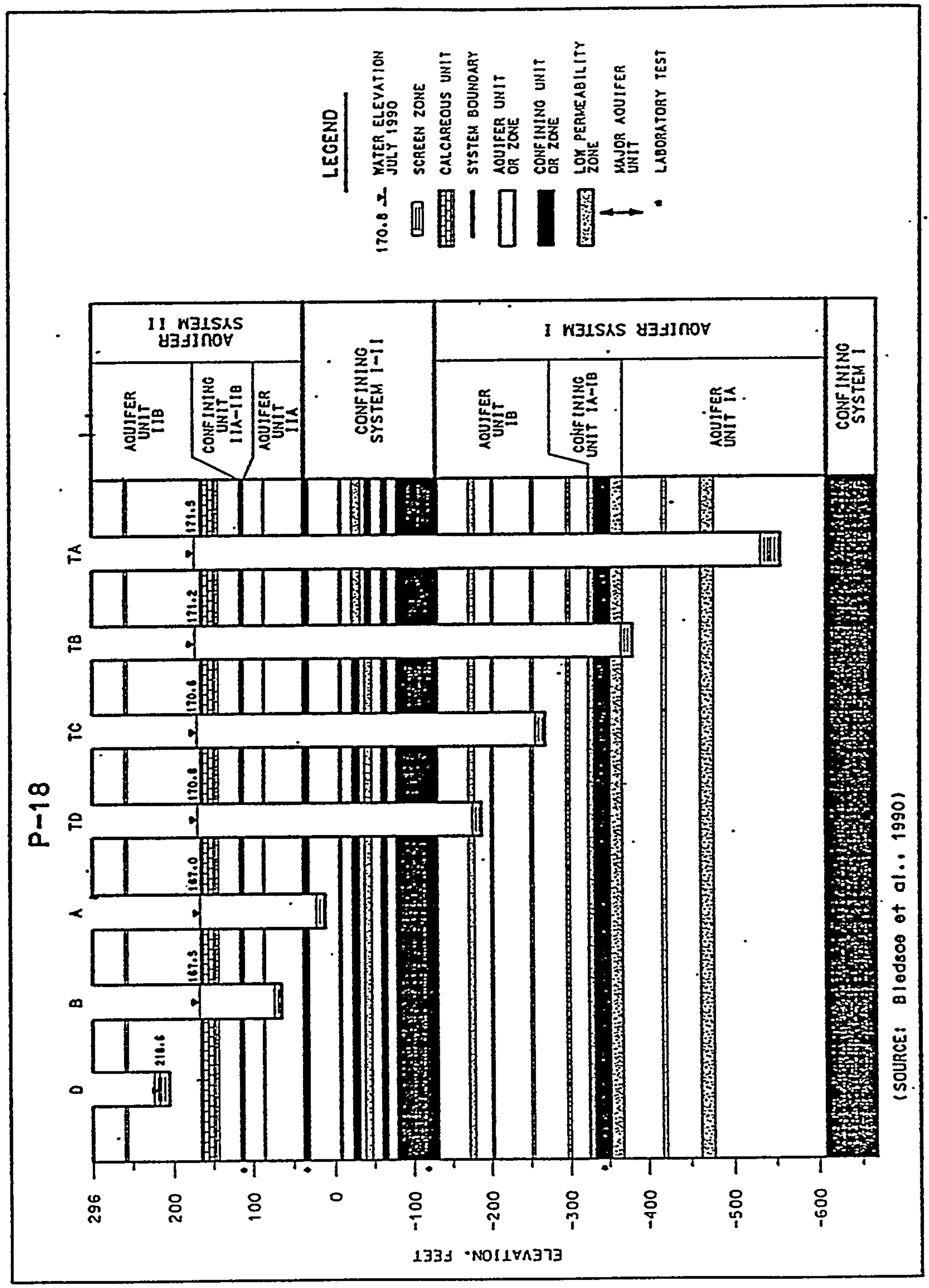

(SOURCE: Bledsoe et al., 1990)

Figure 1-10. Profile of P-18 Well Cluster

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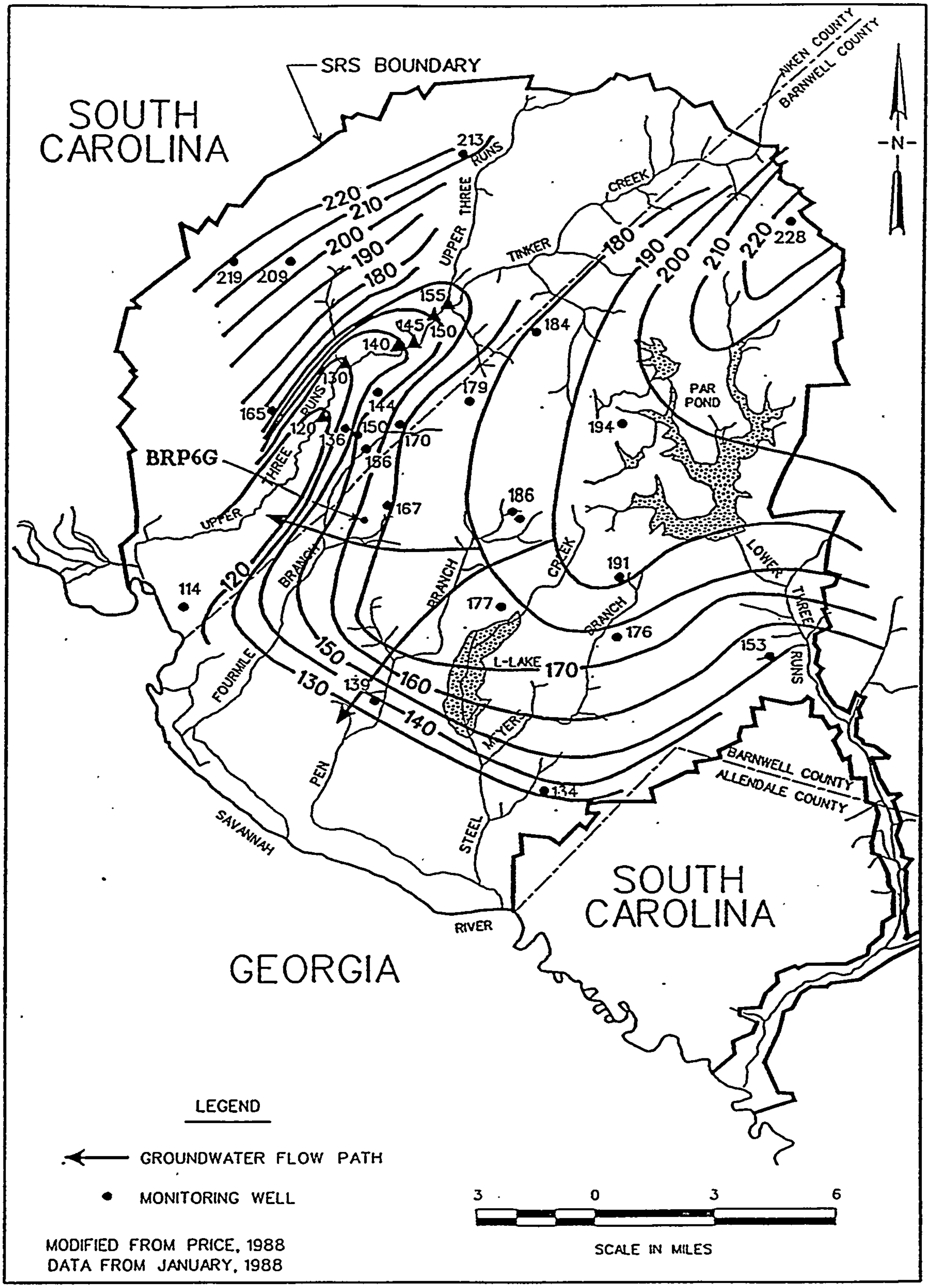

Figure 1-11. Regional Potentiometric Surface Map, Gordon (Congaree) Aquifer Unit

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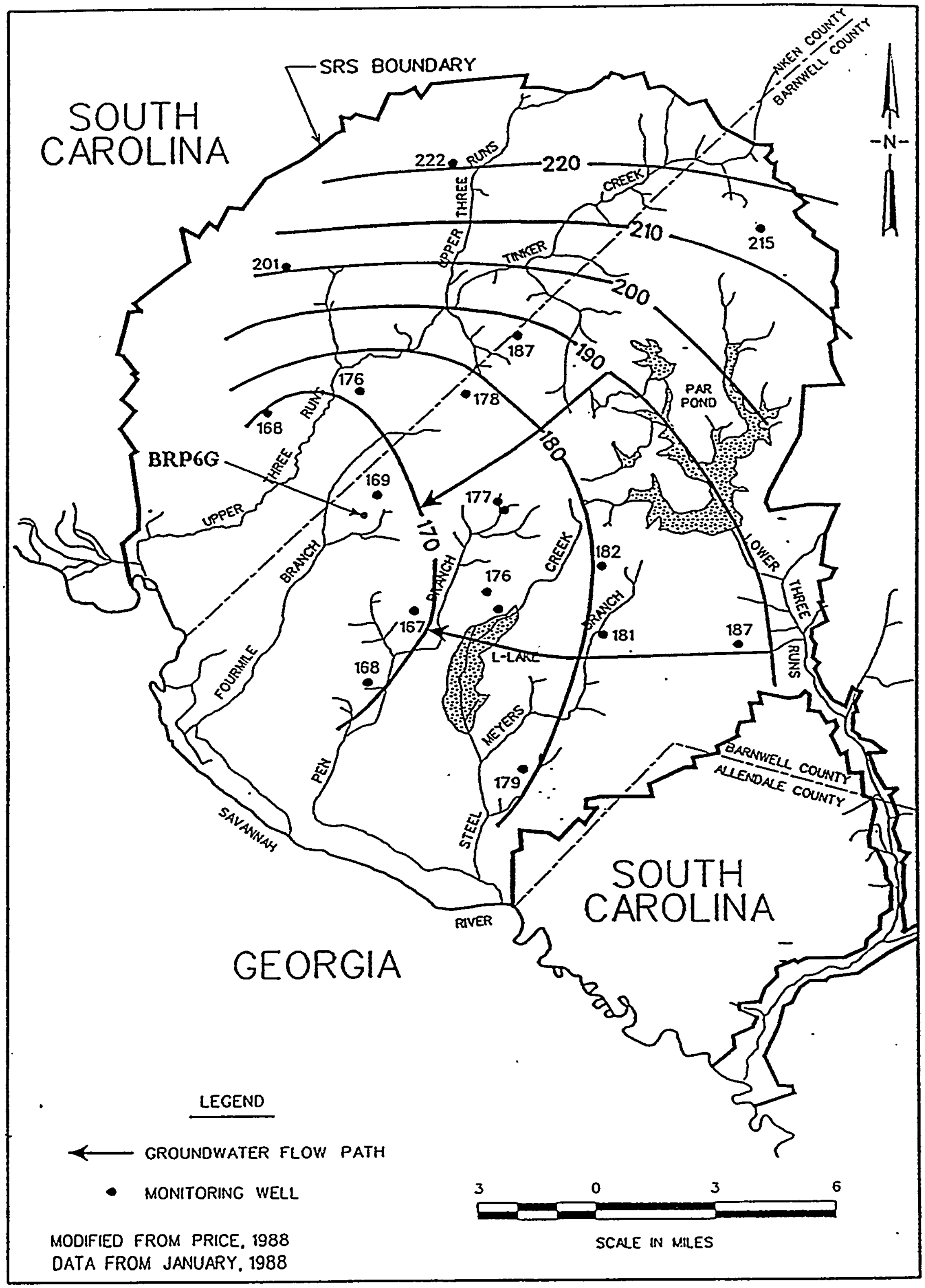

MODIFIED FROM PRICE, 1988
DATA FROM JANUARY, 1988

Figure 1-12. Regional Potentiometric Surface Map, McQueen Branch Aquifer Unit

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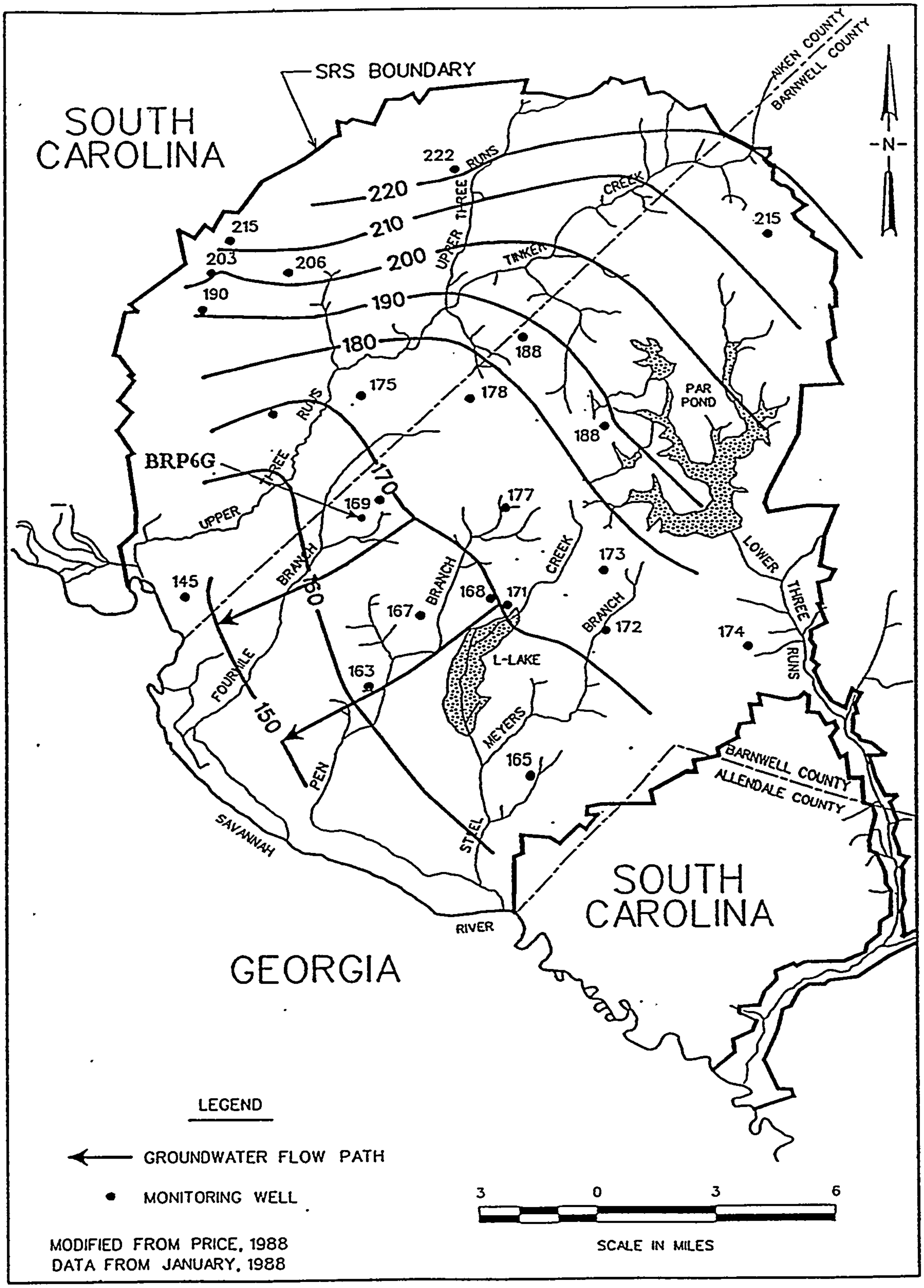

Figure 1-13. Regional Potentiometric Surface Map Upper Member Crouch Branch Aquifer Unit

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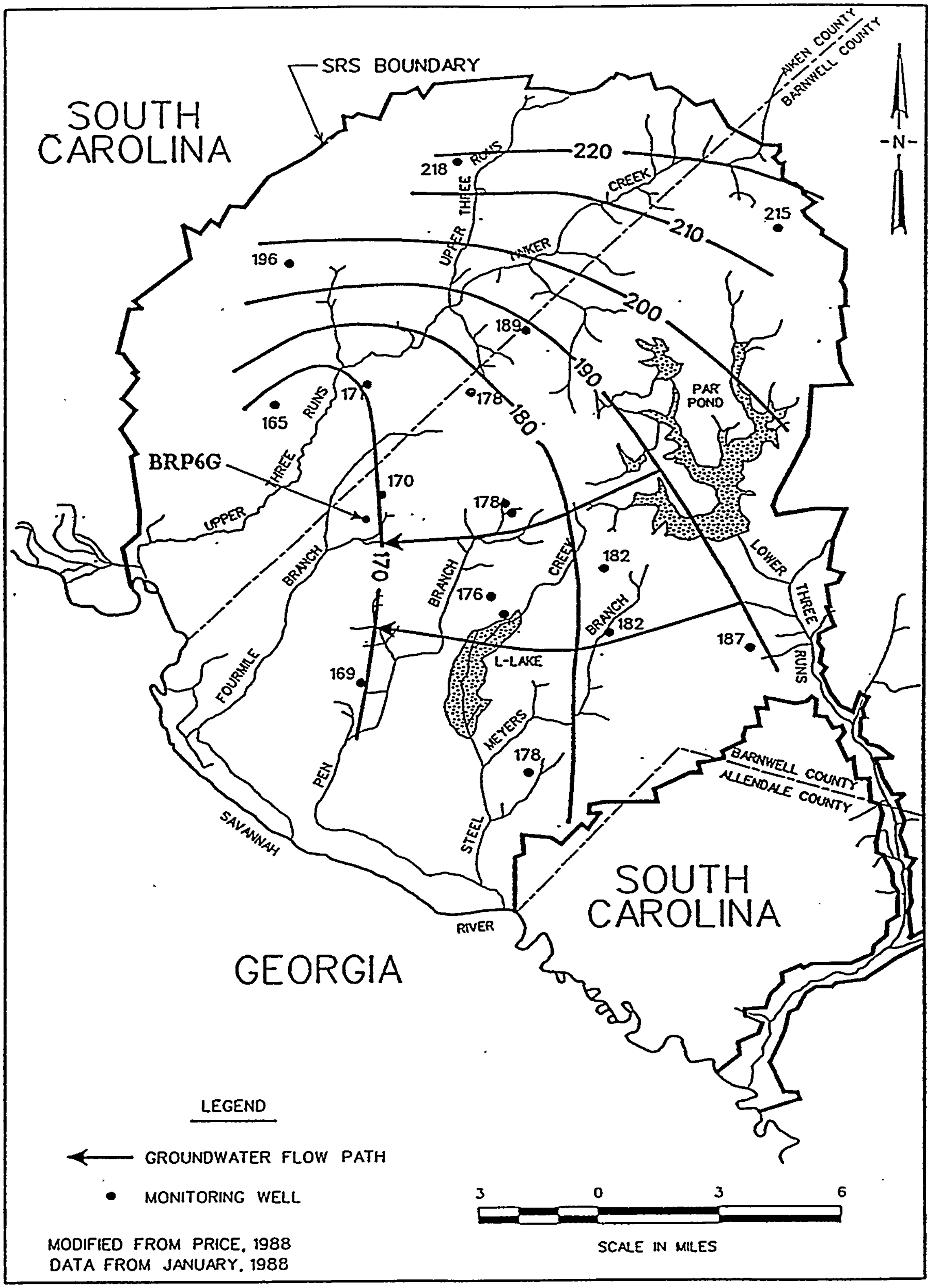

Figure 1-14. Regional Potentiometric Surface Map Lower Member Crouch Branch Aquifer Unit

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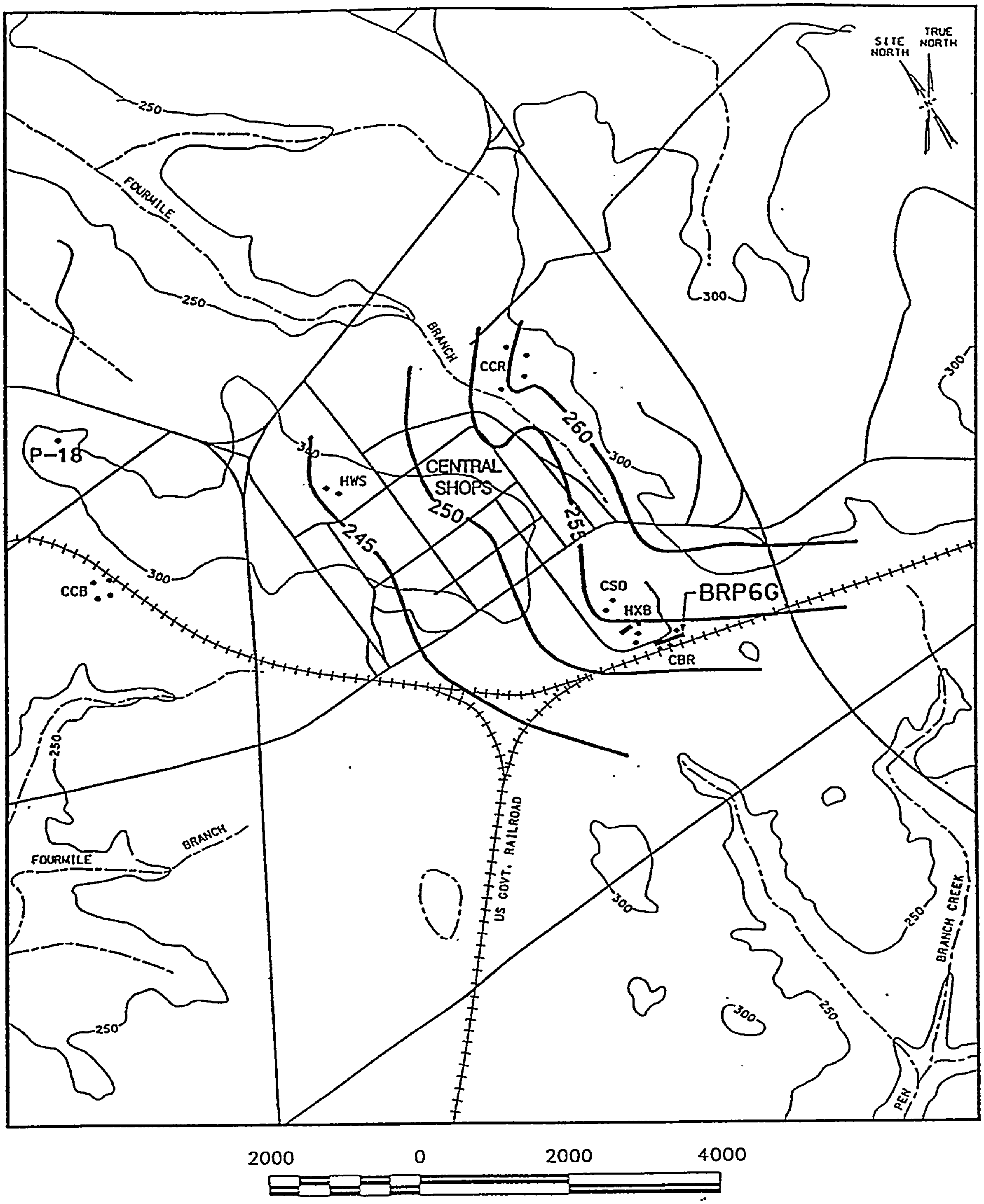

● = Water Table Wells

Figure 1-15. Potentiometric Surface of the Water Table (formerly Aquifer Unit IIB) in the Central Shops Area

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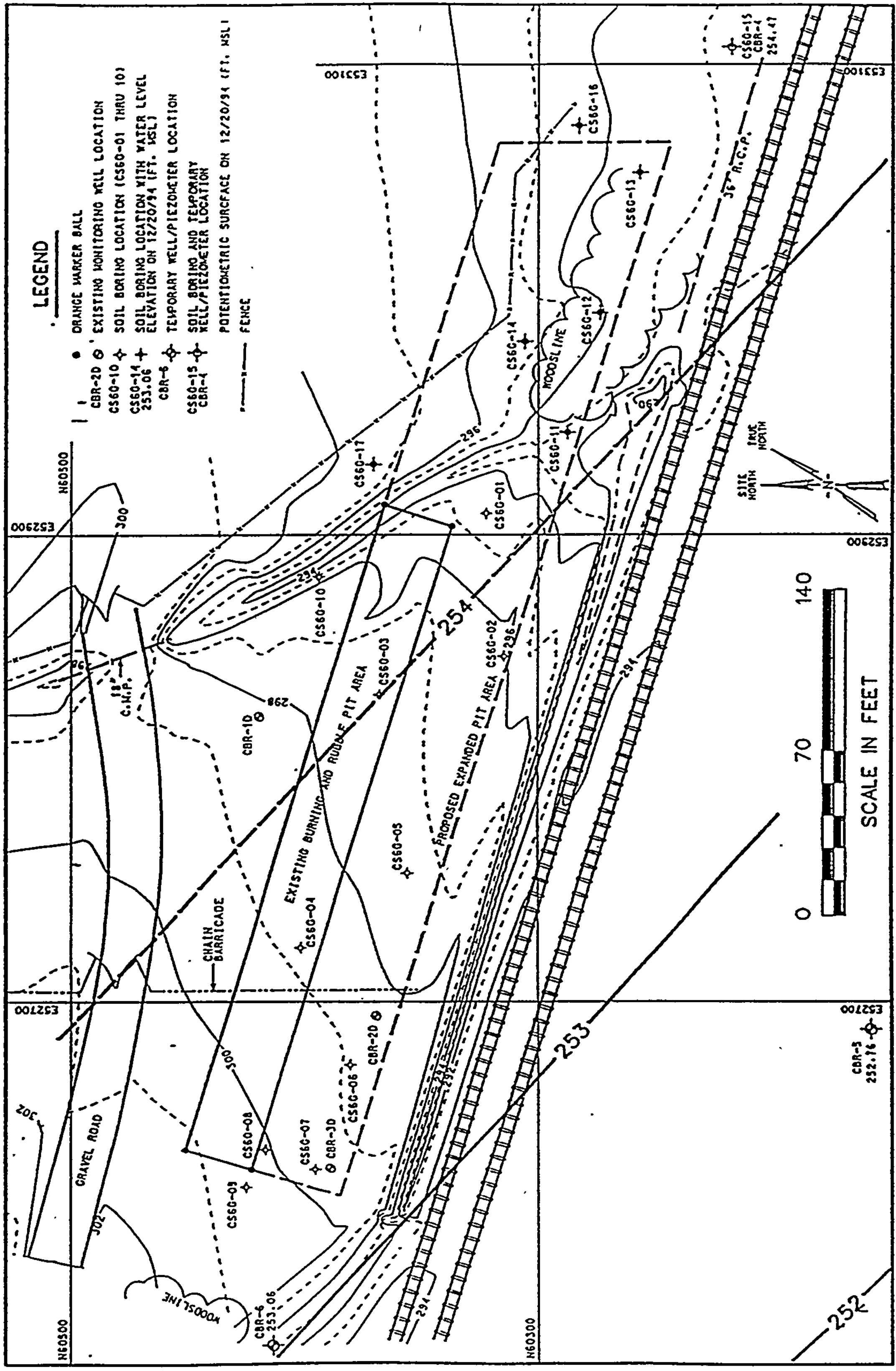

Figure 1-16. Potentiometric Surface of the Water Table (formerly Aquifer Unit IIB) at the BRP6G

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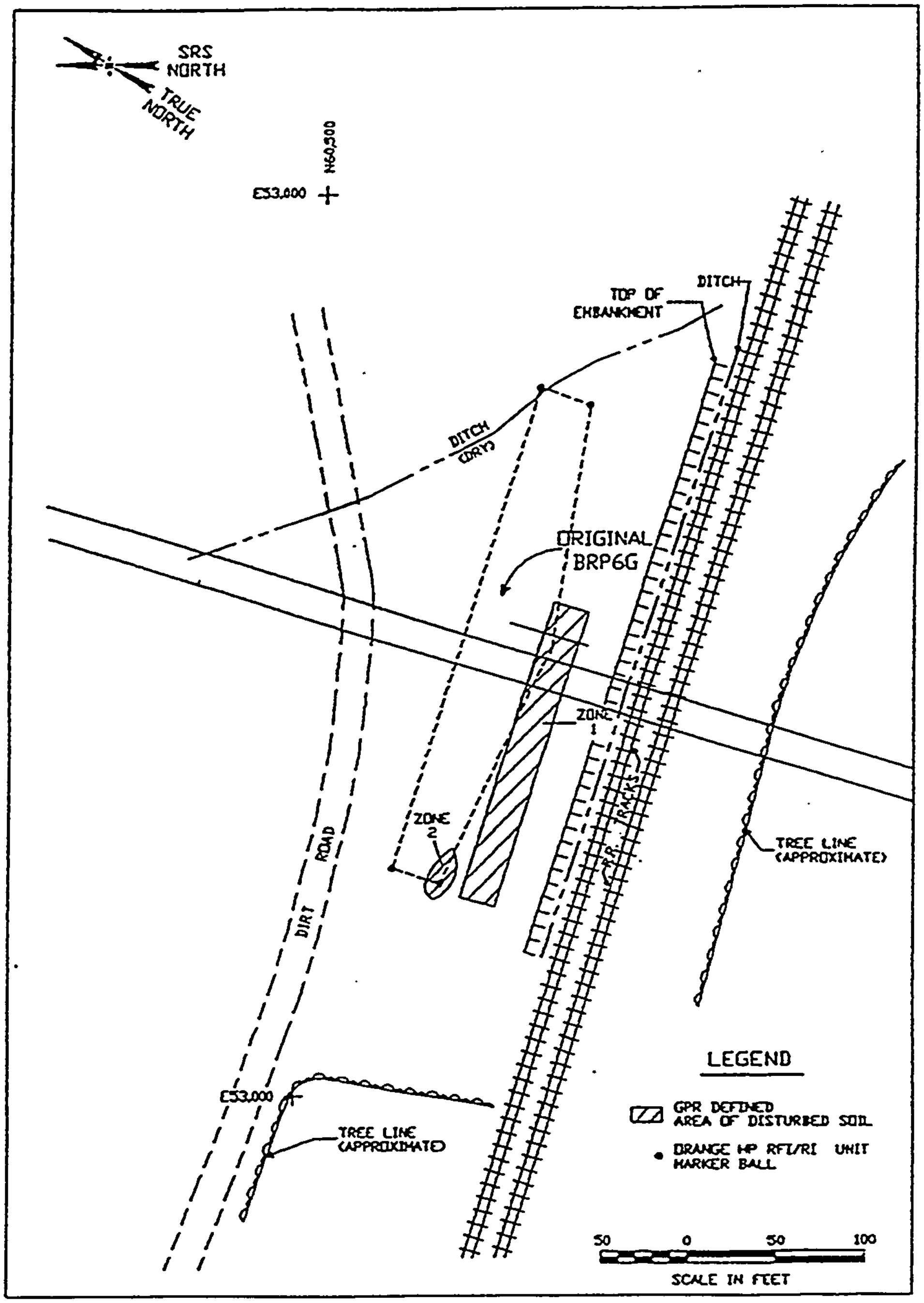

Figure 1-17. Zones of Disturbed Soil Identified at the BRP6G

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2.0 SITE INVESTIGATION PROCEDURES

2.1 Objectives

This section describes the physical and contaminant investigations conducted at the BRP6G. The investigation was conducted during two time frames. The initial investigation utilized soil borings and was conducted from March through April 1994. Subsequent to this investigation, a review of historical aerial photographs implied that the waste unit was actually larger than previously marked and investigated. Therefore, further characterization was deemed necessary. An additional sampling plan and monitor well installation plan was devised to incorporate the required groundwater monitoring well installation, surface water and sediment sampling, and further soil boring investigation. The additional site characterization activities were conducted from November through December 1994. The objectives of these investigations were to:

1. Address all aspects of the Conceptual Site Model, and /or refine the Conceptual Site Model based on the data produced;
2. To confirm the results of the preliminary soil gas survey conducted from October 1990 through November 1991;
3. To further define the pit boundaries as delineated in historical aerial photographs;
4. To determine the extent of hazardous substances release to soil, if any;
5. Assist in determining the feasibility of potential remedial alternatives via the collection of preliminary soil engineering parameters;
6. Enhance and refine the hydrogeologic characterization of the subsurface in the vicinity of the BRP6G;

7. Define the vertical and horizontal extent of possible hazardous substances in the water table aquifer.

2.2 Topographical Mapping

The site of the BRP6G was surveyed during December 1994. The survey incorporated surface features including roads, fences, sampling locations and wooded areas. The topography was mapped on a two foot contour interval as shown in Figure 2-1. There are no buildings present at the BRP6G site. All 1994 sampling locations were surveyed and site coordinates are given in Table 2.4.

2.3 Ground Penetrating Radar

Preliminary site investigations utilizing a Ground Penetrating Radar (GPR) Survey was conducted at the BRP6G site in August 1992. The purpose of this survey was to aid in determining disturbed soil that may indicate trenches and/or trench boundaries. This contributed to the characterization of the primary source as depicted in the the Conceptual Site Model, see Figure 2-1a. Refer to Section 1.2.3.2 of this report and to Appendix B.

2.4 Soil Gas Survey

A preliminary site reconnaissance utilizing a soil gas survey was performed at the BRP6G from October 1990 through November 1991. The purpose of the survey was to monitor for the presence and distribution of C1-C4 hydrocarbons, BTEX, selected chlorinated hydrocarbons, and mercury. This survey provided data aiding in the characterization of the primary release mechanism of volatilization and the exposure medium of air (vapor). This survey also provided some insight into the primary and secondary sourcing of dust as a mechanism for contamination. For further discussion and documentation, refer to Section 1.2.3.1 of this report and Appendix A.

2.5 Contaminant Source Investigation

The primary source of the contamination is the material which was disposed of and burned in the pit. The investigation of this source and other secondary sources and their interaction with the conceptual site model are the topic of the following discussion. The investigative strategy was designed to characterize the source, delineate the release mechanisms of the contamination and to determine the lateral and vertical extent of the contamination and its impact on receptors. These investigations involve both the surface, the pits, as well as the vadose zone.

2.5.1 Initial Investigation

As discussed in Section 2.1, two (2) investigations for the BRP6G site were conducted. The initial investigation conducted from March to April 1994 involved the sampling of a total of 10 boring locations. The soil boring locations for the initial investigation are shown in Figure 2-2. Boring locations CS6G-01 and CS6G-02 were chosen based on the results of the soil gas survey. Boring CS6G-01 was located near soil gas survey point number 29 where low concentrations of xylenes and methane were detected. Boring CS6G-02 was located near soil gas survey point number 39 where toluene was detected at low levels. Borings CS6G-03 and CS6G-04 were located within the orange ball markers. These borings provided information regarding the presence or absence of contaminants within the area originally designated as the BRP6G. Borings CS6G-05, CS6G-06, and CS6G-07 were located within Zone 1 identified by the ground penetrating radar survey as disturbed soil. These borings provided information regarding the presence or absence of contaminants within this area of disturbed soils. Borings CS6G-08 and CS6G-09 were located in Zone 2 identified as disturbed soil by the ground penetrating radar survey. A background soil sample (CS6G-10) was collected from an area north of the BRP6G as indicated in Figure 2-2. Depths of the background soil samples were determined based on field data gathered from the previous soil borings. Site coordinates and ground surface elevations at each borehole sampling location are given in Table 2.4. A minimum of four samples were collected from each borehole. Background boring CS6G-10 was sampled from ten intervals, with soil samples collected from the surface down to a depth of 9.36 m (31.7 ft). The water table was not encountered at this depth.

Table 2.1 summarizes the soil sampling plan and includes sample numbers, sample dates, number of split spoon samples, total depth to the bottom of pit (BOP), EPD/EMS soil sample logbook sample ID numbers, munsell color, sample depth, unified soil classification, analyte code and QA/QC identifier. The sample collection logbooks completed for this sampling program are included in Appendix D. The drilling logs (field geologic logs) and field notes completed for this investigation are presented in Appendix E.

Surface soil samples, 0 to 0.61 m (0 to 2.0 ft) were obtained using a decontaminated 7.62 cm (3 inch) diameter stainless steel auger. Any grass, roots, or debris on the ground surface was first scraped away from the sampling location using a decontaminated stainless steel spoon or scoop. The auger was then used to collect soil from the 0.0 to 0.61 m (0.0 to 2.0 ft) depth. The work plan then called for continuous split spoons through the pit, but no samples to be collected. After the base of the pit was identified, samples were collected via split spoon until two consecutive samples were collected with no Organic Vapor Analyzer (OVA) or Trace Gas Analyzer (HNu) detections.

Subsurface soil samples deeper than 0.61 m (2.0 ft) were collected using a truck-mounted hollow stem auger drill rig. A 61 cm (24 inch) long, 7.62 cm (3 inch) outer diameter (O.D.) stainless steel split-spoon sampler was used to collect the subsurface soil samples. The split-spoon was hydraulically pushed or hammer driven into the formation. The split-spoons were opened in the field onto a clean plastic covered surface and immediately examined and described in the field by a geologist. Prior to homogenizing, the samples for volatile organic and semi-volatile organic analysis were collected. Soil samples were collected in plastic Ziploc bags for volatile monitoring using an OVA and Health Physics (HP) screening. A summary of the OVA readings is given in Table 2.6. If elevated Volatile Organic Compounds (VOCs) were detected, the plan called for samples to be collected every 1.52 m (5.0 ft) down to the water table or until field screening indicated no contamination in two consecutive samples, whichever came first. It was never necessary to sample down to the water table. After the necessary OVA and HP screening was completed, the soil was gently homogenized and the soil sample for laboratory analysis was collected in laboratory supplied containers.

Field quality control samples were collected during the soils investigation. One duplicate sample was collected for every ten (10) soil samples sent for analysis. One rinsate and field blank were collected for each day of soil sampling. Trip blanks and field blanks consisted of clean sample containers which were filled in the field with deionized water. Rinsate samples were collected by pouring deionized water over the decontaminated sampling equipment (i.e., split spoon, hand auger, bowl, spatula) and transferring the rinse water to clean sample containers. Split and duplicate samples were collected from the same split spoon or auger as the associated sample.

To aid in determining feasibility of remedial alternatives, samples of low permeability sediments were collected at soil borings CS6G-03, CS6G-05 and CS6G-09. Relatively undisturbed samples from the sandy clay layer just below the BRP6G and just above the water table aquifer were collected using a Shelby tube. The Shelby tube samples were handled, packaged, and shipped in accordance with industry approved standards. In summary, the Shelby tubes were sealed at both ends with paraffin, maintained in an upright position (as they came out of the ground), and packaged for shipping so that they would remain upright in transit. The samples were shipped to a testing laboratory and analyzed for vertical and horizontal hydraulic conductivity, moisture content, grain size, Atterberg limits, and bulk density. The results of the tests are included in Table 2.7.

Each borehole was grouted through a tremie pipe as specified in WSRC-3Q5 (WSRC, 1992). WSRC-3Q5 is available in DOE Public Reading Rooms.

2.5.2 Additional Investigation

Additional field work at BRP6G was conducted between November 2 and December 30, 1994. Field activities included mud rotary drilling techniques for temporary groundwater monitoring well installation, well development, groundwater sampling, field permeability testing (slug testing), hollow stem auger drilling techniques with split-spoon sample collection, visual classification of soil, collection of surficial soil samples, and collection of surface water/sediment samples. The following contaminant source investigations were completed:

- installation of 12 soil borings
- collection of 6 surficial soil samples
- collection of 5 surface water/sediment samples
- installation of 3 groundwater monitoring wells

An additional 12 soil borings were taken. Soil boring locations are illustrated in Figure 2-4. Refer to Table 2.4 for coordinates and ground surface elevations. Boring locations CS6G-11 through CS6G-14 were chosen to further delineate the proposed expanded pit/unit area. Additionally, these borings provided information regarding the presence or absence of contaminants within the area designated by the historical aerial photographs as the BRP6G. Borings CS6G-15, CS6G-16, and CS6G-17, Figure 2-4, were located outside the proposed expanded unit/area. Results from these borings were expected to provide information regarding the presence or absence of contaminants outside of the area designated as the BRP6G by the historical aerial photographs.

Background soil samples CS6G-18 through CS6G-21 were selected in cooperation with a soil taxonomist at the time the sampling was conducted. Selected locations were considered beyond the area that potentially may have been impacted from waste disposal activities at the unit.

Boring CS6G-18 was located upgradient from the waste site and borings CS6G-21, CS6G-22, and CS6G-23 were located downgradient from the waste unit site.

A drainage feature running through the eastern portion of the pit boundary was identified as having the potential to erode into the actual CS6G pit. Therefore, soil boring CS6G-22 was performed on December 6, 1994. This boring was located to evaluate the potential for contaminants from the pit to impact storm water runoff associated with the drainage feature. Refer to Figure 2-1 for location of the drainage feature running through the eastern portion of the waste unit boundary.

Table 2.2 summarizes the soil sampling plan and includes sample numbers, sample dates, number of split spoon samples, total depth to the bottom of pit (BOP), EPD/EMS Soil Sample Logbook sample ID number, munsell color, sample depth, unified soil classification, analyte code, and QA/QC identifier.

The sample collection logbooks completed for this sampling program are included in Appendix F. The drilling logs (field geologic logs) and field notes completed for this investigation are presented in Appendix H.

Hand auger and hollow stem auger drilling techniques were used throughout the project for soil sample collection. The first two soil samples 0.0 to 0.30m (0.0 to 1.0-ft depth) and 0.30 to 0.61 m (1.0 to 2.0 ft) were collected at each sample location. A stainless steel 7.62 cm (3 inch) diameter hand auger was used to collect these samples and advance the borehole to the required sampling depth. Subsurface soil samples [deeper than 0.61 m (2.0 ft)] were collected at each sample location using a truck-mounted auger drill rig. Hollow-stem augers advanced the borehole to the required sampling depth. Soil samples and lithologic samples were obtained by split-spoon from each soil boring. A 61-cm (24 in.) long, 7.62-cm (3 in.) outside diameter (O.D.) stainless steel split-spoon was lowered on a drill rod through the hollow stem augers to the desired sampling depth. The split-spoon was hydraulically pushed or hammer driven into the formation. A total of 12 soil borings were installed for this additional investigation (CS6G-11 through CS6G-22). The split-spoons were opened in the field onto a clean plastic covered surface and immediately examined and described in the field by the technical oversight. Prior to homogenizing, the samples for volatile organic and semi-volatile organic analysis were collected. Small portions of each sample were placed in Ziplock bags and later screened with either an OVA or a HNu for the presence of volatile organics. The soil was then gently homogenized to ensure a representative composite sample over the depth of the sample interval. Then the soil was placed in appropriate laboratory supplied containers and stored in coolers onsite until prepared for offsite shipment.

The sampling frequency consisted of collecting the first sample at the surface to 0.3 m (1.0 ft) below land surface (bls). The second sample was collected from 0.3 m to 0.6 m (1.0 to 2.0 ft) bls. Samples were then collected continuously at 0.6 m (2.0 ft) intervals until two consecutive samples screened clean for volatile organics below the bottom of the pit. Samples were collected for analysis continuously through the pit and below. The bottom of the pit was designated as the interface from observed burn material and residual soil. Results of borings in delineating the bottom of the pit are presented in Table 2.5.

A split of each soil sample was screened in the field for organic vapors using an OVA or an HNu, as outlined in WSRC 3Q5 and the RFI/RI Program Plan. Sampling continued when VOCs field screening indicated contamination in either of the last two samples. When elevated VOCs were detected, samples were collected every 1.5 m (5 ft) down to the water table or until field screening indicated no contamination as measured by OVA or HNu in two consecutive samples.

In accordance with WSRC 3Q5 and the RFI/RI Program Plan, field quality control samples were collected during the soils investigation. Trip blanks were added to the work plan and were submitted for TCL VOC analytes. Aqueous trip blanks were provided by the laboratory at the frequency of one trip blank per cooler. All samples for VOC analysis were placed in the same cooler for each day's sample shipment.

Results of the soil sampling are given in Table 2.2 and Table 2.5. All borings were installed in numerical order from CS6G-11 through CS6G-22. The first borings drilled were those considered to be within the pit boundaries in order to identify the depth to the bottom of the pit, which was used to determine the minimum depth of borings outside the pit. In addition, this sequence allowed definition of the pit depths and boundaries in the borings that were located within the pit areas (Table 2.2 and Table 2.5). The depths to pit bottom were used to determine sample depths in the four borings located outside the pit (CS6G-11, CS6G-15, CS6G16, and CS6G-17) and the background borings (CS6G-18 through CS6G-21).

During soil boring installation, an OVA or HNu was used to screen for the presence of volatile organics to determine the vertical extent for sampling. OVA readings were below detection limits for all borings inside the pit boundaries except for boring CBR-14 with OVA readings as follows:

Boring CS6G-14

Depth Below Ground Surface (ft)	OVA Reading (ppm)
0-1	15
1-2	20
2-4	3
4-6	10
6-8	12
8-10	0
13-15	0

This boring also noted the highest laboratory data for PAH's, indicating a localized source in the pit.

Table 2.2 is a summary of drilling depths, sample intervals and other information included in the EPD/EMS Soil Sample Logbook. The bottom of the pit (BOP) and a burnt, black layer with debris were encountered in three boreholes inside the pit/unit boundaries and are given in Table 2.5. All 12 borings were installed, sampled, and abandoned. Each borehole was grouted through a tremie pipe as specified in WSRC-3Q5 (WSRC, 1992). WSRC-3Q5 is available in DOE Public Reading Rooms.

2.5.3 Results From Investigations

Nine borings were drilled within the confines of the pit. Twenty-three samples were collected from these borings from the surface down to and including the base of the pit. Analyses of these samples were used to characterize the primary source of contamination, (see Figure 2-1a). The results of these analyses were used in the construction of planar maps and cross-sections which depict the vertical and lateral extent of the more prevalent contaminants. A more detailed discussion of the contaminants is located in Section 4.

The material which was deposited and burned in the pit is the primary source of contamination. The contamination in the pit may impact other media as outlined in the conceptual site model. For example, through infiltration / leaching, the contamination present in the pit is transported to the vadose zone soils and ultimately to the groundwater, (see Figure 2-1a).

2.6 Surface Water/Sediment Sampling

Five surface water and sediment samples were obtained from locations in the area. Surface water and sediments have the ability to transfer contaminants through direct contact with receptors via ingestion, inhalation, and dermal contact.

2.6.1 Sampling Locations and Intervals

Five surface water and sediment samples (CS6G-29 through CS6G-33) were obtained from the ephemeral stream, located approximately 61 m (200 ft) southeast of the unit (Figure 2-3 or 2-4). At the time the unit reconnaissance was made it appeared that the drainage was hydrologically influenced solely by surface runoff. Selection of adequate background locations for surface water was not possible, because of the lack of upgradient surface water.

Surface water/sediment samples were analyzed for Total Organic Halogens (TOH), RCRA metals, semi-volatile organic compounds [including polycyclic hydrocarbons (PAH)], GC/MS VOC, radionuclide indicators and tritium, sediment pH and TOC, Inorganics, Total Organic Carbon (TOC), Total Suspended Solids (TSS), and Total Dissolved Solids (TDS).

Field measurements of the surface water included water temperature, dissolved oxygen, pH, and estimated flow. QA/QC samples were also analyzed and collected as specified in the Addendum to Chapter 4 of the RFI/RI Work Plan for the Central Shops Burning/Rubble Pit, 631-6G. A summary of the surface water/sediment sampling is provided in Table 2.3.

2.6.2 Surface Water/Sediment Sampling Procedures

Surface water/sediment sampling was conducted in accordance with procedures specified in the RFI/RI Program Plan and WSRC 3Q5.

Samples were scheduled to be collected from downstream to upstream locations in order to prevent compromising the sampling locations. Background surface water samples were not collected as no upgradient surface water existed. Caution was taken to ensure minimum loss of volatiles. All disposable sampling supplies and materials were removed from the waste unit area and disposed of in accordance with current WSRC procedures.

2.6.3 Results From Surface Water/Sediment Sampling

Surface water/sediment samples were collected at BRP6G at CS6G-29 through 33. Sediment only was collected from CS6G-23 through 28. Analyses of the samples were used to characterize these secondary sources of contamination. The data from these analyses were used in the baseline risk assessment in Chapter Six. The material which was deposited and burned in the pit provided the primary source material for contamination. Per the conceptual site model, through bioturbation/excavation, contamination of the surface water/sediment can occur. From these media, exposure can occur through inhalation via volatilization and dust generation, ingestion via direct contact and vegetative contact, and dermal contact. Secondarily through the release mechanism of infiltration or leaching, subsurface soil and groundwater can be affected, (see Figure 2-1a).

2.6.4 Surficial Soil Sampling and Analysis

Surficial soil sampling was performed at locations CS6G-23 through -28, (see Figure 2-3). The samples were analyzed for TCL/TAL w/TIC, Dioxins/Furans, and Rad Indicators (gross alpha and non-volatile beta). Data from the analyses of surficial soil were incorporated into the Baseline Risk Assessment in Chapter Six. A summary of the results from these analyses is found in Table 4.13.

2.7 Temporary Groundwater Monitoring Well Design, Installation, and Sampling

2.7.1 Temporary Groundwater Monitoring Well Construction

Three temporary groundwater monitoring wells were installed in the Water Table (CBR-4, CBR-5 and CBR-6). Well construction details for each monitoring well are presented in Appendix I and Table 2.8. The monitoring wells have been surveyed for location and elevation. Site coordinates, top of casing elevation, and pad elevation are presented in Table 2.4. The available as-built survey data for the groundwater monitoring wells are presented in Table 2.9.

All monitoring wells were constructed in accordance with specifications and procedures described in WSRC 3Q5 for monitoring wells, and the South Carolina Well Standards and Regulations, R.61-71 of the Code of Laws of South Carolina (SCDHEC, 1985). Screen intervals for the 5-cm (2-in) diameter wells were selected after considering hydrogeologic data obtained from previous studies, reports and lithology.

The 5-cm (2-in.) diameter wells were constructed of PVC casing, machine slotted PVC screens with 0.041-cm (0.016-in.) slot width, and a bottom plug either 6.1 or 9.1 cm (2.4 or 3.6 in.) in length. Two stainless steel centralizers were installed as presented in Appendix I.

The filter pack consisted of 0.046 to 0.056-cm (0.018 to 0.022-in.) uniform silica sand. The filter pack was installed from the bottom of the borehole to a minimum of 0.6 m (2 ft) above the screen through a tremie pipe placed adjacent to the well screen. A minimum of 0.9 to 1.5-m (3 to 5-ft) thick bentonite pellet seal was installed above the filter pack. After at least 2 hours of hydration time, a cement/bentonite grout cap was installed through a tremie pipe lowered to just above the bentonite seal. The minimum allowable cement weight was 1.58 g/cm^3 (13.2 lb/gal). Any variations in well construction are presented in Appendix I.

A significant effort was made to minimize the potential of introducing contamination into the subsurface or the local environment during drilling operations. This effort was made so that the results of water quality sampling would be representative of actual groundwater conditions. All well construction materials were secured or wrapped in plastic for storage at the drill site. The drilling and downhole equipment, including drilling and development tools, bailers, pumps, well casings, and well screens were decontaminated, per 3Q5, just prior to use or installation and between well sites to minimize the chances of cross-contamination. At each site, plastic sheeting was placed under the drilling rig to contain any fluid leaks from service trucks or the drill rig. Any oil or hydraulic leaks present on the plastic sheet were absorbed with dry bentonite powder and disposed of by WSRC drilling subcontract personnel.

2.7.2 Well Development

Following subsurface completion, each well was developed under guidelines outlined in WSRC 3Q5 and under the direction of WSRC personnel. Well development reports were prepared by the drilling companies and submitted to WSRC Environmental Protection Department Groundwater Monitoring Group. Well development results are summarized in Table 2.9 of this report. Appendix I includes well development records from EMTC, the consultant that installed the wells.

Initially, each well was developed by bailing slowly. This procedure allows the filter-sand to settle around the screen properly, while purging heavy drilling mud from the well casing, and initiating breakdown of the mud cake formed during rotary drilling operations. The wells were bailed as soon as possible after completion in order to facilitate the initial breakdown of the mud cake. As the development process progressed, the wells were surged by rapidly raising the lowering the bailer. The muddy water was then bailed.

If the groundwater monitoring wells required additional development, a submersible pump outfitted with a surge block was used to surge, or swab discreet areas of the screened zone and remove large volumes of fluid. This surge block was made of a rigid rubber stopper attached to the tremie pipe a few feet above the submersible pump. It was only slightly smaller in diameter than the inside diameter of the well being developed, so that the tremie could be raised and lowered to swab an area of the screen. The surge block would push water out of the screen zone as the tremie and pump were lowered and pull water into the screen zone as they were lifted. When the pH, turbidity, and conductivity of the well had stabilized, the submersible pump was removed from the well. Both of these methods were utilized in the development of the groundwater monitoring wells (see Table 2.9).

2.7.3 Groundwater Sampling

Groundwater samples were collected in two different sampling phases from the three temporary groundwater wells (CBR-4, CBR-5, and CBR-6) on December 5 and December 28, 1994. The Addendum to Chapter 4 of the RFI/RI Work Plan for the Central Shops Burning/Rubble Pit, 631-6G lists the sampling analytes. All wells were sampled in accordance with WSRC 3Q5. A summary table of the sampling data is presented in Appendix J.

2.7.3.1 Groundwater Analysis Results

Samples from the monitoring wells were collected and analyzed for various constituents. Analyses of these samples were incorporated into the conceptual site model to evaluate the nature and extent of contamination emanating from the pit contents via infiltration / leaching to the groundwater below. The data from these analyses is tabulated in Table 4-14. A more detailed explanation of the groundwater contamination is located in Section 4.0.

2.7.4 Field Permeability Testing

After well development was complete, slug tests (both rising and falling head) were performed on each monitoring well to estimate the hydraulic conductivity (K) of the screened formations. The data were analyzed using the Bouwer and Rice (1976) method (Aqtesolv Aquifer Test Solver, version 1.1, Aqtesolv Test Design and Analysis Computer Software by Geraghty & Miller, Inc., Environmental Services Modeling Group).

2.7.4.1 Test Procedure

Slug tests require the instantaneous displacement of a volume of water within a well or piezometer. A field testing system was used which could be easily set up with a PVC slug (cylinder). The slug was a cylinder constructed of nominal PVC pipe. The cylinder or slug was 2.54 cm (1 in.) in diameter. The cylinder had caps secured on both ends and one end cap was fitted with a lifting hook. The pipe was filled with clean water to serve as ballast.

Falling head test data were reported for each of the monitoring wells. The falling head tests were performed by tying a nylon rope to the lifting hook of the cylinder, submerging the cylinder, and measuring the fall in head in the well casing as the water level returned to static conditions. A pressure transducer linked to an electronic data recorder was used to record the fall in head.

A rising head test was performed once the falling head test reached near static conditions. The rising head test measures the rise in head or the recharge of water after the submerged cylinder had been quickly removed from the well or piezometer.

2.7.4.2 Data Analysis

The Bouwer and Rice Method (1976) was used in this program to analyze the slug test data. It is applicable to fully or partially-penetrating wells in confined and unconfined aquifers and assumes negligible drawdown of the Water Table around the well and no flow above the Water Table. (Aqtesolv Aquifer Test Solver, version 1.1)

The Bouwer and Rice equation for estimating hydraulic conductivity is:

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \times \frac{1}{t} \times \ln \frac{y_o}{y_t}$$

where, R_e = effective radial distance over which the head difference is dissipated

r_c = radius of the section where the water level is rising. If the water level is rising within the screen,

$$r_c = \sqrt{r_c^2 + n(r_w^2 - r_c^2)}$$

r_w = radial distance between well center and undisturbed aquifer (r_e plus thickness of gravel envelope or developed zone outside casing)

L = height of perforated, screened, encased or otherwise open section of well through which groundwater enters

y = the level of water in the well above or below the Water Table

y_0 = y at time zero

y_t = y at time t

t = time since y_0

An empirical equation is used that relates Re to the geometry and boundary conditions of the system:

$$\ln \frac{R_e}{r_w} = \frac{1}{\frac{1.1}{\ln(H/r_w)} + \frac{A + B\ \ln[(D-H)/r_w]}{(L/r_w)}}$$

where H = vertical distance from the Water Table to the base of L

D = the aquifer thickness

A,B = dimensionless parameters found by comparing their relationship to L/rw on a graph of curves provided by Bouwer and Rice (1976).

The observed values of (y) are plotted against (t) on semilogarithmic paper (y on the log scale).

2.7.4.3 Results

Hydraulic conductivity estimates for temporary wells CBR-04 through CBR-06 ranged from 9.72×10^{-5} cm/sec (3.19×10^{-6} ft/sec) to 2.59×10^{-4} cm/sec (8.48×10^{-6} ft/sec) and averaged 1.88×10^{-4} cm/sec (6.18×10^{-6} ft/sec). The hydraulic conductivity estimates for all the wells slug tested (rising and falling head) are presented in Table 2.10 and data plots of the slug tests are included in Appendix I. These hydraulic conductivity estimates were fairly typical for the lithologies encountered.

2.7.5 Boring Activity/Problems for Temporary Groundwater Monitoring Wells

Field logs, well construction diagrams, and monitoring well installation reports are presented in Appendices H and I. This section describes any problems associated with well installation.

2.7.5.1 CBR-4

Temporary well CBR-4 was installed on November 4, 1994 to a total depth of 18.43 m (60.48 ft) below land surface. This well is located southeast of the bit boundary. Difficulties during well installation included improper placement of the bentonite seal. The use of tremie pipe to place well material (sand, bentonite etc.) at the desired depths is highly effective. However, during installation of bentonite an obstruction between the top of the sandpack 11.15 m (36.30 ft) and the measured top of bentonite 8.38 m (27.5 ft) was encountered. The amount of bentonite added to the well should have raised the bentonite to approximately 10 m (33.0 ft), therefore not accounting for an approximate 1.5 m (5 ft) section of the well. Since this well was to be considered a temporary well, additional bentonite was added to the well and allowed to hydrate for over 48 hours to 5.8 m (18.9 ft) bls. The additional bentonite was placed to prevent possible portland cement intrusion during placement. This temporary well was considered acceptable for the specified purposes. When the determination of which well(s) are to be permanent, the condition of CRB-4 will be taken into consideration.

2.7.5.2 CBR-5

Temporary well CBR-5 was installed on November 3, 1994. The well was installed to a depth of 16.7 m (55 ft) bls south of the pit boundary. No problems were encountered during drilling or well installation.

2.7.5.3 CBR-6

Temporary well CBR-6 was installed on November 3, 1994. The well was installed to a depth of 18.4 m (60.4 ft) bls east of the pit boundary. No problems were encountered during drilling or well installation.

2.8 Ecological Investigation

Ecological investigations were performed in to assess the primary and secondary release mechanisms of direct contact, vegetative uptake, and food chain uptake through inhalation, ingestion, and dermal contact by potential receptors in the environment. A unit reconnaissance survey was conducted on November 2, 1988; a copy of which is located in Appendix K. The objectives of the unit reconnaissance were to:

- Assess the general characteristics of on-unit biological communities including mammals, birds, reptiles, amphibians, and any aquatic communities present;
- Determine the location, extent, and characteristics of on-unit ecological resources, such as forested areas and wetlands, that could serve as important wildlife habitat or provide other ecological features; and
- Identify any overt effects of contamination of biological communities and the relationship of this contamination to the Conceptual Site Model.

The field investigations included mapping and describing all wetland and terrestrial habitats; recording wildlife observations of birds, mammals, and reptiles; and investigation ecological resources in nearby downgradient and downstream areas which could be affected by mobile contaminants or future remedial actions. In preparation for the field investigations, existing unit information including aerial photographs and reports were reviewed to help identify and describe ecological resources at the waste unit.

In addition, as part of the unit reconnaissance, a Unit Reconnaissance Field Data Sheet (FDS) was completed. This FDS addressed general waste unit characteristics, topography, past waste disposal practices, water bodies, vegetation, and wildlife. The FDS was developed by SRS and adapted for use at the BRP6G. The data on the FDS will support both the ecological and human health risk assessments.

2.9 Future Investigations

No further investigations for the BRP6G will be conducted.

2.10 ASCAD Applications

ASCAD has as its purpose at SRS to focus data collection on remedial technologies, eliminate/reduce redundant documentation, obtain/facilitate pre-approved remedial decisions and standardize remedial design. Since the BRP6G is one of the lead sites for the burning/rubble pits, the application of the sampling layout and analysis would be applicable for other similar sites. It should be noted however, that the individual lay of the land, topographic influences and geomorphologic texture of the individual sites bear on the location of the sampling points. Since the other burning/rubble pits at Central Shops would be in similar soil types and would probably have had similar primary source material deposited and burned in them, a sampling layout and protocol equal to or less than BRP6G should be adopted. The analysis performed on the samples should note the recommendations in Section 4.7.

FIGURES

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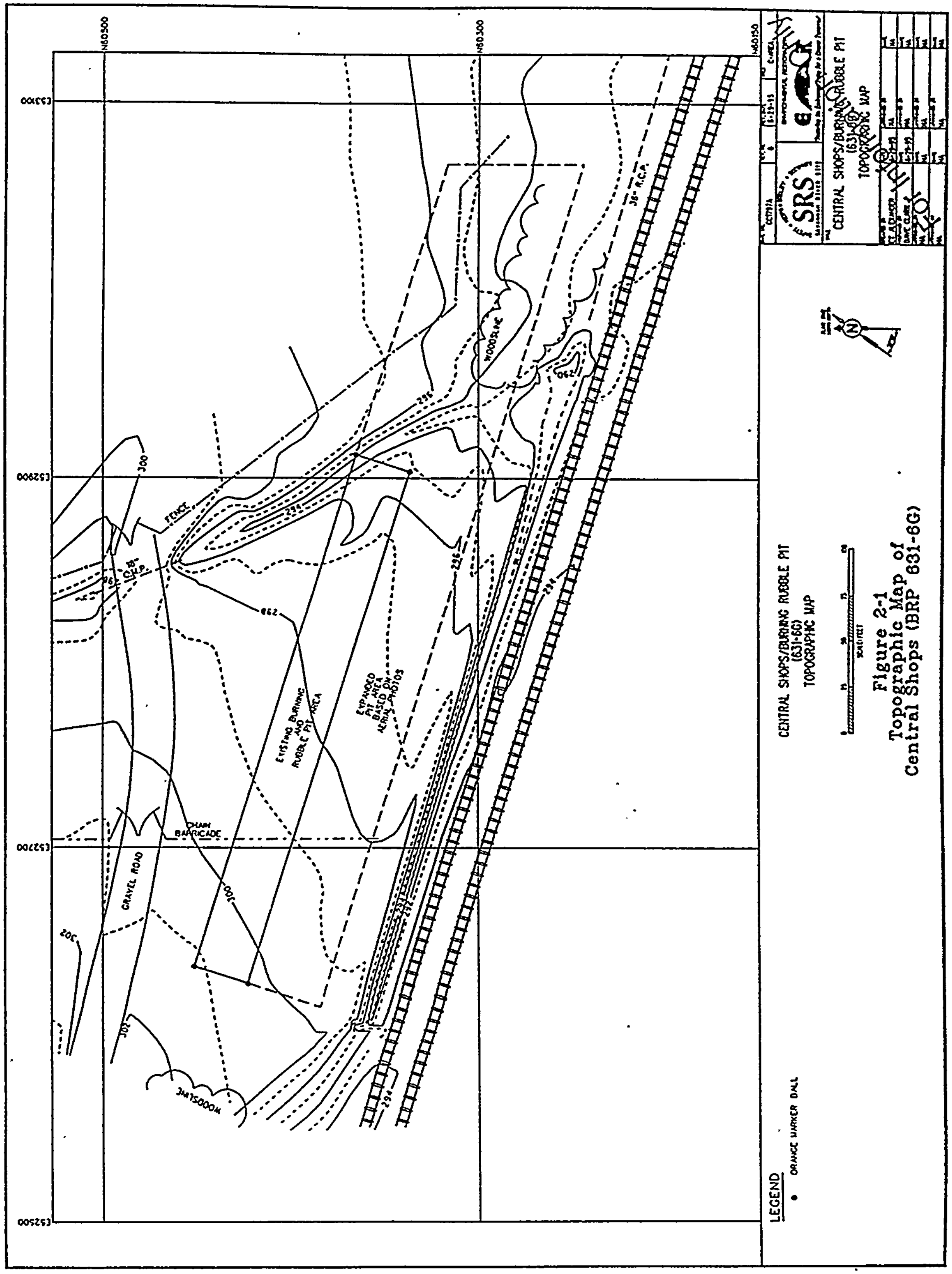

Figure 2-1 Topographic Map of Central Shops BRP 631-6G

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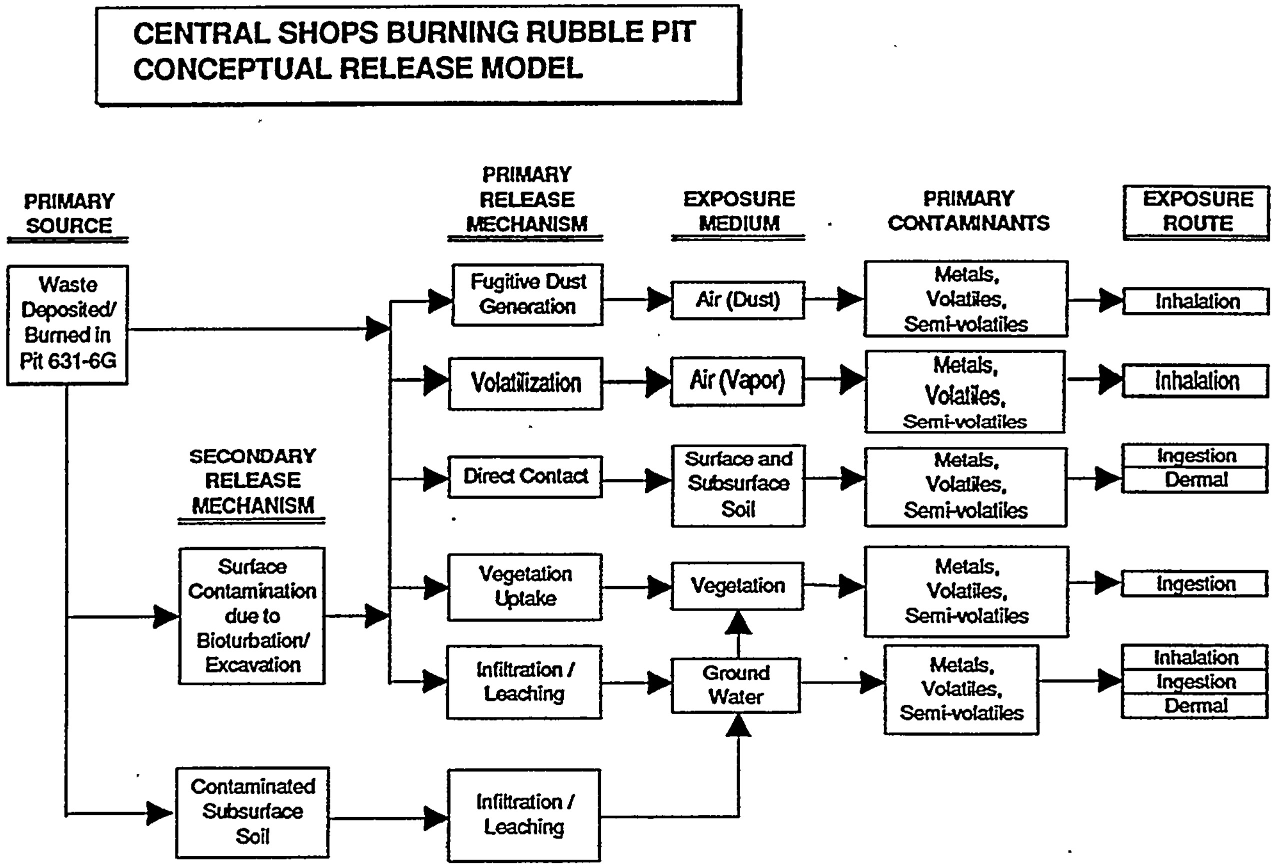

Figure 2-1a Conceptual Site Model

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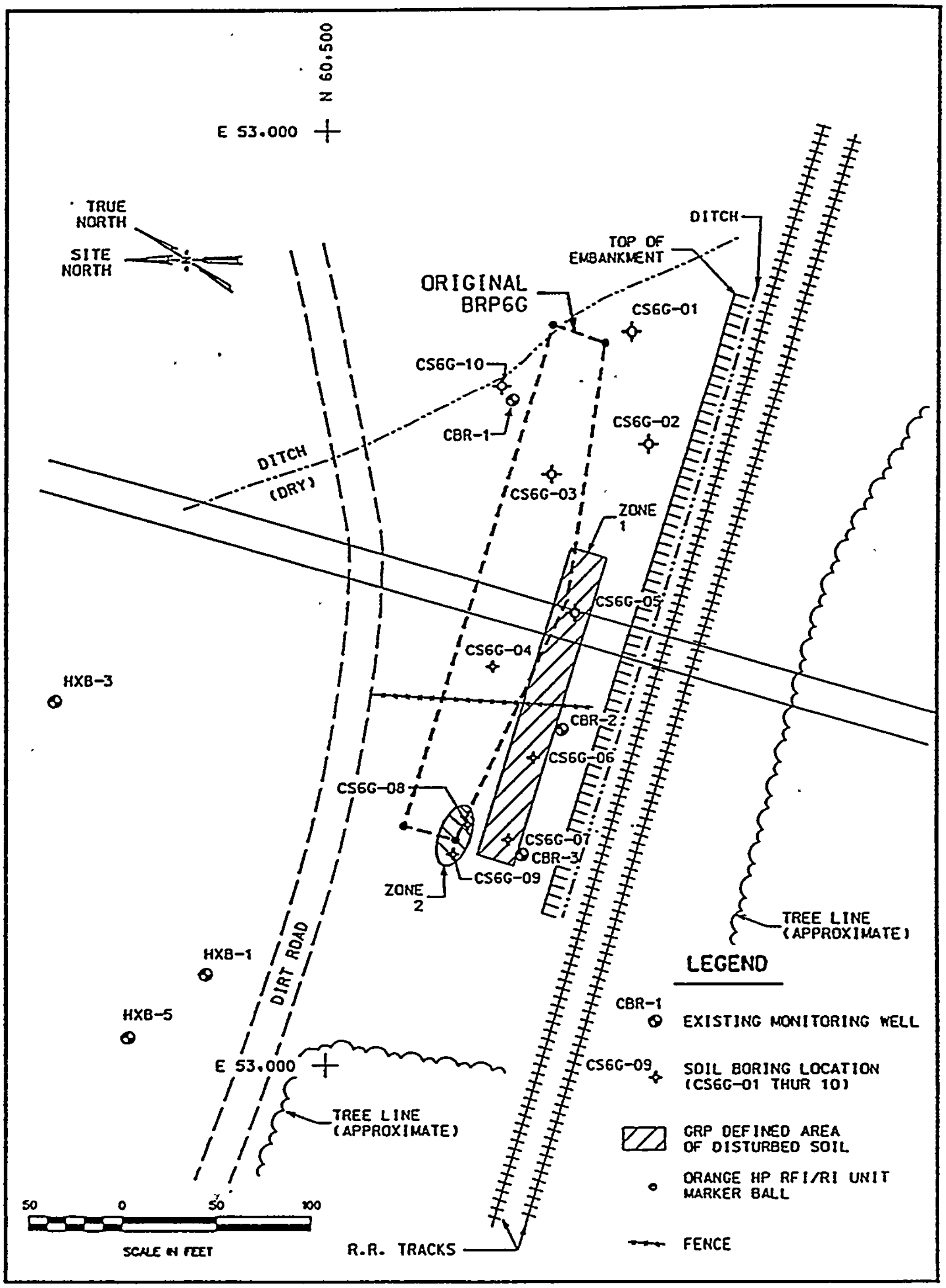

Figure 2-2 Initial Investigation (March–April 1994) Soil Boring Locations

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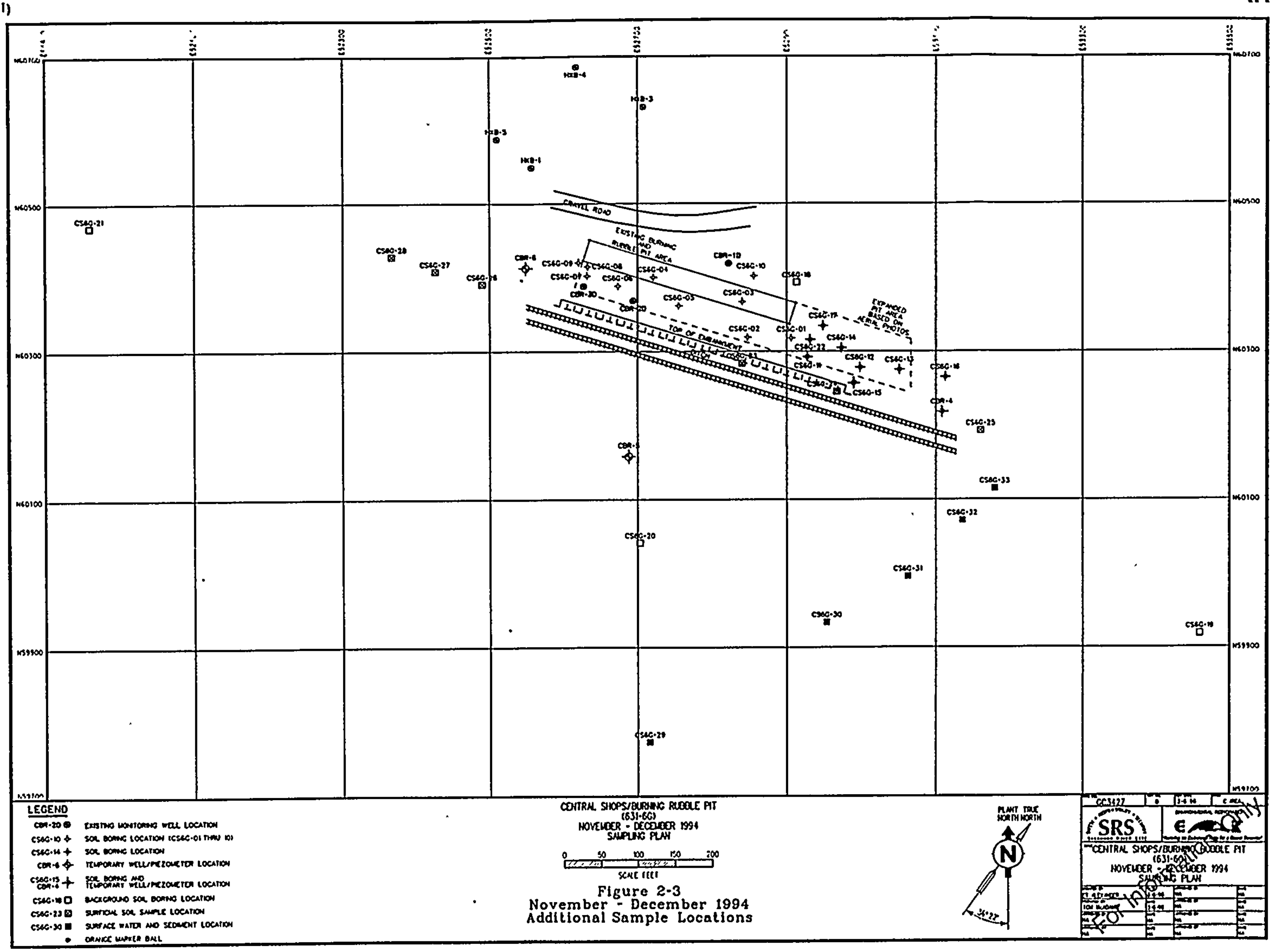

Figure 2-3 November–December 1994 Additional Sample Locations

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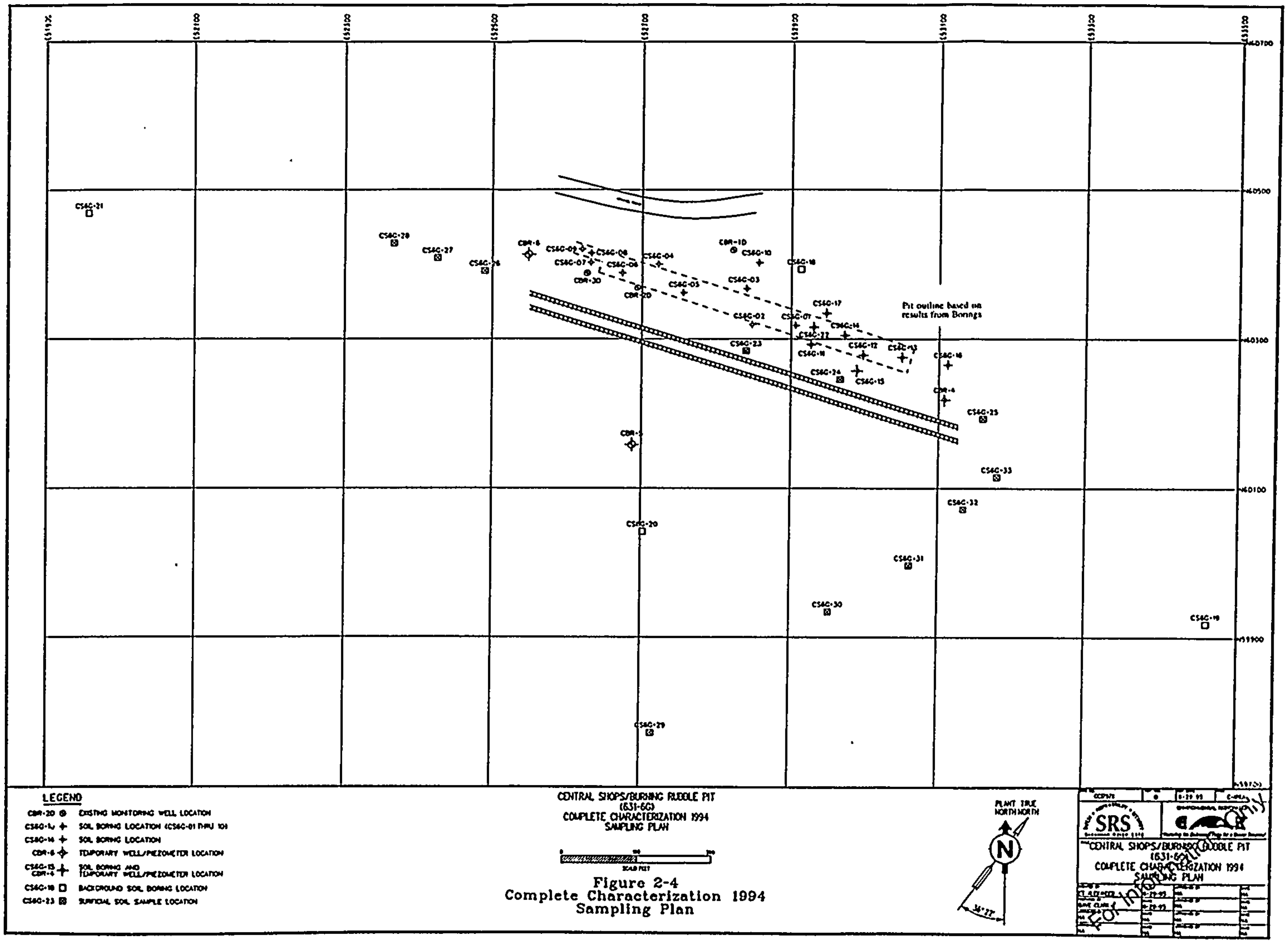

Figure 2-4 Complete Characterization of 1994 Sampling Plan

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TABLES

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Table 2.1
Summary of Soil Sampling Plan (March-April 1994)

Sample Location	Sample Number	Sampling Date	Number Of Split-Spoon Samples	Total Depth HSA (Ft)	Total Depth of the Hole (Ft)	Depth of the BOP (Ft)	Sample ID Number	Sampling Depths From/To (Ft)	Munsell™ Color		Unified Soil Classification	Analyte Code
									Primary	Secondary		
CS6G-01			3	7.0	9.0	4.0						
	01	04/05/94					101856	0.0-2.0	5YR 5/6	5YR 4/4	SC	1,2,3
	02	04/05/94					101857	3.0-5.0	N9	5R 4/6	CH	1,2,3
	03	04/05/94					101858	5.0-7.0	N9	5R 4/6	CH	1,2,3
	04	04/05/94					101859	7.0-9.0	N9	5R 4/6	CH	1,2,3
	04A	04/05/94					101860	NA	-	-	-	1,2,3
CS6G-02			3	7.0	9.0	-						
	01	04/04/94					101851	0.0-2.0	5YR 5/6	10R 5/2	SM	1,2,3
	02	04/04/94					101852	3.0-5.0	5YR 5/6	5Y 8/1	CH	1,2,3
	03	04/04/94					101853	5.0-6.0	5YR 5/6	5Y 8/1	CH	1,2,3
	04	04/04/94					101854	7.0-9.0	5Y 8/1	5YR 5/6	CH	1,2,3
	TB-6B	04/04/94					101855	NA	-	-	-	7
CS6G-03			3	13.5	15.5	4.0						
	01	04/04/94					101845	0.0-2.0	10R 4/6	10YR 5/4	SW-SM	1,2,3
	02	04/04/94					101846	3.0-5.0	5YR 5/6	10R 4/6	SW-SC	1,2,3
	03	04/04/94					101847	5.0-7.0	10R 4/6	5YR 5/6	SW-SC	1,2,3
	04	04/04/94					101848	7.0-9.0	10R 4/6	5YR 5/6	SW-SC	1,2,3
	6C	04/04/94					101849	NA	-	-	-	1,2,3
	6E	04/04/94					101850	NA	-	-	-	1,2,3
CS6G-04			3	7.0	9.0	4.0						
	RB-4E	03/30/94					101831	NA	-	-	-	1,2,3
	01	03/30/94					101832	0.0-2.0	10R 4/6	10YR 5/4	SW-SM	1,2,3
	02	03/30/94					101833	3.0-5.0	10YR 5/4	10R 4/6	CH	1,2,3,4
	03	03/30/94					101834	5.0-7.0	10R 4/6	10YR 6/6	CH	1,2,3
	04	03/30/94					101835	7.0-9.0	10R 4/6	10YR 6/6	CH	1,2,3
	TB-4B	03/30/94					101836	NA	-	-	-	7

Table 2.1
Summary of Soil Sampling Plan (March-April 1994)
(Continued)

Sample Location	Sample Number	Sampling Date	Number Of Split-Spoon Samples	Total Depth HSA (Ft)	Total Depth of the Hole (Ft)	Depth of the BOP (Ft)	Sample ID Number	Sampling Depths From/To (Ft)	Munsell™ Color		Unified Soil Classification	Analyte Code
									Primary	Secondary		
CS6G-05			3	25.0	27.0	8.2						
	01	03/31/94					101837	0.0-2.0	10YR 5/4	10R 4/6	SW	1,2,3
	02	03/31/94					101838	7.9-9.2	5R 4/6	5YR 5/6	SC	1,2,3,4
	2A	03/31/94					101839	NA	-	-	-	1,2,3,4
	03	03/31/94					101840	9.2-11.2	5R 4/6	10YR 5/6	SC	1,2,3
	04	03/31/94					101841	11.2-12.2	5R 4/6	10YR 7/4	SC	1,2,3
	FB-5C	03/31/94					101842	NA	-	-	-	1,2,3
	RB-5E	03/31/94					101843	NA	-	-	-	1,2,3
	TB-5B	03/31/94					101844	NA	-	-	-	7
CS6G-06			5	28.7	30.7	11.7						
	01	03/25 & 28/95					101800	0.0-2.0	10YR 5/4	5Yr 5/6	SW-SM	1,2,3
	02	03/25 & 28/95					101801	10.7-12.7	10R 6/6	10R 4/6	SM	1,2,3,4
	TB-1B	03/25/94					101802	NA	-	-	-	7
	FB-1C	03/25/94					101803	NA	-	-	-	1,2,3
	RB-1E	03/25/94					101804	NA	-	-	-	1,2,3
	03	03/25 & 28/94					101805	12.7-14.7	5R 4/6	10 R 3/4	SW-SC	1,2,3
	TB-2B	03/28/94					101806	NA	-	-	-	7
	04	03/25 & 28/94					101807	14.7-16.7	N9	5RP 6/2	CH	1,2,3
	05	03/25 & 28/94					101808	21.7-23.7	5RP 6/2	5R 4/6	CH	5,6
	06	03/25 & 28/94					101809	28.7-30.7	5RP 4/2	5RP 6/2	CH/MH	5,6
	6A	03/28/94					101810	NA	-	-	-	5,6
	FB-2C	03/28/94					101811	NA	-	-	-	1,2,3
	RB-2E	03/28/94					101812	NA	-	-	-	1,2,3

Table 2.1
Summary of Soil Sampling Plan (March-April 1994)
(Continued)

Sample Location	Sample Number	Sampling Date	Number Of Split-Spoon Samples	Total Depth HSA (Ft)	Total Depth of the Hole (Ft)	Depth of the BOP (Ft)	Sample ID Number	Sampling Depths From/To (Ft)	Munsell™ Color		Unified Soil Classification	Analytic Code
									Primary	Secondary		
CS6G-07			3	11.0	13.0	8.1						
	01	03-29/94					101813	0.0-2.0	5YR 5/6	10YR 5/4	SP-SC	1,2,3
	02	03-29/94					101814	7.5-9.5	5RP 6/2	5Y 7/2	CH	1,2,3,4
	03	03-29/94					101815	9.5-11.0	5RP 6/2	5Y 7/2	ML	1,2,3
	03A	03-29/94					101816	NA	-	-	-	1,2,3
	04	03-29/94					101817	11.0-13.0	5Y 7/2	5RP 6/2	ML	1,2,3
	RB-3E	03-29/94					101818	NA	-	-	-	1,2,3
	FB-3C	03-29/94					101819	NA	-	-	-	1,2,3
CS6G-08			5	9.0	11.0	6.0						
	01	03-29/94					101820	0.0-2.0	10R 4/6	10YR 6/6	SW-SC	1,2,3
	02	03-29/94					101821	5.0-7.0	10R 4/6	10YR 6/6	CH	1,2,3,4
	03	03-29/94					101822	7.0-9.0	10R 4/6	10YR 6/6	CH	1,2,3
	04	03-29/94					101823	9.0-11.0	10R 4/6	10YR 6/6	CH	1,2,3
	TB-3B	03-29/94					101824	NA	-	-	-	7
CS6G-09			4	9.6	11.85	4.6						
	01	03/30/94					101825	0.0-2.0	5YR 5/6	10R 4/6	SC	1,2,3
	02	03/30/94					101826	3.6-5.6	5YR 5/6	10R 4/6	CH	1,2,3,4
	03	03/30/94					101827	5.6-7.6	5YR 5/6	10R 4/6	CH	1,2,3
	03A	03/30/94					101828	NA	5RP 4/6	10R 4/6	CH	1,2,3
	04	03/30/94					101829	7.6-9.6	-	-	-	1,2,3
	FB-4C	03/30/94					101830	NA	-	-	-	1,2,3

Table 2.1
Summary of Soil Sampling Plan (March-April 1994)
(Continued)

Sample Location	Sample Number	Sampling Date	Number Of Split-Spoon Samples	Total Depth HSA (Ft)	Total Depth of the Hole (Ft)	Depth of the BOP (Ft)	Sample ID Number	Sampling Depths From/To (Ft)	Munsell™ Color		Unified Soil Classification	Analyte Code
									Primary	Secondary		
CS6G-10			9	28.7	30.7	NA						
	RB-7E	04/05/94					101861	NA				1,2,3
	01	04/05/94					101862	0.0-2.0	5YR 5/6	10YR 5/4	SC	1,2,3
	02	04/05/94					101863	3.0-4.6	5YR 5/6	10YR 6/2	SW-SC	1,2,3
	03	04/05/94					101864	5.0-7.0	5R 4/6	5RP 2/2	SP-SC	1,2,3
	04	04/05/94					101865	7.0-9.0	5RP 4/2	5Y 8/1	CH	1,2,3
	05	04/05/94					101866	9.0-11.0	5P 4/2	N9	SC	1,2,3
	FB-7C	04/05/94					101867	NA				1,2,3
	06	04/05/94					101868	11.0-13.0	5P 4/2	N9	SC	1,2,3
	07	04/05/94					101869	13.0-15.0	5P 4/2	N9	SC	1,2,3
	08	04/05/94					101870	15.0-17.0	5P 4/2	N9	SC	1,2,3
	09	04/05/94					101871	21.7-23.7	5RP 6/6	5RP 8/2	CH	5,6
	10	04/05/94					101872	28.7-30.7	5R 4/6	5 P 4/2	CH	5.6
	TB-7B	04/05/94					101873	NA				7

ANALYTE CODE

1. TCL/TAL with TIC
2. Dioxins/Furans
3. Radiological Indicators
4. TCLP
5. GC/MS VOCs
6 RCRA Metals
7. TCL VOCs Only

Shaded Where No Data Exists

ABBREVIATIONS

HSA- Hollow Stem Augered
TB- Trip Blank
BOP- Bottom of Pit
FB- Field Blank
NA- Not Applicable
RB- Rinsate Blank

QA/QC Sample Codes
A = Duplicate Sample
D = Split Sample
E = Rinsate Sample

NOTES:

1. All measurements were from original ground surface.
2. All first samples 0.0 to 2.0 feet were collected with a 3" diameter stainless steel hand auger.
3. At sampling location CS6G-06 the original hole could not be completed in the same day (3/25/94); therefore, it was backfilled. Then on 3/28/94, moved over 2 ft. and drilled down to sample depth (12.7 ft bls) and continued sampling.
4. At Sampling Points CS6G-03, CS6G-05, and CS6G-09 Shelby tubes were pushed.

Table 2.2
Summary of Soil Sampling Plan (November-December 1994)

Sample Location	Sample Number	Sampling Date	Number Of Split-Spoon Samples	Total Depth HSA (Ft)	Depth of the BOP (Ft)	Sample ID Number	Sampling Depths From/To (Ft)	Munsell™ Color		Unified Soil Classification	Analyte Code
								Primary	Secondary		
CS6G-11			4	10.0	NA						1,2,3
	01E	11/14/94				101874	0.0-1.0	NA	NA	NA	1,2,3
	01	11/14/94				101786	0.0-1.0	10 Yr 4/2	NA	CL	1,2,3
	02	11/14/94				101877	1.0-2.0	10 Yr 8/2	10 Yr 6/6	CL	1,2,3
	03	11/14/94				101878	2.0-4.0	10 Yr 6/6	10 Yr 8/2	CL	1,2,3
	04	11/14/94				101879	4.0-6.0	5 Yr 5/6	NA	CL	1,2,3
	05	11/14/94				101880	6.0-8.0	10 Yr 8/2	NA	CL	1,2,3
	06	11/14/94				101881	8.0-10.0	10 Yr 8/2	NA	CL	
CS6G-12			3	8.0	3.5						1,2,3
	01	11/15/94				101884	0.0-1.0	10 Yr 5/4	NA	CL	1,2,3
	02	11/15/94				101885	1.0-2.0	5 PB 3/2	NA	SM	1,2,3
	03	11/15/94				101886	2.0-4.0	10 Yr 6/2	NA	CL	1,2,3
	04	11/15/94				101887	4.0-6.0	10 Yr 6/6	10 Yr 6/2	CL	1,2,3
	05	11/15/94				101888	6.0-8.0	10 Yr 6/6	10 Yr 6/2	CL	1,2,3
	07E	11/15/94				101889	6.0-8.0	NA	NA	NA	
CS6G-13			3	8.0	3.8						1,2,3
	01	11/15/94				101890	0.0-1.0	10 Yr 5/4	NA	CL	1,2,3
	02E	11/15/94				101891	1.0-2.0	NA	NA	NA	1,2,3
	02	11/15/94				101892	1.0-2.0	NA	NA	NA	1,2,3
	03	11/15/94				101893	2.0-4.0	10 Yr 8/2	NA	CL	1,2,3
	04	11/15/94				101894	4.0-6.0	10 Yr 8/2	NA	CL	1,2,3
	04D	11/15/94				101895	4.0-6.0	10 Yr 8/2	NA	CL	1,2,3
	05	11/15/94				101896	6.0-8.0	10 Yr 8/2	NA	CL	1,2,3

Table 2.2
Summary of Soil Sampling Plan (November-December 1994)

Sample Location	Sample Number	Sampling Date	Number Of Split-Spoon Samples	Total Depth HSA (Ft)	Depth of the BOP (Ft)	Sample ID Number	Sampling Depths From/To (Ft)	Munsell™ Color		Unified Soil Classification	Analyte Code
								Primary	Secondary		
CS6G-14			5	15.0	7.0						
	01	11/16/94				101897	0.0-1.0	5Y 4/1	NA	SM	1,2,3
	02	11/16/94				101898	1.0-2.0	5Yr 6/4	NA	SM	1,2,3
	03	11/16/94				101899	2.0-4.0	5 Yr 6/4	NA	CL	1,2,3
	04	11/16/94				103700	4.0-6.0				1,2,3
	05	11/16/94				103701	6.0-8.0				1,2,3
	06	11/16/94				103702	8.0-10.0	10Yr 8/2	NA		1,2,3
	07A	11/16/94				103703	13.0-15.0	10Yr 8/2	5Yr 5/6	CH	5,6
	07	11/16/94				103704	13.0-15.0	10Yr 8/2	5Yr 5/6	CH	5,6
	08E	11/16/94				103706	13.0-15.0	NA	NA	NA	5,6
CS6G-15			3	12.0	NA	103707	0.0-1.0	5Yr 4/1	NA	SM	1,2,3
	01	11/17/94				103708	0.0-1.0	5Yr 4/1	NA	SM	1,2,3
	01A	11/17/94				103710	1.0-2.0	10Yr 6/6	NA	SM	1,2,3
	02	11/17/94				103711	2.0-4.0	10Yr 8/2	5Yr 5/6	CL	1,2,3
	03	11/17/94				103712	2.0-4.0	NA	NA	NA	1,2,3
	03E	11/17/94				103713	4.0-6.0	10Yr 8/2	5Yr 5/6	CL	1,2,3
	04	11/17/94				103714	10.0-12.0	10Yr 8/2	5Yr 5/6	CL	1,2,3
	05	11/17/94									
CS6G-16			3	12.0	NA						
	01	11/17/94				103716	0.0-1.0	10Yr 5/4	NA	SM	1,2,3
	02	11/17/94				103717	1.0-2.0	N2	NA	SM	1,2,3
	03	11/17/94				103718	2.0-4.0	N2	NA	SM	1,2,3
	04	11/17/94				103719	5.0-7.0	10Yr 6/2	5Yr 5/6	CL	1,2,3
	05	11/17/94				103720	10.0-12.0	N8	NA	CH	1,2,3

Table 2.2
Summary of Soil Sampling Plan (November-December 1994)

Sample Location	Sample Number	Sampling Date	Number Of Split-Spoon Samples	Total Depth HSA (Ft)	Depth of the BOP (Ft)	Sample ID Number	Sampling Depths From/To (Ft)	Munsell™ Color		Unified Soil Classification	Analyte Code
								Primary	Secondary		
CS6G-17			3	12.0	NA						
	01	11/17/94				103721	0.0-1.0	10Yr 7/4	NA	SP	1,2,3
	02	11/17/94				103722	1.0-2.0	5Yr 6/4	NA	CL	1,2,3
	03	11/17/94				103723	2.0-4.0	5Yr 6/4	NA	CL	1,2,3
	03A	11/17/94				103724	2.0-4.0	5Yr 6/4	NA	CL	1,2,3
	04	11/17/94				103725	5.0-7.0	10Yr 8/2	5Yr 6/4	CH	1,2,3
	05	11/17/94				103726	10.0-12.0	10Yr 8/2	NA	CH	1,2,3
CS6G-18			10	47.0	NA						
	01	11/18/94				103727	0.0-1.0	5Yr 4/4	NA	CL	1,2,3
	02	11/18/94				103728	1.0-2.0	5Yr 5/6	NA	CL	1,2,3
	03	11/18/94				103729	2.0-4.0	5Yr 5/6	NA	CL	1,2,3
	04	11/18/94				103730	5.0-7.0	5Yr 5/6	NA	SP	1,2,3
	04E	11/18/94				103731	5.0-7.0	NA	NA	NA	1,2,3
	05	11/18/94				103732	10.0-12.0	5RP 4/2	NA	CL	1,2,3
	06	11/18/94				103733	15.0-17.0	5RP 4/2	NA	CL	5,6
	07	11/18/94				103734	20.0-22.0	5R 8/2	5Yr 7/4	CL	5,6
	07A	11/18/94				103735	20.0-22.0	5R 8/2	5Yr 7/4	CL	5,6
	08	11/18/94				103736	25.0-27.0	5R 8/2	5Yr 7/4	CL	5,6
	09	11/18/94				103737	30.0-32.0	5RP 6/2	NA	CH	5,6
	10	11/18/94				103738	35.0-37.0	5R 6/2	NA	CH	5,6
	11	11/18/94				103739	40.0-42.0	5R 6/2	NA	CH	5,6
	12	11/18/94				103740	45.0-47.0	5R 6/2	NA	CH	5,6
	12A	11/18/94				103741	45.0-47.0	5R 6/2	NA	CH	5,6

Table 2.2
Summary of Soil Sampling Plan (November-December 1994)

Sample Location	Sample Number	Sampling Date	Number Of Split-Spoon Samples	Total Depth HSA (Ft)	Depth of the BOP (Ft)	Sample ID Number	Sampling Depths From/To (Ft)	Munsell™ Color		Unified Soil Classification	Analyte Code
								Primary	Secondary		
CS6G-19			10	47.0	NA						
	01	11/22/94				103743	0.0-1.0	10 Yr 7/4	NA	SB	1,2,3
	02	11/22/94				103744	1.0-2.0	10 Yr 7/4	NA	SM	1,2,3
	03	11/22/94				103745	2.0-4.0	5 Yr 5/6	10 Yr 6/2	CL	1,2,3
	04	11/22/94				103746	5.0-7.0	5 Yr 5/6	10 Yr 8/2	CL	1,2,3
	04A	11/22/94				103747	5.0-7.0	5 Yr 5/6	10 Yr 8/2	CL	1,2,3
	05	11/22/94				103748	10.0-12.0	5RP 4/2	10 Yr 8/2	CL	1,2,3
	06	11/22/94				103749	15.0-17.0	5RP 4/2	5 Yr 8/1	CL	5,6
	07	11/22/94				103750	20.0-22.0	5R 4/6	NA	CL	5,6
	08	11/22/94				103751	25.0-27.0	5RP 6/2	NA	CH	5,6
	09	11/22/94				103752	30.0-32.0	5R 4/6	NA	CL	5,6
	10	11/22/94				103753	35.0-37.0	5P 6/2	NA	CL	5,6
	11	11/22/94				103754	40.0-42.0	5P 6/2	NA	CL	5,6
	12	11/22/94				103755	45.0-47.0	5R 7/4	NA	SP	5,6
	12D	11/22/94				103756	45.0-47.0	5R 7/4	NA	SP	5,6
CS6G-20			10	47.0	NA						
	01	11/28/94				103758	0.0-1.0	10 Yr 6/6	10 Yr 6/2	SC	1,2,3
	02	11/28/94				103759	1.0-2.0	10 Yr 8/6	NA	CL	1,2,3
	02E	11/28/94				103760	1.0-2.0	NA	NA	NA	1,2,3
	03	11/28/94				103761	2.0-4.0	10 Yr 8/6	NA	CL	1,2,3
	03D	11/28/94				103762	2.0-4.0	10 Yr 8/6	NA	CL	1,2,3
	04	11/28/94				103763	5.0-7.0	10 Yr 6/6	NA	CL	1,2,3
	05	11/28/94				103764	10.0-12.0	10 Yr 8/2	10R 5/4	CL	5,6
	06	11/28/94				103768	15.0-17.0	10 Yr 8/2	10R 3/4	CL	5,6
	07	11/28/94				103769	20.0-22.0	10 Yr 8/2	5RP 4/2	CH	5,6
	08	11/28/94				103770	25.0-27.0	10 Yr 8/2	5RP 4/2	CH	5,6

Table 2.2
Summary of Soil Sampling Plan (November-December 1994)

Sample Location	Sample Number	Sampling Date	Number Of Split-Spoon Samples	Total Depth HSA (Ft)	Depth of the BOP (Ft)	Sample ID Number	Sampling Depths From/To (Ft)	Munsell™ Color		Unified Soil Classification	Analyte Code
								Primary	Secondary		
CS6G-20	(Continued)										
	09	11/28/94				103771	30.0-32.0	10Yr 8/2	5RP4/2	CH	5,6
	10	11/28/94				103773	35.0-37.0	10Yr 7/4	NA	SP	5,6
	11A	11/28/94				103774	40.0-42.0	10Yr 8/2	NA	SM	5,6
	11	11/28/94				103775	40.0-42.0	10Yr 8/2	NA	SM	5,6
	12D	11/28/94				103776	45.0-47.0	10Yr 8/2	NA	SM	5,6
	12	11/28/94				103777	45.0-47.0	10Yr 8/2	NA	SM	5,6
CS6G-21			10	47.0	NA						
	01	12/01/94				103780	0.0-1.0	10Yr 6/6	10R6/4	CL	1,2,3
	02	12/01/94				103781	1.0-2.0	10Yr 6/6	10R 6/4	CL	1,2,3
	03	12/01/94				103782	2.0-4.0	10Yr 8/2	5Yr 5/6	CL	1,2,3
	03E	12/01/94				103783	2.0-4.0	NA	NA	NA	1,2,3
	04	12/01/94				103784	5.0-7.0	10Yr 8/2	5Yr 5/6	CL	1,2,3
	05	12/01/94				103785	10.0-12.0	10Yr 8/2	5Yr 5/6	CL	5,6
	06	12/01/94				103786	15.0-17.0	10 Yr 8/2	5Yr 5/6	CH	5,6
	06A	12/01/94				103787	15.0-17.0	10 Yr 8/2	5Yr 5/6	CH	5,6
	07D	12/01/94				103788	20.0-22.0	5RP 4/2	NA	CH	5,6
	07	12/01/94				103789	20.0-22.0	5RP 4/2	NA	CH	5,6
	08	12/01/94				103790	25.0-27.0	5Y 8/1	5RP 4/2	CH	5,6
	09	12/01/94				103791	30.0-32.0	10 Yr 8/2	NA	CH	5,6
	10	12/01/94				103792	35.0-37.0	N9	NA	CL	5,6
	11	12/01/94				103793	40.0-42.0	N9	NA	CL	5,6
	12	12/01/94				103794					5,6

Table 2.2
Summary of Soil Sampling Plan (November-December 1994)

Sample Location	Sample Number	Sampling Date	Number Of Split-Spoon Samples	Total Depth HSA (Ft)	Depth of the BOP (Ft)	Sample ID Number	Sampling Depths From/To (Ft)	Munsell™ Color		Unified Soil Classification	Analyte Code
								Primary	Secondary		
CS6G-22					NA						
	01	12/06/94				102534	0.0-1.0	10R 6/6	10R 6/2	CL	1,2,3
	02	12/06/94				102535	1.0-2.0	N1	NA	SM	1,2,3
	03	12/06/94				102536	2.0-4.0	N1	NA	SM	1,2,3
	03D	12/06/94				102537	2.0-4.0	N1	NA	SM	1,2,3
CS6G-23	01	12/06/94				102532	0.0-1.0	10R 6/6	NA	SM	1,2,3
CS6G-24	01	12/05/94				102530	0.0-1.0	10R 6/6	NA	SM	1,2,3
CS6G-25	01	12/06/94				102531	0.0-1.0	10R 6/6	NA	SM	1,2,3
CS6G-26	01	12/05/94				102529	0.0-1.0	5Yr5/6	NA	SM	1,2,3
CS6G-27	01	12/05/94				102528	0.0-1.0	5Yr5/6	NA	SM	1,2,3
CS6G-28	01	12/05/94				102526	0.0-1.0	5Yr5/6	NA	SM	1,2,3
CS6G-28	01A	12/05/94				102527	0.0-1.0	5Yr5/6	NA	SM	1,2,3

<u>Analyte Codes for Soil Samples:</u>

1. TCL/TAL w/TIC
2. Dioxins/Furans
3. Rad Indicators (gross alpha and non-volatile beta)
5. GC/MS VOCs
6. RCRA Metals
7. TCL VOCs only
8. TCL VOCs w/TIC

<u>Abbreviations</u>

HSA = Hollow Stem Augered
BOP = Bottom Of Pit
NA = Not Applicable

<u>QA/QC Sample Codes</u>

A = Duplicate Sample
D = Split Sample
E = Rinsate Sample

Table 2.3
Summary of Surface Water/Sediment Sampling (November-December 1994)

Sample Location	Sample Number	Sampling Date	Sample ID	Sampling Depths	Munsell™ Color		Unified Soil Classification	Analyte Code
					Primary	Secondary		
CS6G-29								
	01	12/07/94	102540	NA	NA	NA	NA	2,33,5,8,9
	02	12/07/94	102541	Surface	5Yr 5/6	NA	SM	2,3,4,5,7
	02E	12/07/94	102542	NA	NA	NA	NA	4,5
CS6G-30								
	01	12/07/94	102543	NA	NA	NA	NA	1,2,3,4,5,8,9
	02	12/07/94	102544	Surface	5Yr 5/6	NA	SM	2,3,4,5,7
CS6G-31								
	01	12/07/94	102545	NA	NA	NA	NA	1,2,3,4,8,9
	01D	12/07/94	102555	NA	NA	NA	NA	1,2,3,4
	02	12/07/94	102546	Surface	5Yr 5/6	NA	SM	2,3,4,5,7
	02D	12/07/94	102556	Surface	5Yr 5/6	NA	SM	2,3,4
CS6G-32								
	01	12/07/94	102547	NA	NA	NA	NA	1,2,3,4,5,8,9
	02	12/07/94	102548	Surface	5Yr 5/6	NA	SM	2,3,4,55,7
CS6G-33								
	01	12/07/94	102549	NA	NA	NA	NA	1,2,3,4,5,8,9
	01A	12/07/94	102550	NA	NA	NA	NA	1,2,3,4
	02	12/07/94	102551	Surface	5Yr 5/6	NA	SM	2,3,4,5,7
	02A	12/07/94	102552	Surface	5Yr 5/6	NA	SM	2,3,4,5

Analyte Codes for Soil Samples:

1. TCL/TAL w/TIC
2. Metals (Ag, As, Ba, Cd, Cr, Cu, Pb, Mn, Hg, Ni, Se)
3. Semi-Volatile organic constituents, including polycyclic hydrocarbons (PAH)
4. Volatile Organic constituents, (volatile organic analysis, gas chromatography, mass spectrometer (VOA GC/MS)
5. Radionuclide indicators (gross alpha, nonvolatile bet, total radium) and tritium
6. Surface water temperature, dissolved oxygen, pH, depth, flow (estimate)
7. Sediment pH, TOC
8. Inorganics (Cl, F, SO_4,NO_3, Na, Fe
9. TOC, TSS, TDS

Abbreviations

NA = Not Applicable

QA/QC Sample Codes

A = Duplicate Sample

D = Split Sample
E = Rinsate Sample

Table 2.4 Monitoring Wells and Soil Boring Coordinates and Elevation Details

Well Number	Northing (LAT)	Easting (LON)	Top of Casing Elevation (Ft)*	Pad Elevation (Ft)*
CBR-1D	60,419.47	52,822.14	300.60	298.5
CBR-2D	60,368.89	52,694.04	300.94	298.8
CBR-3D	60,388.53	52,627.19	301.76	299.6
CBR-4	60,218.24 33.24560867	53,107.95 81.64393628	295.84	293.4
CBR-5	60,158.39 33.24479117	52,687.98 81.64492561	295.89	293.3
CBR-6	60,413.28 33.24512914	52,549.53 81.64578486	303.91	301.4

Soil Boring	Northing (LAT)	Easting (LON)	Ground Surface Elevation (Ft)*
CS6G-01	60,318.36 33.24550105	52,906.22 81.64466167	294.4
CS6G-02	60,319.40 33.24540794	52,847.72 81.64481767	296.6
CS6G-03	60,367.51 33.24550253	52,840.49 81.64493008	297.6
CS6G-04	60,400.50 33.24538130	52,721.44 81.64530753	298.8
CS6G-05	60,361.97 33.24535180	52,755.59 81.64514283	297.6
CS6G-06	60,388.87 33.24527780	52,673.78 81.64541039	299.7
CS6G-07	60,402.90 33.24523097	52,626.05 81.64556328	299.6
CS6G-08	60,415.27 33.24526933	52,632.76 81.64556964	299.7
CS6G-09	60,420.69 33.24526139	52,620.57 81.64561222	300.2
CS6G-10	60,402.14 33.24560478	52,856.18 81.64495603	296.9
CS6G-11	60,292.81 33.24547969	52,927.78 81.64455530	293.0

Table 2.4 Monitoring Wells and Soil Boring Coordinates and Elevation Details (contd)

Soil Boring	Northing (LAT)	Easting (LON)	Ground Surface Elevation (Ft)*
CS6G-12	60,278.56 33.24556414	52,998.90 81.64434044	294.2
CS6G-13	60,275.55 33.24564386	53,051.84 81.64419522	293.9
CS6G-14	60,304.73 33.24558158	52,974.07 81.64445658	295.4
CS6G-15	60,257.33 33.24550322	52,990.29 81.644432189	293.4
CS6G-16	60,265.53 33.24572022	53,112.24 81.64401678	293.4
CS6G-17	60,334.64 33.24560667	52,948.92 81.64458086	296.6
CS6G-18	60,393.28 33.24567778	52,912.99 81.64478928	298.4
CS6G-19	59,918.47 33.24551744	53,458.61 81.64243128	293.3
CS6G-20	60,041.66 33.24455736	52,702.91 81.64465972	290.1
CS6G-21	60,468.84 33.24428697	51,957.93 81.64744997	299.9
CS6G-22	60,315.96 33.24553683	52,931.42 81.64459067	292.4
CS6G-23	60,284.13 33.24531669	52,839.65 81.64477044	291.0
CS6G-24	60,245.76 33.24544075	52,967.73 81.64435880	289.2
CS6G-25	60,192.74 33.24563730	53,160.10 81.64374947	288.1
CS6G-26	60,391.23 33.24498311	52,489.87 81.64589911	293.1
CS6G-27	60,408.66 33.24491783	52,426.24 81.64610044	293.7
CS6G-28	60,428.72 33.24486497	52,366.66 81.64629622	293.6

Table 2.4 Monitoring Wells and Soil Boring Coordinates and Elevation Details (contd)

Soil Boring	Northing (LAT)	Easting (LON)	Ground Surface Elevation (Ft)*
CS6G-29	59,772.66 33.24398319	52,715.75 81.64410372	279.8
CS6G-30	59,934.33 33.24472905	52,953.74 81.64379108	282.2
CS6G-31	59,996.22 33.24504417	53,062.99 81.64362364	284.4
CS6G-32	60,071.58 33.24532817	53,134.87 81.64358072	285.7
CS6G-33	60,114.87 33.24549680	53,179.56 81.64354711	286.4

Table Notes:

1. (*) Elevations are relative to Mean Sea Level
2. LAT indicates latitude in decimal degrees.
3. LON indicates longitude in decimal degrees.
4. Northing and Easting coordinates are given in feet.

Table 2.5 Bottom of Pit Summary

Soil Boring No.	Bottom of Pit (ft bls)	Zone of Burnt Black Material (ft bls)
CS6G-01	4.0	3.5 to 4.0
CS6G-02	NA	NA
CS6G-03	4.0	NA
CS6G-04	4.0	NA
CS6G-05	8.2	7.6 to 8.2
CS6G-06	11.7	10.7 to 11.7*
CS6G-07	8.1	NA
CS6G-08	6.0	5.7 to 5.92**
CS6G-09	4.6	4.4 to 4.6
CS6G-10	NA	NA
CS6G-11	NA	NA
CS6G-12	3.5	1.0 to 2.0
CS6G-13	3.8	0.5 to 2.5
CS6G-14	7.0	5.0 to 7.0
CS6G-15	NA	NA
CS6G-16	NA	NA
CS6G-17	NA	NA
CS6G-18	NA	NA
CS6G-19	NA	NA
CS6G-20	NA	NA
CS6G-21	NA	NA
CS6G-22	3.5	1.5 to 3.5

Table Notes:

*	No recovery from 9.5 to 10.7 ft
**	No recovery from 5.9 to 6.0 ft
NA =	Not Applicable
bls =	Below land surface

Shaded where bottom of pit is noted

Table 2.6 Summary of OVA Readings

Soil Boring Number	OVA Reading (ppm)		Location*
	Ambient	Actual	
CS6G-01	0.3	0.3	5 - 7 ft
	0.4	0.4	breathing zone around augers at 7 ft
	3.0	3.0	7 - 9 ft
CS6G-02	6.0	6.0	5 - 7 ft
	6.0	6.0	breathing zone around augers at 7 ft
	0.5	0.5	7 - 9 ft
CS6G-03	4.0	4.0	0-2 ft
	8.0	8.0	5-7 ft
	2.0	2.0	7-9 ft
CS6G-04	10.0	10.0	0-2 ft
	8.1	8.1	3-5 ft
	8.1	6.1	5-7 ft
	6.8	6.8	breathing zone around augers at 7 ft
	5.8	5.8	7-9 ft
CS6G-05	0.0	0.0	breathing zone around 0-2 ft
	0.0	0.0	breathing zone around 2-4 ft
	0.0	0.3	breathing zone around 4-6 ft
	0.0	0.0	9.2-22.1 ft
	0.0	0.0	11.2-13.2 ft
CS6G-06	0.0	0.0	0.0-2.0 ft
	0.0	0.0	2.0-4.0 ft
	0.0	0.0	4.0-6.0 ft
	0.0	0.0	6.0-8.0 ft
	0.0	0.0	8.0-10.0 ft
	0.0	0.0	10.0-12.0 ft
	0.0	0.0	12.0-12.7 ft
	1.5	2.5+	breathing zone around augers at 14.7 ft
	0.0	2.5	12.7-14.7 ft
	0.0	0.6	14.7-16.7 ft
	0.0	0.4	breathing zone around augers at 16.7 ft
	2.0	4.0++	breathing zone around augers at 23.7 ft

Table 2.6 Summary of OVA Readings (Contd)

Soil Boring Number	OVA Reading (ppm)		Location*
	Ambient	Actual	
CS6G-06• (Continued)	0.0	0.3	21.7-23.7
	0.0	0.3	28.7-30.7
CS6G-07	0.6	1.0+++	breathing zone for 0-2 ft sample
	1.2	1.2	0.0-2.0 ft
	1.4	1.4	7.5-9.5 ft
	2.0	2.0	9.5 -11.0 ft
	2.2	2.2	11.0-13.0 ft
CS6G-08	1.0	1.0	0-2 ft
	3.0	3.0	5-7 ft
	0.8	0.8	7-9 ft
	0.8	0.8	9-11 ft
	0.8	0.8	breathing zone around augers at 9 ft
CS6G-09	0.5	0.5	3.6-5.6 ft
	8.0	8.0	5.6-7.6 ft
	11.1	11.1	7.6-9.6 ft
	11.2	11.2	breathing zone around augers at 7.6 ft
CS6G-10	7.0	7.2**	5-7 ft
	7.9	8.1**	7-9 ft
	10.0	10.0	9-11 ft
	5.8	5.8	11-13 ft
	6.0	6.0	13-15 ft
	5.8	6.0**	15-17 ft
	6.0	6.0	breathing zone around augers at 23.7 ft
	8.2	8.2	21.7-23.7 ft
	9.0	9.0	28.7-30.7 ft

* Headspace reading of soil sample collected at designated depth in a Ziploc bag unless otherwise indicated.

• these ambient or background readings were zeroed out.

\+ Steady reading of 1.5 ppm with maximum of 2.5 ppm.

++ Steady reading of 2 ppm with maximum of 4 ppm.

+++ Steady reading of 0.6 ppm with maximum of 1 ppm.

** Tested theory of decon person collecting OVA reading. All had minor (0.2 to 0.3 ppm) readings.

Table 2.7
Laboratory Results From Low Permeability Sediments

Boring Number	Date Sampled	Sample Depths (ft)	Length Pushed/ Recovered (ft)	Bulk Density (pcf)	Unified Soil Classification	Hydraulic Conductivity (cm/sec)		Natural Moisture Content (%)	Atterberg Limits		
						Vertical	Horizontal		LL	PL	PI
CS6G-03	04/04/94	13.5-15.5	2.0/2.0	123.7	Purple and gray sandy clay (CH)	2.5 x 10-7	2.7 x 10-7	19.9	81	31	58
CS6G-05	03/31/94	25.0-27.0	2.0/2.0	125	Purple clayey fine to medium sand (SC)	1.8 x 10^{-7}	1.0 x 10^{-7}	18.1	72	20	57
CS6G-09	03/30/94	9.6-11.85	2.25/2.25	126.8	Pink, white and yellow sandy clay (CL)	1.1 x 10^{-7}	2.9 x 10^{-7}	18.0	40	19	21

Table Notes:

LL = Liquid Limit

PL = Plastic Limit

PI = Plasticity Index

PCF = Pounds Per Cubic Foot

Table 2.8
Summary of Groundwater Monitoring Well Installation

Well Number	Date Well Installed	Original Ground Surface Elevation	Depth Drilled	Top of Liquid Level Pipe Elevation	Depth to Top of Screen	Screen Length	Depth To Bottom of Well	Depth To Top of Filter Pack	Depth to Top of Fine Sand	Depth To Top of Bentonite Seal
CBR-4	11/04/94	--	62.0	--	40.2	20.0	60.5	36.6	NA	18.9
CBR-5	11/03/94	--	57.0	--	35.0	20.0	55.2	33.0	NA	30.0
CBR-6	11/03/94	--	62.0	--	40.2	20.0	60.4	35.9	NA	32.5

NOTES:

1. All depths from original ground surface (ft bls).
2. All elevations relative to msl in ft.
3. All wells constructed with screen size 0.016 in. and filter pack 0.018-0.022 in (FX-50).
4. -- Not available

ABBREVIATIONS:

NA - Not Applicable

Table 2.9
Summary of Well Development

Well Number	Development Method **	Development Hours	Approximate Well Yield (gpm) During Development	Estimated Volume of Water Removed in gallons during Development	pH Initial/Final	Specific Conductance (μmhos/cm) Initial/Final	Water Level Initial/Final (Depth in ft bls)	Water Level Elevation (ft msl)
CBR-6	B/S	6.5	0.1	202	6.25/NR	NR	48/53.5	- -
CBR-5	B/S	8	0.5	152	6.14/NR	NR	41/50	- -
CBR-4	B/S	12	0.75	425	NR	NR	29/41.5	- -

Table Notes:

** B-Bailing /S-Swabbing and Surging
NR-No Record
-- Not Available
Table was prepared from well development records from EMTC.

Table 2.10 Groundwater Monitoring Well Hydraulic Conductivity Estimates*

Well Number	**Hydraulic Conductivity (K)**		
	(ft/sec)	**(ft/day)**	**(cm/sec)**
CBR-4◊	3.19E-6	0.276	9.72E-5
CBR-5	8.48E-6	0.733	2.59E-4
CBR-6	6.78E-6	0.587	2.068E-4
		Average	
Hydrostratigraphic Unit/Zone	**Range Ft/Sec**	**ft/day**	**cm/sec**
Aquifer Zone IIB_2 (Water Table)	9.68E-7 to 1.38E-5	0.53	1.88E-4

Table Notes:

* Based on Field Permeability Testing (Slug Tests)

◊ The Falling Head slug test for CBR-4 was not acceptable; therefore, the K presented is for the Rising Head slug test only.

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3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

3.1 Surface Features

The BRP6G is located in the southern region of the Central Shops Area (Figure 3-1). The surface topography slopes gently from a surface elevation of 91.4 m (300 ft) to 90.2 m (296 ft) at the eastern end of the waste unit (Figure 3-2). The surface area is sparsely covered with weeds and grass.

A dry drainage ditch cuts approximately through the center of the waste unit. This drainage ditch receives surface runoff from drainage areas that are upgradient to the pit. Over a period of years, erosion had brought the surface elevation of the ditch to within 20.32 cm to 30.48 cm (8 to 12 in.) of a zone of burnt material. To prevent further erosion of the drainage ditch, a 45.72 cm (18 in.) diameter corrugated PVC pipe was installed during April 1995 to convey the stormwater runoff from drainage areas upgradient from the BRP6G. This pipe was installed above ground and connected to an 45.72 cm (18 in.) corrugated metal pipe north of the pit. From this connection point, the pipe extended 76.8 m (252 ft) to within 3 m (10 ft) of an existing 91.44 cm (36 in.) reinforced concrete pipe located southeast of the unit and occupying a position along the railroad tracks right-of-way.

The stormwater runoff from the 91.44 cm (36 in.) is received by a drainage ditch located approximately 61 m (200 ft) southeast of the pit (Figure 3-2). At the time of the unit reconnaissance, it appeared that the drainage ditch was hydrologically influenced solely by surface runoff. This drainage ditch is approximately 1.3 km (0.8 mi) in length and discharges into the Pen Branch stream.

An embankment separates BRP6G from a shallow dry ditch and railroad right-of-way. The top of the embankment is approximately 7.6 m (25 ft) south of the southern edge of the suspected rectangular pit. The embankment is approximately 1.5 m (5 ft) high. Soils exposed in the embankment are undisturbed. The shallow dry ditch serves to contain drainage from the railroad right-of-way. Water has not been observed in the ditch during any unit reconnaissance.

3.2 SRS Climate

The SRS has a temperate climate with a mild winters and relatively warm and humid summers. During the winter months the region is subject to the influence of cool continental air. The extreme effects of occasional outbreaks of Arctic air into the United States are moderated by the Appalachian Mountains to the northwest. The site and the surrounding area are characterized by gently rolling hills with no unusual topographic features that would significantly influence the local climate (Hunter, 1989).

The winds in the area are relatively light with an annual average speed of about 3 m per second. Due to seasonal changes in prevailing weather patterns, winds tend to blow somewhat more frequently from the northwest during the winter, from the west and southwest during the spring, and from the east and northeast during the summer and fall (Hunter, 1989).

Average temperatures at the SRS are warmest in July 27.3°C (81.1°F) and coolest in January 7.4°C (45.4°F). For a thirty-year period from 1961 through 1990, temperatures ranged from a maximum of 42.2°C (108°F) to a minimum of -19.4°C (-3°F). Temperatures below freezing occur approximately 58 days per year (Hunter, 1989 and WSRC, 1991).

There are, on average, 56 thunderstorm days per year in the SRS area. Thunderstorms occur during every month of the year, but are more prevalent during summer afternoons. Thunderstorm activity in the winter and spring is associated with the passage of cold fronts through the area (Hunter, 1989).

The estimated probability of a tornado striking a point at SRS is 7 x 10-5/yr. (DOE, 1991). Nearly half of the tornadoes reported in Georgia and South Carolina occur in March, April, and May. However, tornadoes have occurred during every month of the year. Based on tornado statistics for a thirty year period from 1954 through 1983, South Carolina can be expected to experience one or two tornadoes per year on the average. Since operations began in 1953, six tornadoes have been confirmed in or near SRS. Nothing more than light damage was reported in any of these storms, with the exception of a tornado in October 1989; this tornado caused considerable damage to timber resources in an unpopulated wooded area of SRS (DOE,1991).

A total of thirty-six hurricanes have caused damage in South Carolina over the period from 1700 through 1990. The average frequency of storms during this period was eight years, with most occurring during August and September. Due to the inland location of the SRS, wind speeds have generally diminished below hurricane intensity at the site (WSRC, 1991).

3.3 Surface-Water Hydrology

The BRP6G RCRA/CERCLA unit is located in the Central Shops Area near the center of the SRS. The BRP6G SWMU is on the southeastern flank of an interstream divide between Pen Branch Creek (approximately 1.62 km (1 mi) to the southeast) and Fourmile Branch (approximately 4.05 km (2.5 mi) to the northwest).

The waste site is approximate 0.32 ha (0.8 ac) in size. The surface topography slopes gently from a surface elevation of 91.4 m (300 ft) above mean sea level at the northwest end of the site down to 90.2 m (296 ft) at the southeastern end of the waste unit (Figure 3-2). A dry drainage ditch cuts approximately through the center of the BRP6G. This drainage ditch receives surface stormwater runoff from the waste unit area. Additionally, this ditch also includes a 45.72 cm (18 in.) diameter corrugated PVC pipe which conveys stormwater runoff from upgradient drainage areas as previously discussed in Section 3.1. Stormwater runoff collected in the drainage ditch discharges into a 91.44 cm (36 in.) reinforced concrete pipe south of the unit along the railroad tracks. The stormwater runoff from the site is further conveyed by a drainage ditch located approximately 61 m (220 ft) southeast of the waste unit. This drainage ditch is approximately 1.3 km (0.8 mi) in length and discharges in to Pen Branch Creek. The Pen Branch Creek eventually discharges into the Savannah River.

3.4 Local Site Geology

Three monitoring wells (CBR-1D, CBR-2D, and CBR-3D) were installed in January and February 1990 at the BRP 631-6G. These wells provide sampling sites for the shallow groundwater aquifer. Locations of these wells are shown on Figure 3-2. Pilot holes for wells CBR-2D and CBR-3D were drilled at the edge of the large area of disturbed soil. No debris or waste materials were encountered in these boreholes. The wells are currently being used for determining water levels and for monitoring groundwater quality in the Water Table Aquifer. Figures 3-3 and 3-4 are lithologic and hydrostratigraphic cross-sections prepared from the monitoring well boring logs. Figure 3-2 provides a more regional perspective for the location of these cross-sections. These figures indicate that the wells are screened in the Water Table (Aquifer Zone IIB2) below a 7.6 to 10.7 m (25 to 25-ft) thick sandy clay layer. This formation appears to be equivalent to a member of the Dry Branch formation (see Figure 1-9).

3.5 Soils

The ground elevation at BRP6G is approximately 88.4 m (290 ft) MSL (Gordon et al., 1987). Dothan soil (soil group three of Looney et al., 1989) is at the surface at BRP6G. A review of the Soil Conservation Service Soil Survey of the Savannah River Plant Area indicates that the soils in the BRP6G SWMU are Udorthents. Udorthents are soils that formed in heterogeneous materials which are the spoil or refuse from excavations and major construction (Rogers, 1990).

3.6 Local Site Hydrogeology

Numerous groundwater monitoring wells exist in C Area, including the CBR, HXB, and CSD well clusters. The location of Water Table monitoring wells in the vicinity of BRP6G is illustrated in Figure 3-5. All of the depicted wells are screened in the shallow Water Table Aquifer [approximately 15.2 m (50 ft) below land surface (bls)]. The "Tan Clay" (previously Confining Zone IIB1- IIB2) is not reported at well cluster P-18, and not evident at BRP6G also, which indicates that the shallow Water Table Aquifer and lower Water Table Aquifer (previously Aquifer Zone IIB1 and IIB2) are part of the upper Three Runs Aquifer (previously Aquifer Unit IIB). None of the CBR wells were drilled to sufficient depth to encounter the "green clay". Logs of CBR-04, -05, and -06 are located in Appendix I.

Using recently available groundwater data, the water table surface elevation was contoured Figure 3-5. The map indicates that the direction of shallow groundwater flow is southward, with probable discharge into a tributary of Pen Branch ("Pen Branch Tributary") where the water table contours intersect the ground surface. Figure 3-6 is a potentiometric surface map of the Water Table (previously Aquifer IIB) at the BRP6G using water level measurements (December 20, 1994) from the three temporary groundwater monitoring wells. The potentiometric surface data from wells CBR-01D, -02D, and -03D were collected at an earlier time than wells CBR-04, -05, and -06. The measurements noted for CBR -1D, -2D, and -03D are within one foot of the contour intervals on the map at their locations.

In-situ measurements of hydraulic conductivity are not available for the Water Table Aquifer in N Area. Estimates of hydraulic conductivity for temporary wells CBR-04 through CBR-06 ranged from 9.72 x 10^{-5} cm/sec (3.19 x 10^{-6} ft/sec) to 2.59 x 10^{-4} cm/sec (8.48 x 10^{-6} ft/sec) and averaged 1.88 x 10^{-4} cm/sec (6.18 x 10^{-6} ft/sec) or 0.53 ft/day. The hydraulic conductivity estimates for all the wells slug tested (rising and falling head) are presented in Table 3.1 and data plots of the slug tests are included in Appendix I. These hydraulic conductivity estimates were fairly typical for the lithologies encountered. An estimated flow velocity in the Water Table Aquifer is calculated to be 0.00123 feet/day using the hydraulic gradient of 0.0064 feet/ft, a 30% average porosity and the average estimated hydraulic conductivity of 0.53 ft/day.

3.7 Demography and Land Use

Access to SRS is limited by guards and security forces. However, once on site, access to the BRP6G is available by paved road (Road 3) and exiting on an unpaved road (Bussey Street) which leads to the site (Figure 3-1). The BRP6G is currently not used for any purpose. Most of the site is sparsely covered by weeds/grass and is routinely mowed.

A large gravel surface laydown materials storage area bounds the site to the north and east of the waste unit, (see Plate 1-1). This storage area is enclosed with a chain link fence. Daily operation activities are conducted within the storage area. In addition, Central Shop Area buildings are nearby, with the Ford Building approximately 244 m (800 ft) to the north. The Ford Building Seepage Basin, a radiologically controlled area, is approximately 61 m (200 ft) northwest of the BRP6G unit. This Seepage Basin is on the north side of the gravel access road to BRP6G, and is marked by a chain and signs indicating it is a controlled area.

Railroad tracks are within 15.24 m (50 ft) of BRP6G to the south. Rail traffic along these tracks is generally light and train speed is slow.

3.8 Ecology

3.8.1 General Site Conditions

The BRP6G is located on the southern boundary of the Central Shops Area, an active industrial/material storage area. The BRP6G pit is located to the south and immediately adjacent to an active excess materials lay-down yard and approximately 100 m southeast of the Ford Building Seepage Basin, a radiologically contaminated, inactive waste unit. The BRP6G is situated both topographically and hydrologically down-gradient of these facilities (see Plate 1-1). The unit area is routinely mowed.

Immediately south of the waste unit (<30 m) are railroad tracks and associated right of way, which are believed to have received routine herbicide treatments in the past and are mowed for maintenance.

3.8.2 Habitat Characteristics

The area within the physical boundary of BRP6G, visually delineated by markers, is a highly disturbed area with sparse ground cover comprised primarily of grass and sedge species. The area north of the unit is extensively disturbed due to industrial use and development since the 1950's and therefore offers limited wildlife habitat. A small forested area exists to the west of the unit and a heavily forested pine plantation habitat exists to the south of the unit beyond the railroad tracks.

A Threatened, Endangered, and Sensitive (TES) Species Survey was conducted for the unit and surrounding area in the summer of 1994 (USFS, 1994). The survey was performed in accordance to the Savannah River Site Proposed, Threatened, Endangered, and Sensitive Plants and Animals listing (SRFS, 1994). The survey revealed that waste unit itself contains no TES habitat nor were any TES species observed at the waste unit. The forested regions of the survey area were dominated by Loblolly Pine (*Pinus taeda*) and included Water Oak (*Quercus nigra*), White Oak (*Quercus alba*), Sycamore (*Plantanus occidentalis*), Black Gum (*Nyssa sylvatica*), Black Cherry (*Prunus serotina*), Scarlet Oak (*Quercus coccinea*), Black Oak (*Quercus velutina*), American Elm (*Ulmus americana*), and Nuttall Oak (*Quercus nuttallii*). The midstory consists primarily of young Loblolly Pine, various Oaks, Hickories (*Carya* spp.), and Sweet Gum

(*Liquidambar styraciflua*). Ground cover invading open areas included Japanese Honeysuckle (*Lonicera japonica*), Poison Ivy (*Rhus radicans*), Greenbrier (*Smilax* spp.), Blackberry (*Rubus* spp.), Ragweed (*Ambrosia artemisiifolia*), Muscadine (*Vitis rotundifolia),* and Peppervine (*Ampelopsis arborea*).

The survey results indicated that habitats in the vicinity of BRP6G do not meet the needs of most SRS listed TES plant or animal species. Some upland plant species could potentially occur in the area, but no specimens were found during the survey and there is a fairly low potential of occurrence.

The BRP6G and land immediately surrounding the unit offers limited habitat for small mammals and their associated predators (avian, mammalian, and reptilian), and ground-level feeding birds. The forested regions of the survey area provide habitat for species that feed and/or nest in mature pine canopies (song birds and squirrels, for example). The open canopy associated with the forested regions have resulted in dense mid- and ground-story growth which provides habitat for certain small mammals, song birds, and White-tailed deer (*Odocoileus virginianus*). Birds identified by song during conduct of the TES survey include the Blue Jay (*Cyanocitta cristata*), Carolina *Chickadee (Parus carolinensis*), Carolina Wren (*Thryothorus ludovicianus*), Common *Crow (Corvus brachyrhynchos*), Mourning Dove (*Zenaida macroura*), Northern Cardinal (*Cardinalis cardinalis*), Summer Tanager (*Piranga ruba*), and Tufted Titmouse (*Parus bicolor*).

3.8.3 Soils

The disturbed soils characteristic of the BRP6G include two Udorthent soil types, Ud and Uo, as well as the Dothan sand series to the east of the unit. These soil types are described in detail in the SRS Soil Survey (USDA, 1990). A brief description is provided below.

- Udorthent (Uo) —This soil type encompasses the waste unit and is characterized as spoil from excavated areas, disturbed areas, and borrow pits of friable soil material. Slopes are 0 to 6% and soil properties generally vary within a few feet. The Udorthents have a very low content of organic matter and a low available water capacity. They are strongly acid to extremely acid throughout and the permeability is generally moderate but ranges from moderately slow to rapid. Due to the very low supply of plant nutrients, acidity, and the very low organic content these soils are unsuited for row crops. These soils are also poorly suited for timber production. The soils are fairly suited as habitat for openland and woodland wildlife and very poorly suited to wetland wildlife habitat.

- Udorthent (Ud)—These are well drained soils at which the upper part of the original soil has been completely removed or truncated by heavy equipment that the diagnostic horizons are gone. The remaining soil material is indurated layers high in ironstone content that were once plinthite or dense, brittle material similar to Ailey and Vaucluse soil substrata. Slopes are dominantly 0 to 10%. The Udorthents have a very low content of organic matter and a low available water capacity. They are strongly acid to extremely acid throughout and the permeability is slow to moderate. These soils are not suited to row crop or timber production. They are fairly suited as habitat for openland wildlife, poorly suited to woodland wildlife habitat, and very poorly suited to wetland wildlife habitat.

- Dothan sand (DoB)—These are well drained soils found on broad ridgetops and smooth side slopes of the coastal plain. The 2 to 6% slopes are smooth and generally convex. The Dothan soil has a low organic content and a moderate available water capacity. It is moderately to very strongly acid in the layers above the plinthite and ranges to extremely acid below those layers. Permeability is moderately slow in the subsoil and a perched water table at 3 to 5 ft below the surface is common for brief periods in the winter and early spring. The soil is well suited to row crops as well as timber production. Erosion is a significant management concern. The soil is well suited to openland and woodland wildlife habitat.

3.8.4 Surface Topography and Drainage Patterns

Surface drainage at the BRP6G is generally to the south-southeast. There is evidence of surficial sheet flow and sedimentation from the upgradient lay down yard, and site management currently includes placement of erosion control fencing. Upgradient surface water run-off drainage from the lay-down yard and Ford Building area migrates toward the BRP6G pit. This drainage is a consolidation of the Ford building's CS-008 permitted outfall and run-off from the upgradient lay down yard. A drainage conduit has been added at the site to control and eliminate further erosion across the site. The drainage accepts run-off from the drainage pipe under the dirt road to the north of the site and discharges to the railroad track embankment that ultimately discharges to Pen Branch approximately 7000 ft to the southeast.

The BRP6G unit has visible signs of erosion which were lessened by recent placement of the conduit. This erosion could serve as a potential migration/transport route, but is an insignificant contributor to the overall flow of the drainage area. The overall setting, however, increases the complexity of both the background reference determination and contaminant source definition for this assessment since the drainage area represents potential contaminants from a large area not attributable to the BRP6G.

No wetlands or surface water bodies are present at the BRP6G or in the vicinity of the unit.

3.9 ASCAD Applications

Unit specific information that may vary for one unit to the next will be developed during individual characterization. One potential key constant with BRP6G and other Burning/Rubble

Pits could be the soil series in which the pit are located. The background soil samples collected at BRP6G could be representative for all the Burning/Rubble Pits, and therefore streamline future background characterization by reducing or eliminating the need for additional background borings in each area.

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FIGURES

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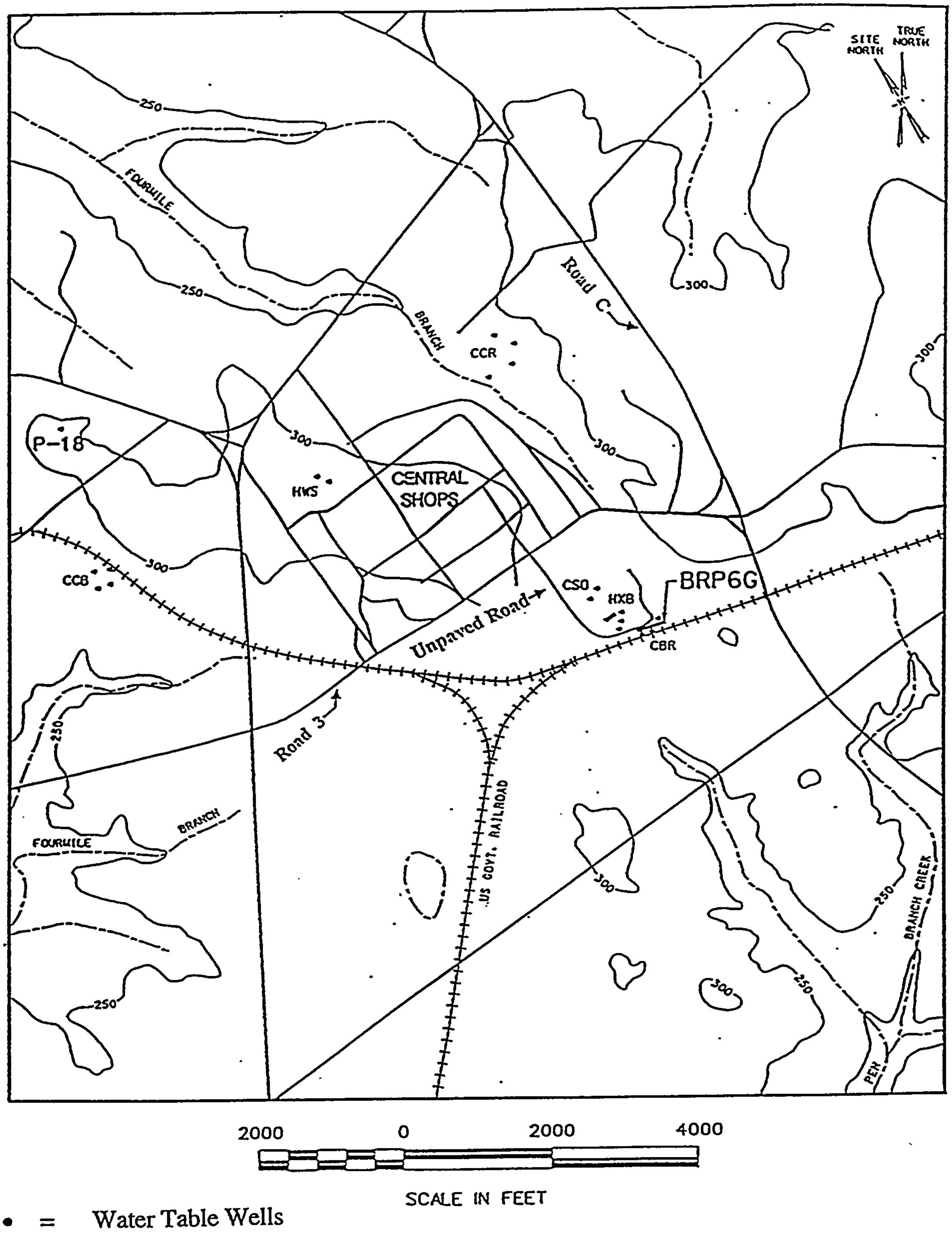

● = Water Table Wells

Figure 3-1 Location of the BRP6G in the Central Shops Area of SRS

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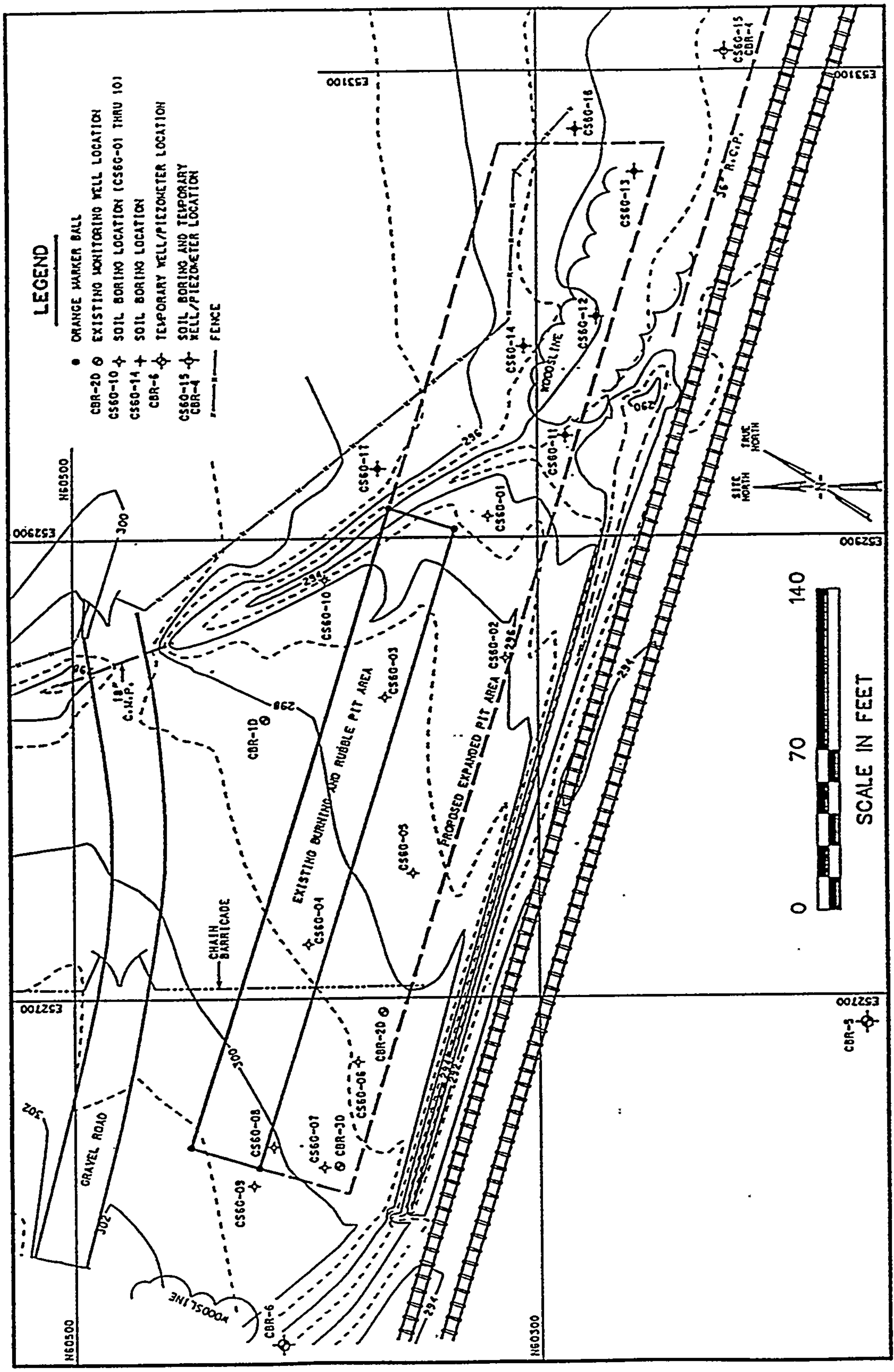

Figure 3-2 Waste Unit Topographical Map

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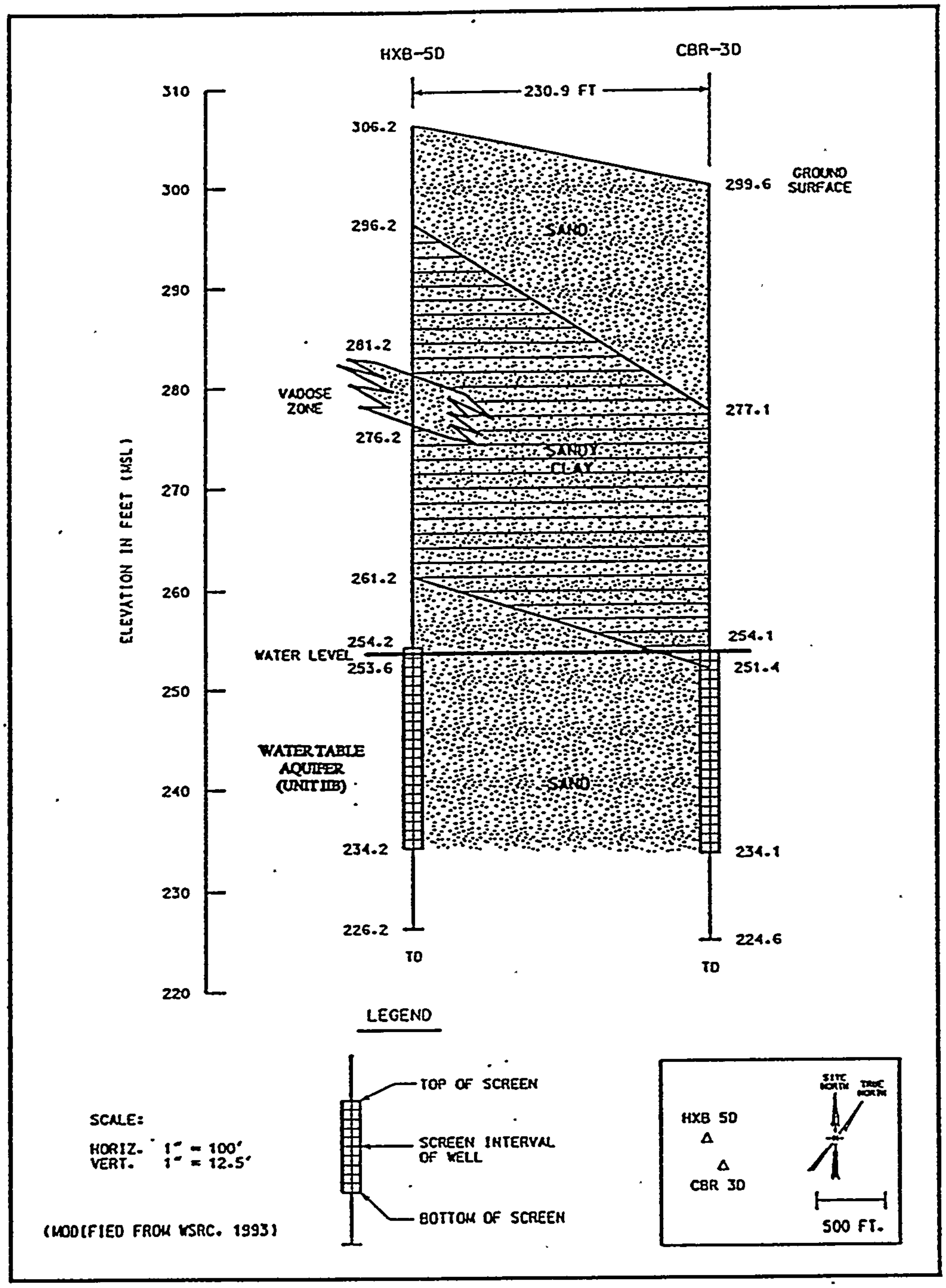

Figure 3-3 Lithologic and Hydrologic Cross Section HXB-5D to CBR-3D

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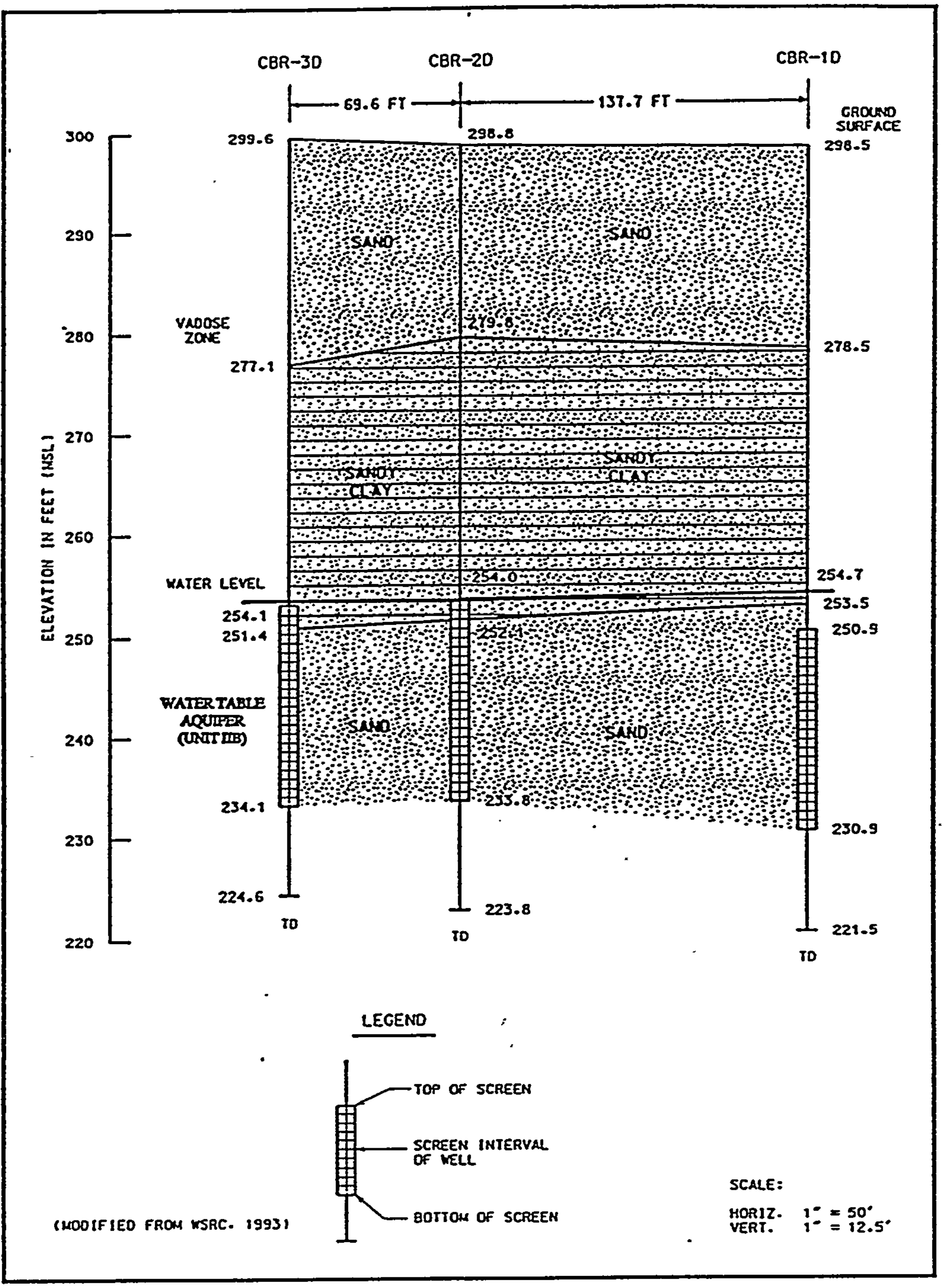

Figure 3-4 Lithologic and Hydrologic Cross Section CBR-3D, CBR-2D, and CBR-1D

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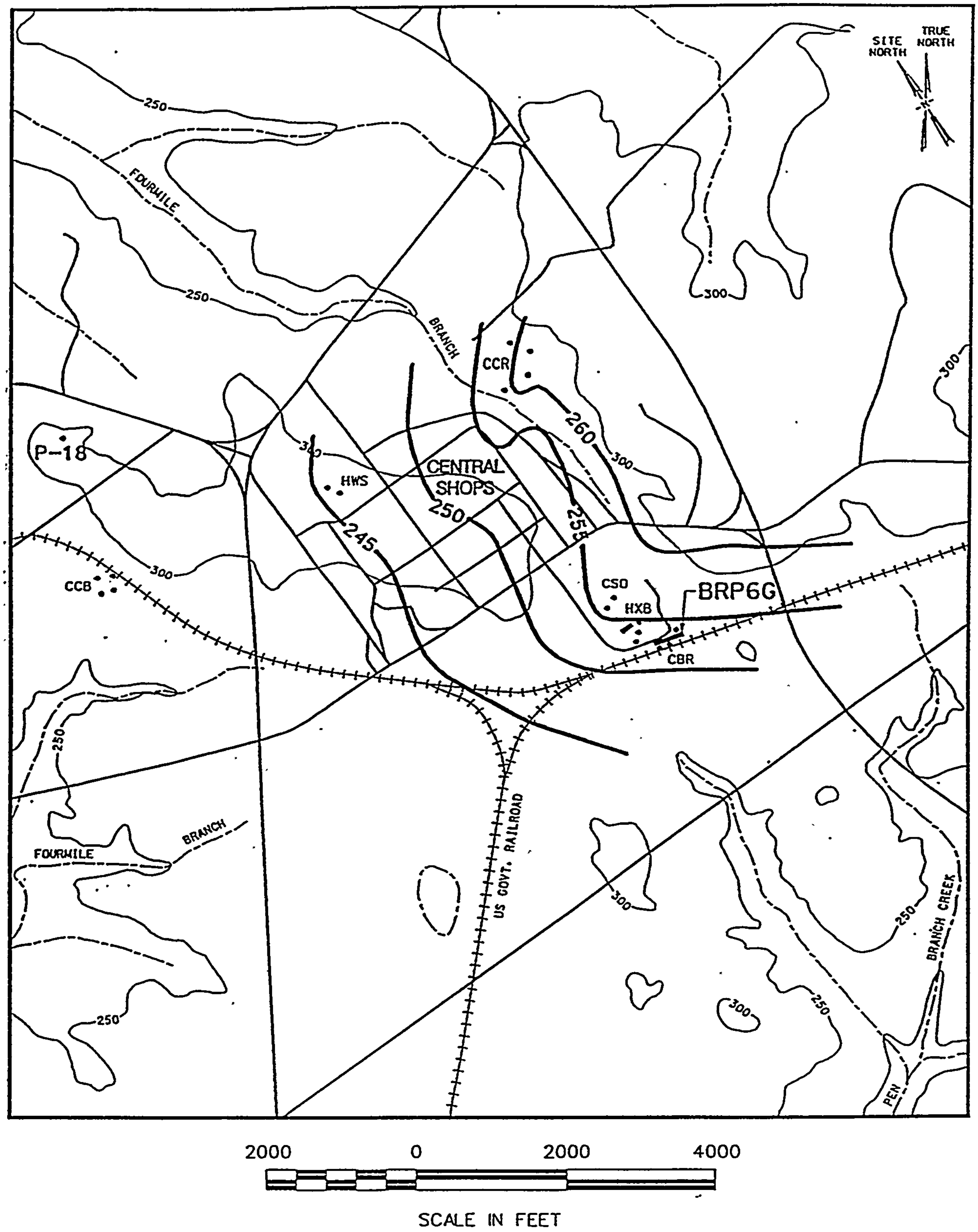

• = Water Table Wells

Figure 3-5 Potentiometric Surface of the Water Table (Aquifer Unit IIB) in the BRP6G Area

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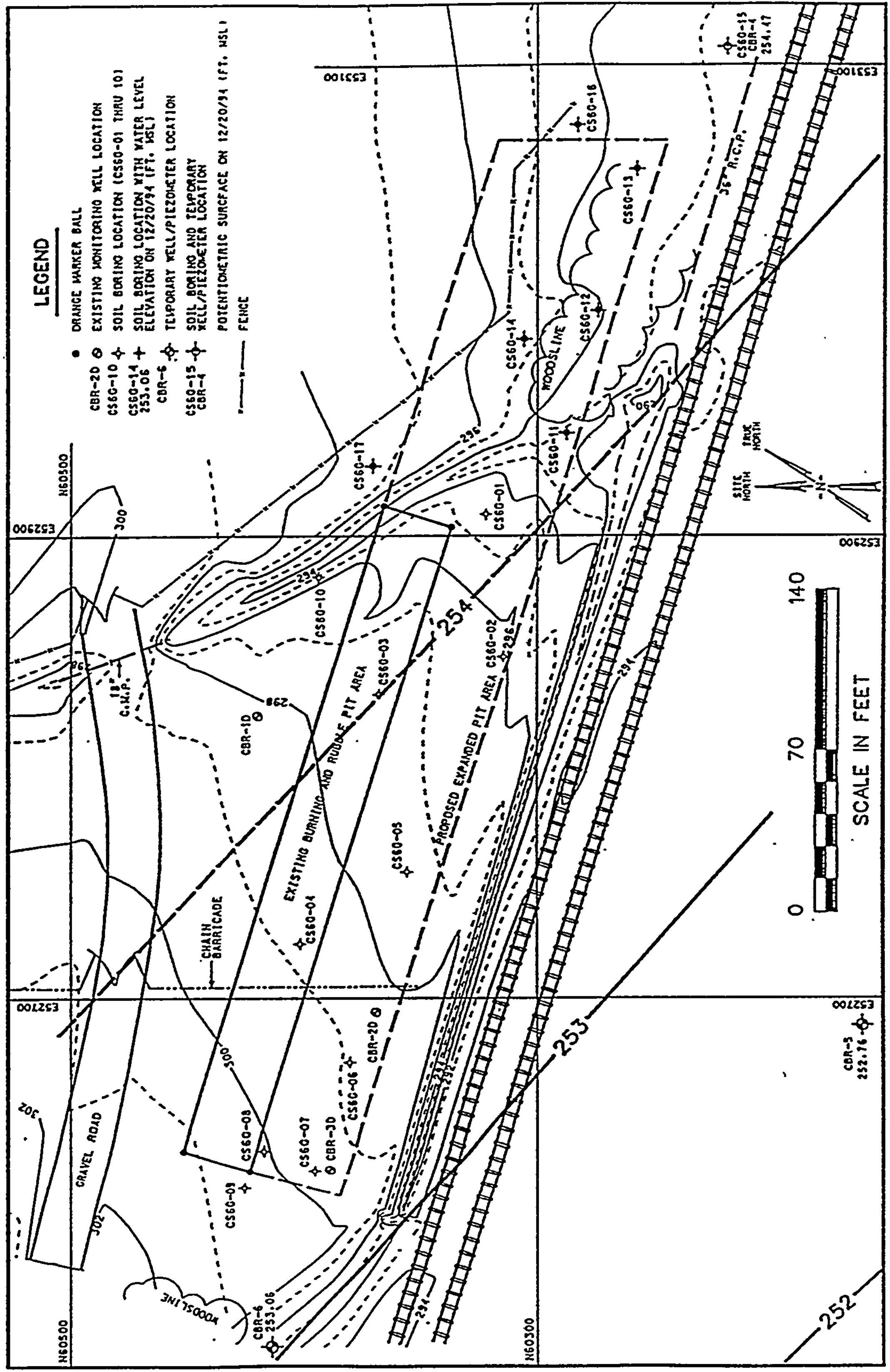

Figure 3-6 Potentiometric Surface of the Water Table (Aquifer Unit IIB) at the BRP6G

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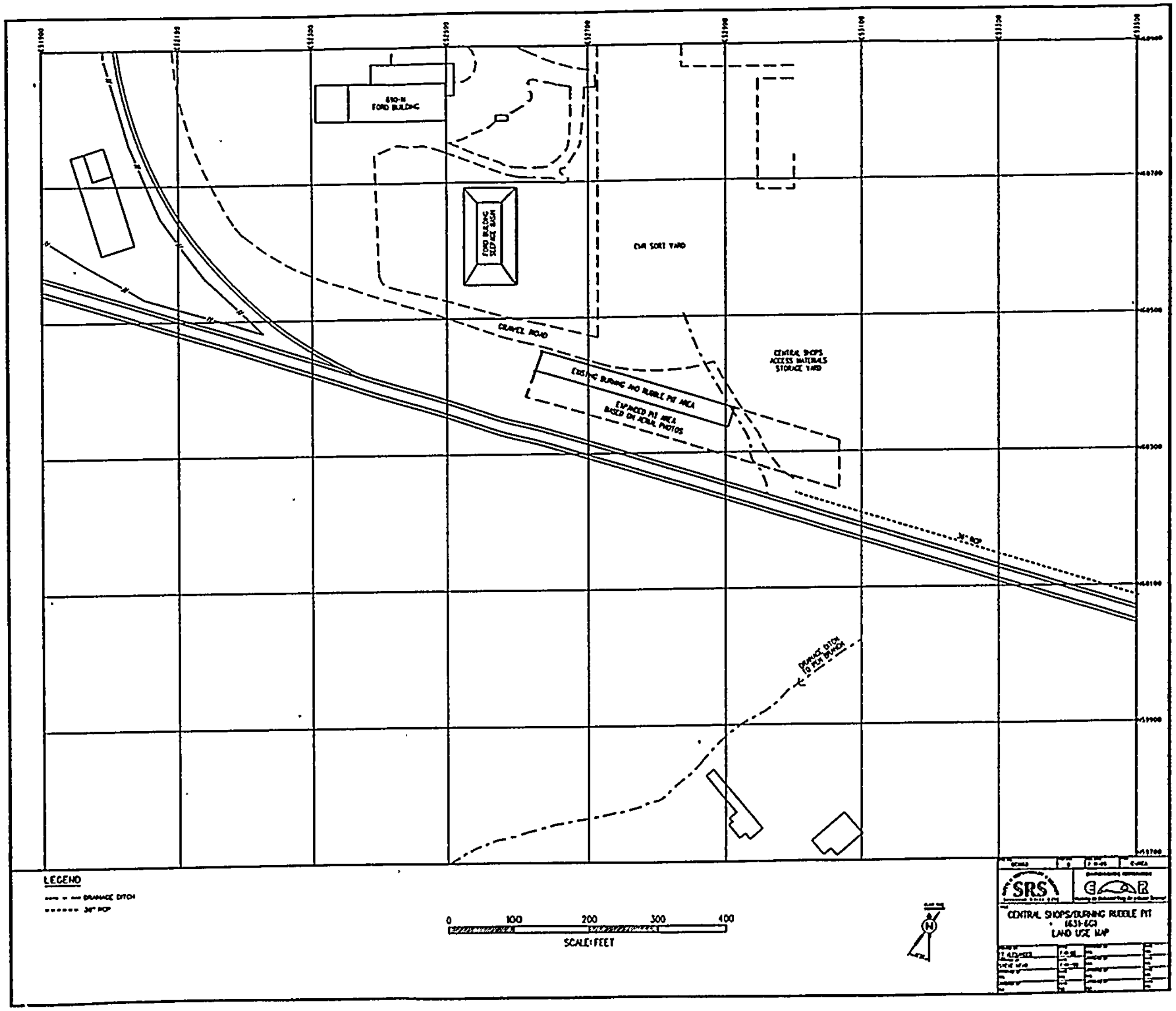

Figure 3-7 Demography and Land Use Map at the BRP6G

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TABLES

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Table 3.1 Groundwater Monitoring Well Hydraulic Conductivity Estimates*

Well Number	(ft/sec)	(ft/day)	(cm/sec)
CBR-4×	3.19E-6	0.276	9.72E-5
CBR-5	8.48E-6	0.733	2.59E-4
CBR-6	6.78E-6	0.587	2.068E-4

Hydrostratigraphic Unit/Zone	Range Ft/Sec	Average ft/day	Average cm/sec
Water Table Aquifer (previously Aquifer Zone IIB2)	9.68E-7 to 1.38E-5	0.53	1.88E-4

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* Based on Field Permeability Testing (Slug Tests)

× The Falling Head slug test for CBR-4 was not acceptable; therefore, the K presented is for the Rising Head slug test only.

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4.0 NATURE AND EXTENT OF CONTAMINATION

4.1 Introduction

This chapter provides an analysis of contaminant concentrations and patterns at the BRP6G area. The assessment is organized by medium (surface soil, soil borings, surface water/sediment, and groundwater) and by type of contaminant (metals, semivolatiles, volatiles, pesticides/PCBs, and radionuclide indicators). The soil is the primary medium of concern at this Unit and much of this chapter is focused on the results of the soil investigation. Soil contaminants are compared to two times average background concentrations. Constituents which exceed two times average background are discussed in detail as to their nature and extend. The data are only summarized in this chapter. All analytical results are available in the Data Summary Report. Tables and figures are located at the end of this chapter.

4.2. Background Concentrations

4.2.1 Background Surface and Subsurface Soils

4.2.1.1 Background Metals

The soils sampled at this Unit are considered Udorthents. Udorthents are so extensively graded, exposed, transported, mixed, and compacted during earth moving and construction, that they can not be assigned to a particular soil series with a high level of confidence. These soils typically lack the horizonation and soil structures which characterize mature soils. They are generally more friable, but may be firmer due to compaction, than in situ soils. Organic matter and other plant nutrients are usually low in these soils due to stripping and mixing. Extreme variations may occur laterally within very small distances. In udorthent soil, the pH may be more strongly acidic and permeability is slow to moderate. The pH was measured in sludge sediment samples CS6G-29 through -32 and the average was 5.8 with a range of 5.3 to 6.3.

Since Udorthents do not have a soil profile, concentrations of substances at the surface can be compared to concentrations of substances down to the depth of disturbance. Unit specific background data was collected from CS6G-10, CS6G-18, CS6G-19, CS6G-20, and CS6G-21. Refer to Figure 2-4 in Chapter 2 for boring locations. Table 4.1 summarizes the background data for metals, and the range of concentrations detected.

4.2.1.2 Background Semivolatile Organics or Base/Neutral and Acid Extractables (BNAs)

The base/neutral and acid extractables (BNAs) detected in the soil samples can be divided into two groups: Polynuclear Aromatic Hydrocarbons (PAHs) and others. This grouping is done to facilitate conclusions as to the origin of contaminants. For example, PAHs are products of incomplete combustion and are more likely to be found in areas where materials were burned.

PAHs are composed of fused benzene rings. PAHs include, but are not limited to, the following compounds: acenaphthene, acenaphthylene, anthracene, benzo[a] anthracene, benzo[a]pyrene, benzo[ghi]perylene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenzo[ah]anthracene, dibenzofuran, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, 2-methyl naphthalene, phenanthrene, and benzo[def]phenanthrene (pyrene).

Other compounds detected in the soils which are not considered PAHs include benzoic acid, 1,2-dichlorobenzene, and common solvents. Common solvents include bis(2-ethylhexyl)phthalate, butylbenzyl phthalate, di-n-butyl phthalate, and di-n-octyl phthalate. Looney et al. (1990) reported that bis(2-ethylhexyl) phthalate and butyl benzyl phthalate were detected in background soil samples.

The maximum background concentration of PAHs detected in CS6G-18 was 23.9 μg/kg. The specific PAHs detected in the background samples were Fluoranthene and Pyrene. No PAHs were detected in CS6G-10. The maximum concentration of common solvents detected in CS6G-

20 was 51.4 µg/kg. The specific solvents detected were: bis(2-ethylhexyl)phthalate, Di-n-butyl phthalate and Diethyl phthalate.

Table 4.2 lists the unit specific background data as well as the range detected in soil samples for semi-volatile organic contaminants detected in the soil samples collected from the BRP6G waste unit.

4.2.1.3 Background Volatile Organic Compounds (VOCs)

Acetone, Benzene, Carbon disulfide, Chloroform, Dichloromethane (Methylene chloride), Ethylbenzene, Methyl ethyl ketone, Styrene, Tetrachloroethylene, Toluene, 1,1,1-Trichloroethane, Trichloroethylene and Xylenes were detected in the background soil samples collected. Acetone, Methylene Chloride and Toluene are common laboratory artifacts. Acetone was detected in all the background soil samples. Acetone was detected at a maximum concentration of 46.3 µg/kg. Methylene Chloride was detected in all background soil samples except at CS6G-10. The maximum concentration detected for Methylene Chloride was 2.88 µg/kg. Toluene was detected as a laboratory blank contaminant in all but three of the background soil samples. The unit specific background data for volatile organic contaminants detected in the soil samples from the BRP6G are presented in Table 4.3, which summarizes the range of detection for each contaminant detected in the soil samples.

4.2.1.4 Background Pesticides, Polychlorinated Biphenyls (PCBs), and Dioxins/Furans

All background sampling locations were analyzed for pesticides, polychlorinated biphenyls (PCBs), and dioxins/furans. Pesticides were detected at background sample locations CS6G-18, CS6G-19, CS6G-20 and CS6G-21. No pesticides were detected at background sampling location CS6G-10. The detected pesticides and their maximum concentrations (in µg/kg) are as follows: p,p'-DDE (1.6). p,p'-DDT (5.72), Dieldrin (2.67), Endosulfan I (0.99) and Endrin ketone (1.98). There were no detections for PCBs in any of the background soil samples. The only dioxin/furan contaminant detected in the background samples was octachlorodibenzo-p-dioxin isomers at background sampling locations CS6G-18, CS6G-19 and CS6G-20. The maximum octachlorodibenzo-p-dioxin concentration of 6.82 μg/kg occurred at CS6G-18 at a depth of 1.22 m (4 feet) below the land surface. The unit specific background data for pesticides, PCBs, and dioxins/furans detected in the soil samples collected from the BRP6G are listed in Table 4.4, which also summarizes the range of contaminants detected in the soil samples.

4.2.1.5 Background Radionuclides

The BRP6G has no known history of receiving any radioactive waste. All background sampling locations indicated the presence of radionuclides. The background concentrations for gross alpha ranged from 6.21-33.9 pCi/gm. The range of gross alpha detected in soil samples from inside and outside the BRP6G were less than the background samples. Nonvolatile beta was detected in all background soil sampling locations. Table 4.5 lists the background radionuclide concentrations and also summarizes the range of radionuclides detected in the soil samples.

4.2.2 Background Surface Water

No background data are available for Surface Waters as no background surface waters exist in the vicinity of the BRP6G.

4.2.3 Background Sediment

Three sample locations, CS6G-26, CS6G-27, and CS6G-28 were utilized in obtaining surficial sediment samples for background data. These locations are upgradient of any surface runoff from the BRP6G and were located in the drainage ditch between the railroad tracks and embankment. Analytes detected in sediment samples will be compared against two times the average background.

4.2.4 Background Groundwater

Unit specific background data for groundwater are summarized in Table 4.6. Background data was taken from well CBR-1D for a period from first quarter of 1993 to first quarter 1995. Well CBR-1D is screened in a thick sand layer (the Water Table Aquifer) approximately 14.63 m (48 feet) below the land surface.

4.3 Surface Soil

The objective of the surface soil sampling program was to determine the horizontal extent of contamination. Surface soil samples, defined as the first sample collected, were acquired from locations CS6G-01 through CS6G-22. The concentrations of the contaminants in these samples are compared to surface soil background concentrations. Surface soil samples collected from CS6G-10, CS6G-18 through CS6G-21, background locations, were analyzed and the average background concentrations were obtained. The concentrations of the various analytes were then compared to two times the average background concentration (average detection limit used when no detections occurred in background samples), as a primary screening device. Subsurface soil samples were also collected from CS6G-01 through CS6G-22 and are discussed in Section 4.4.

4.3.1 Metals

A summary of the concentrations of metal contaminants in surface soils is located below and is tabulated in Table 4.7.

4.3.1.1 Aluminum

The two times average background concentration for aluminum was 15,984 mg/kg. Aluminum was detected above the two times average background concentration in one of the surface soil samples collected from outside the suspected pit area, CS6G-11 with a concentration of 17,700 mg/kg.

4.3.1.2 Antimony

Antimony was not detected above the two times average background concentration in any of the surface soil samples collected within or outside the suspected pit area.

4.3.1.3 Arsenic

The two times average background concentration for arsenic was 1.664 mg/kg. Arsenic was detected above the two times average background concentration in one of the surface soil samples collected from within the suspected pit area, CS6G-01 with a concentration of 7.92 mg/kg.

4.3.1.4 Barium

Within the pit, barium exceeded the two times average background concentration (35.64 mg/kg) in CS6G-13 (53.8 mg/kg). Outside of the pit area, barium concentration exceeded the background concentration in CS6G-15 (39.2 mg/kg) and CS6G-17 (37.9 mg/kg).

4.3.1.5 Beryllium

Beryllium was not detected above the two times average background concentration in any of the surface soil samples collected within or outside the suspected pit area.

4.3.1.6 Cadmium

Cadmium was not detected above the background concentration in any of the surface soil samples collected within or without the suspected pit area.

4.3.1.7 Calcium

Within the pit, calcium exceeded the two times average background concentration (312.8 mg/kg) in CS6G-13 (444 mg/kg), CS6G-01 (504 mg/kg), and CS6G-22 (339 mg/kg). Outside of the pit area, calcium concentration exceeded the background concentration in CS6G-11 (481 mg/kg), CS6G-15 (352 mg/kg), and CS6G-17 (369 mg/kg).

4.3.1.8 Chromium

In the area adjacent to and outside of the suspected pit area, the two times average background concentration of 22.8 mg/kg was exceeded in CS6G-02 (108 mg/kg), and CS6G-11 (46.9 mg/kg). Within the pit CS6G-01 exceeded the two times average background with a value of 43 mg/kg.

4.3.1.9 Cobalt

Within the pit, cobalt exceeded the two times average background concentration (1.248 mg/kg) in CS6G-01 (1.32 mg/kg). Outside of the pit area, cobalt concentration exceeded the two times average background concentration in CS6G-11 (1.69 mg/kg), and CS6G-02 (2.62 mg/kg).

4.3.1.10 Copper

Within the suspected pit area, copper exceeded the two times average background concentration (323.84 mg/kg) in CS6G-12 (1160 mg/kg), and CS6G-22 (400 mg/kg). Copper was not detected above the two times average background concentration in any of the surface soil samples collected outside of the suspected pit area.

4.3.1.11 Cyanide

Within the suspected pit area, cyanide exceeded the two times average background concentration (114.2 mg/kg) in CS6G-05 (184 mg/kg), and CS6G-06 (703 mg/kg). Cyanide was not detected above the two times average background concentration in any of the surface soil samples collected outside of the suspected pit area.

4.3.1.12 Iron

Within the pit, iron exceeded the two times average background concentration (19,688 µg/kg) in CS6G-01 (20,300) µg/kg, CS6G-09 (20,000) µg/kg, and CS6G-22 (22,800) µg/kg. Outside of the pit area, iron concentration exceeded the two times average background concentration in CS6G-11 (24,400 µg/kg).

4.3.1.13 Lead

Within the pit, lead exceeded the two times average background concentration (18.996 mg/kg) in CS6G-01 (20.5) mg/kg, CS6G-12 (32.2) mg/kg, and CS6G-13 (45.9) mg/kg. Outside of the pit area, lead concentration exceeded the background concentration in CS6G-02 (48 mg/kg) and CS6G-11 (54.5 mg/kg).

4.3.1.14 Magnesium

Outside the suspected pit area, magnesium exceeded the two times average background concentration (224.2 mg/kg) in CS6G-11 (307 mg/kg) and CS6G-17 (231 mg/kg). Magnesium was not detected above the two times average background concentration in any of the surface soil samples collected inside the pit area.

4.3.1.15 Manganese

Manganese was detected at concentrations above two times average background of 82.12 mg/kg in one of the surface soil samples collected within the pit, CS6G-14 (84.5 mg/kg). Outside of the pit, manganese concentrations in boring CS6G-15 (133 mg/kg) exceeded the two times average background concentrations of 82.12 mg/kg.

4.3.1.16 Mercury

Mercury was detected at concentrations above two times average background of 20 µg/kg in four of the surface soil samples collected within the pit, CS6G-01 (24.1 µg/kg), CS6G-05 (37.1 µg/kg), CS6G-08 (31.6 µg/kg), and CS6G-09 (38.8 µg/kg). Outside of the pit, mercury concentrations in boring CS6G-04 (74.6 µg/kg), and CS6G-07 (47.4 µg/kg) exceeded the two times average background concentrations of 20 µg/kg.

4.3.1.17 Nickel

At the surface within the pit, nickel concentrations exceeded the two times average background concentration of (3.336 mg/kg) at borings CS6G-01 (16.2 mg/kg), and CS6G-06 (3.37 mg/kg). Outside of the pit area, nickel concentrations exceeded two times average background concentrations at borings CS6G-02 (350 mg/kg) and CS6G-11 (19.6 mg/kg).

4.3.1.18 Potassium

Outside the suspected pit area, potassium exceeded the two times average background concentration (186.48 mg/kg) in CS6G-11 (250 mg/kg). Potassium was not detected above the two times average background concentration in any of the surface soil samples collected inside the pit area.

4.3.1.19 Selenium

Outside the suspected pit area, selenium exceeded the two times average background concentration (3.208 mg/kg) in CS6G-11 (8.36 mg/kg). Selenium was not detected above the two times average background concentration in any of the surface soil samples collected inside the pit area.

4.3.1.20 Silver

Silver was not detected above the two times average background concentration of 1 mg/kg in any of the surface soil samples collected outside the pit area. Silver was detected at 1.81 mg/kg in boring CS6G-22, which is located inside the pit area.

4.3.1.21 Sodium

Sodium was detected above the two times average background concentration of 12.656 mg/kg in boring CS6G-13 (15.8 mg/kg), which is located within the pit area. Sodium was not detected above the two times average background concentration in any of the surface soil samples collected outside the pit area.

4.3.1.22 Thallium

At the surface within the pit, thallium concentrations exceeded the two times average background concentration of (4.228 mg/kg) at borings CS6G-13 (7.82 mg/kg), and CS6G-14 (4.73 mg/kg). Outside of the pit area, thallium concentrations exceeded two times average background concentrations at borings CS6G-02 (4.4 mg/kg).

4.3.1.23 Vanadium

Vanadium was not detected above the two times average background concentration of 53.08 mg/kg in any of the surface soil samples collected within the pit area. Vanadium was detected at 55.4 mg/kg in boring CS6G-11, which is located outside the suspected pit area.

4.3.1.24 Zinc

At the surface within the pit, zinc concentrations exceeded the two times average background concentration of (16.052 mg/kg) at borings CS6G-13 (55.0 mg/kg), and CS6G-12 (18.3 mg/kg), and CS6G-01 (16.2 mg/kg). Outside of the pit area, zinc concentrations exceeded two times average background concentrations at borings CS6G-02 (60.3 mg/kg), CS6G-11 (28.4 mg/kg), and CS6G-17 (23.8 mg/kg).

4.3.2 Semi-Volatiles

A summary of the concentrations of contaminants for semi-volatiles in surface soils is located in Table 4.8. A further breakdown as to whether the boring is located in and out of the pit, is also made. A summary of the individual contaminants detected above two times average background and their concentrations follows.

Within the designated pit area, the data indicates little BNA contamination at the surface. The PAHs contribute approximately 34 percent to the total BNAs. Boring CS6G-22 had the maximum concentration of BNAs at 120.4 µg/kg and is substantially elevated compared to other boring locations within the pit. However, boring CS6G-22 is located in the drainage ditch which conveys surface runoff which may have increased the concentration level. Borings outside the pit area also indicate little BNA contamination at the surface with the PAHs contributing about 47 percent of the total BNAs. Common solvents are the primary contributors to the elevated total BNA levels.

4.3.2.1 2-Methylnaphthalene

2-Methylnaphthalene was found above the two times background concentrations of 1.566 µg/kg in two surface soil samples. CS6G-15, located outside the pit, noted a concentration of 9.27 µg/kg. CS6G-14, located in the pit, noted a concentration of 5.74 µg/kg.

4.3.2.2 4-Chloro-m-cresol

4-Chloro-m-cresol was found above the two times background concentrations of 1.29 µg/kg in one surface soil samples. CS6G-07, located outside the pit, noted a concentration of 5.31 µg/kg.

4.3.2.3 4-Chlorophenyl phenyl ether

4-Chlorophenyl phenyl ether was found above the two times background concentrations of 1.148 µg/kg in one surface soil samples. CS6G-15, located outside the pit, noted a concentration of 7.49 µg/kg.

4.3.2.4 Anthracene

Anthracene was detected above the two times background concentrations of 0.436 µg/kg in one surface soil samples. CS6G-15, located outside the pit, noted a concentration of 14.6 µg/kg.

4.3.2.5 Benzo(b)fluoranthene

Benzo(b)fluoranthene was detected above the two times background concentrations of 1.046 µg/kg in two surface soil samples. CS6G-15, located outside the pit, noted a concentration of 27.1 µg/kg. CS6G-09, located inside the pit, noted a concentration of 5.78 µg/kg.

4.3.2.6 Benzo(k)fluoranthene

Benzo(k)fluoranthene was detected above the two times background concentrations of 1.116 µg/kg in one surface soil sample. CS6G-15, located outside the pit, noted a concentration of 18.5 µg/kg.

4.3.2.7 Benzoic Acid

Benzoic Acid was detected above the two times background concentrations of 31.788 µg/kg in one surface soil sample. CS6G-22, located inside the pit, noted a concentration of 50.9 µg/kg.

4.3.2.8 Bis(2-ethyl hexyl)phthalate

Bis(2-ethyl hexyl)phthalate was detected above the two times background concentrations of 6.208 µg/kg in one surface soil sample. CS6G-07, located outside the pit, noted a concentration of 78.1 µg/kg.

4.3.2.9 Di-n-butyl phthalate

Di-n-butyl phthalate was detected above the two times background concentrations of 9.738 µg/kg in eight surface soil samples. CS6G-11, CS6G-15, CS6G-16, and CS6G-17 located outside the pit, noted concentrations of 17.4 µg/kg, 39.2 µg/kg, 43.0 µg/kg, and 24.7 µg/kg, respectively. CS6G-06, CS6G-12, CS6G-13, and CS6G-22, located inside the pit, noted concentrations of 23.2 µg/kg, 15.2 µg/kg, 17 µg/kg, and 54 µg/kg, respectively.

4.3.2.10 Dibenzo furan

Dibenzo furan was detected above the two times background concentrations of 1.47 µg/kg in two surface soil samples. CS6G-03,and CS6G-15, located outside the pit, noted concentrations of 3.72 µg/kg and 9.63 µg/kg, respectively.

4.3.2.11 Diethyl phthalate

Diethyl phthalate was detected above the two times background concentrations of 1.122 µg/kg in three surface soil samples. CS6G-02, CS6G-03, and CS6G-15, located outside the pit, noted concentrations of 5.49 µg/kg, 22.7 µg/kg, and 8.56 µg/kg, respectively.

4.3.2.12 Fluoranthene

Fluoranthene was detected above the two times background concentrations of 3.1258 µg/kg in seven surface soil samples. CS6G-03, CS6G-11, and CS6G-15, located outside the pit, noted concentrations of 4.83 µg/kg, 24.7 µg/kg, and 22.5 µg/kg, respectively. CS6G-09, CS6G-12, CS6G-14, and CS6G-22, located inside the pit, noted concentrations of 6.17 µg/kg, 11.6 µg/kg, 28 µg/kg, and 8.3 µg/kg, respectively.

4.3.2.13 Fluorene

Fluorene was detected above the two times background concentrations of 1.396 µg/kg in one surface soil sample. CS6G-15, located outside the pit, noted a concentration of 4.28 µg/kg.

4.3.2.14 Hexachlorobenzene

Hexachlorobenzene was detected above the two times background concentrations of 0.9092 µg/kg in one surface soil sample. CS6G-15, located outside the pit, noted a concentration of 12.1 µg/kg.

4.3.2.15 Ideno(1,2,3-c,d) pyrene

Ideno(1,2,3-c,d) pyrene was detected above the two times background concentrations of 0.9092 µg/kg in one surface soil sample. CS6G-04, located outside the pit, noted a concentration of 8.84 µg/kg.

4.3.2.16 N-Nitrosodiphenylamine

N-Nitrosodiphenylamine was detected above the two times background concentrations of 1.046 µg/kg in one surface soil sample. CS6G-15, located outside the pit, noted a concentration of 4.64 µg/kg.

4.3.2.17 Pyrene

Pyrene was detected above the two times background concentrations of 17.83 µg/kg in three surface soil samples. CS6G-11, and CS6G-15, located outside the pit, noted concentrations of 30.8 µg/kg, and 22.5 µg/kg, respectively. CS6G-14, located inside the pit, noted a concentration of 29.1 µg/kg.

4.3.3 Volatile Organics

Acetone, toluene, and xylenes were the most frequently detected volatile organic compounds from inside and outside the BRP6G. Of these three contaminants, acetone occurred in the greatest amount comprising 95 percent of all VOCs detected. Both acetone and toluene are common laboratory artifacts. In addition, toluene is also used as a solvent for paints and coatings. Xylene is used as a solvent; as a constituent of paint, lacquers, varnishes, inks, dyes, adhesives, cements, and cleaning fluids. A summary of the volatile organics which exceeded two times average background screening concentration are listed in Table 4-9. Two times average background concentration is calculated for non detections by averaging the detection limit for that analyte.

Within the designated pit area, acetone was detected at eight places in the soil surface samples. Concentrations of acetone ranged from 4.5 µg/kg to 27.4 µg/kg. In the area outside of the designated pit and adjacent to it, acetone was detected in seven of the soil surface samples. Concentrations ranged from 6.49 µg/kg to 58.5 µg/kg. Field screening of the surface soil samples did not detect the presence of volatile contaminants. Maximum concentration of acetone for background samples was 46.3µg/kg.

Xylenes were detected in four surface soil samples within the pit at concentrations ranging from 0.08 µg/kg to 1.24 µg/kg. In the area outside of the designated pit and adjacent to it, xylenes were detected at six soil surface samples. Concentrations ranged from 0.08 µg/kg to 3.97 µg/kg. Maximum concentration of xylenes for background surface soil samples was 0.18 µg/kg.

Toluene was detected at five soil surface samples within the designated pit area. Concentrations of toluene ranged from 0.2 µg/kg to 4.11 µg/kg. Toluene was also detected at four surface samples outside the pit area at concentrations ranging from 0.16 µg/kg to 0.71 µg/kg. Maximum concentration of toluene for background surface soil samples was 0.38 µg/kg.

Benzene was detected at CS6G-12, CS6G-13, and CS6G-14 in the soil surface samples within the pit area. The maximum concentration occurred at CS6G-12 (0.8 µg/kg). Outside of the pit area, benzene was detected at CS6G-15, CS6G-16, and CS6G-17. The maximum concentration occurred at CS6G-17 (1.12 μg/kg). Benzene was not detected in any of the background surface soil samples.

Chloroform was detected at four locations within the designated pit area and three places outside the pit. The maximum concentration of chloroform within the pit occurred at CS6G-14 (1.87 μg/kg). The maximum concentration of chloroform outside the pit occurred at CS6G-17 (1.46 μg/kg). Maximum concentration of chloroform detected in background surface soil samples was 0.19 μg/kg.

Carbon disulfide occurred at one surface soil sample within the pit. The maximum concentration of 0.51 μg/kg occurred at CS6G-13. Carbon disulfide was not detected in any of the background surface soil samples.

1,1,2,2-Tetrachloroethane occurred within the pit at boring CS6G-05 at a concentration of 0.05 μg/kg. 1,1,2,2-Tetrachloroethane was not detected in any of the background surface soil samples.

Methylene chloride occurred within the pit at borings CS6G-06, CS6G-12, and CS6G-22. Maximum concentration occurred at CS6G-22 at 1.45 μg/kg. Methylene chloride was detected at a maximum background concentration of 0.33 μg/kg in the background surface soil samples.

Methyl ethyl ketone was detected in the pit soil surface samples at CS6G-12 and CS6G-14. The maximum concentration occurred at CS6G-12 (0.34 μg/kg). Methyl ethyl ketone was detected at a maximum background concentration of 0.32 μg/kg in the background surface soil samples.

Ethyl benzene was detected in the pit at borings CS6G-01 and CS6G-14. The maximum concentration occurred at CS6G-01 (0.18 μg/kg). In addition, ethyl benzene occurred twice outside the pit at borings CS6G-02 and CS6G-03. Maximum concentration was 0.25 μg/kg and occurred at CS6G-02. Ethyl benzene was detected at a maximum background concentration of 0.055 µg/kg in the surface soil samples.

2-Hexanone was detected in the pit once at boring CS6G-05. The 2-hexanone concentration was 0.38 µg/kg. 2-hexanone was not detected in any of the surface soil background samples.

Tetrachloroethylene was detected in the pit once at boring CS6G-22 with a concentration of 0.15 µg/kg. Tetrachloroethylene was not detected in any of the surface soil background samples.

4.3.4 Pesticides, PCB's, Dioxins and Furans

All detections within the surface soil samples and those that exceeded two times average background for surface soil samples are listed in Table 4.10.

4.3.4.1 Pesticides

Pesticides were detected in the background soil samples and are listed in Table 4.4. Pesticides were detected within the pit soil surface samples. Concentrations above two times background are noted in Table 4.10. At CS6G-22, Dieldrin was detected at a concentration of 4.8 µg/kg. The pesticide p,p'-DDE was detected at borings CS6G-06, CS6G-12, CS6G-13, and CS6G-22 at concentrations ranging from 1.53 to 5.77 µg/kg. The highest concentration occurred at CS6G-12. In addition to these pesticides, p,p'-DDT was detected at boring CS6G-06 at a concentration of 5.5 µg/kg. For the boring located outside of the pit area, Dieldrin was detected at CS6G-17 at a concentration of 1.24 µg/kg. Endosulfan I was detected at CS6G-15 at a concentration 4.69 µg/kg. Borings CS6G-16 and CS6G-17 had detections of p,p'-DDE at concentrations of 1.04 and 1.4 µg/kg, respectively. At boring CS6G-17, p,p'-DDT was detected at 3.08 µg/kg.

All of the aforementioned pesticides were detected in the background surface soil samples. Dieldrin ranged from 1.3 to 2.7 µg/kg. Endosulfan I was detected at only background sampling location CS6G-19 at a concentration of 0.99 µg/kg. Pesticide p,p'-DDE was detected at CS6G-18, CS6G-20, and CS6G-21. The range of concentrations were 1.2 to 1.6 µg/kg. At CS6G-18, p,p'-DDT was detected at a background concentration of 2.6 µg/kg and CS6G-21 had a concentration of 5.7 µg/kg.

4.3.4.2 PCBs

Aroclor, PCB-1254 was detected inside the pit at one boring location CS6G-12. The PCB concentration was 115 µg/kg. PCBs were not detected in any of the background surface soil samples.

4.3.4.3 Dioxins/Furans

Octachlorodibenzo-p-dioxin was detected at concentrations exceeding background inside and outside of the BRP6G. Concentrations ranged from 0.99 µg/kg to 2.64 µg/kg.

4.3.5 Radionuclide Indicators

Radionuclide indicators were examined to determine if gross alpha or nonvolatile beta values were elevated above two times the average surface soil background concentrations. Gross alpha did not exceed two times average background within the pit, however, two times average background was exceeded at soil boring CS6G-11 at a concentration of 21.9 pCi/g. Nonvolatile beta did not exceed two times average background within the pit area. However, two times average background was exceeded at boring locations CS6G-11 and CS6G-16 with concentrations of 15.8 pCi/g and 715 pCi/g respectively All detections within the surface soil samples and those that exceeded two times average background for surface soil samples are published in Table 4.11.

4.3.6 Surface Soil Summary

Several metals were detected within and outside of the BRP6G. The number of detects for metals were much greater towards the central to eastern portion of the pit for samples taken in and out of the pit. Boring location CS6G-01 had the highest number of recorded detects. Iron had the most detects both inside and outside of the pit. At least 28 metals had concentrations above detection levels. All metals that exceeded two times the average background for surface samples are summarized in Table 4.7.

The greatest concentration of semi-volatiles occurred at sampling location CS6G-15 which is adjacent to and slightly outside of the pit at the southeastern end. Several semi-volatile organics exceeded two times the average surficial soil background with the largest number occurring outside of the pit. All semi-volatiles exceeding two times the average surface soil background for surface soil samples are summarized in Table 4.8.

The greatest number of volatile organic compounds occurred within the pit with the largest number occurring at sample location CS6G-12. CS6G-12 is located toward the southeastern edge of the pit. Chloroform exceeded two times the average surface soil background more than any other detected volatile and was detected both inside and outside of the pit. Benzene had the next largest number of detects and also occurred inside and outside of the pit. Other volatiles were detected but less frequently. Table 4.9 summarizes all volatiles which exceeded two times the average surface soil samples background.

The pesticide p,p'-DDE was the most detected both within and outside the BRP6G. Dieldrin and p,p'-DDT were both detected twice and Endosulfan I once. PCB 1254 was detected only once in soil boring location CS6G-12. The concentration of 115 mg/kg exceeded two time the average surface soil background. Octachlorodibenzo-p-dioxin was detected at three locations outside of the pit and one inside the pit. All of these samples exceeded two times the average background for surface soil samples and are summarized in Table 4.10.

4.4 Subsurface Soils (Contaminant Source Identification)

Subsurface soil samples were collected from locations CS6G-01 through CS6G-22. CS6G-10, CS6G-18 through CS6G-21 are locations from which background samples were taken for determination of background. Table 4.12 presents a summary of the contaminants detected in the soils, noting two times average background concentration, frequency of detection above two times average background, range of concentrations and the range of depths encountered. A table listing all of the soil detects is located in Appendix G.

4.4.1 Background

The subsurface soil samples will be compared to the background concentrations depicted in Table 4.12.

4.4.2 Metals/ Target Analyte List (in subsurface soils)

The total number of samples per analyte may differ from other analytes due to the nature of the sampling approved in the Work Plan. For instance, the deeper samples acquired in CS6G-19, -20, and -21 were analyzed for RCRA metals versus the shallower intervals having TCL/TAL w/TIC analysis performed. Therefore the number of analyses for different analytes is not the same.

4.4.2.1 Aluminum

Aluminum was detected in 56 of 74 samples. In 18 samples the concentration for two times the average background of 10,282 mg/kg was exceeded. The maximum value detected was 31,900 mg/kg, in CS6G 1204 (4-6). Eleven of the eighteen samples which exceeded 10,282 mg/kg, were from borings located in the pit. The concentrations of those soil samples range from 12,100 to

31,900 mg/kg, and from depths of from 0.0 to 10 feet. The seven samples from borings located outside the pit have concentrations ranging from 12,100 to 17,700 mg/kg, and from depths ranging from 0.0 to 7 feet. Even though physically located outside the pit, these four samples are from borings located within 50 feet of the pit outline.

4.4.2.2 Antimony

Antimony was detected in 16 of 74 samples. The concentration for two times the average background of 3.12 mg/kg was exceeded in 13 samples. Six of the 13 samples which exceeded the 3.12 mg/kg, were from borings located in the pit. The concentrations of those soil samples range from 3.25 to 40.1 mg/kg, and from depths of from 0.0 to 12.7 feet. The seven samples from borings located outside the pit have concentrations ranging from 3.35 to 3.79 mg/kg, and from depths ranging from 0.0 to 9 feet. Even though physically located outside the pit, these five samples are from borings located within 50 feet of the pit outline. Two cross-sections and three isoconcentration maps have been constructed depicting the lateral and vertical extent of the antimony contamination, see Figures 4-1 through 4-5.

4.4.2.3 Arsenic

Arsenic was detected in 31 of 79 samples. The concentration for two times the average background of 5.436 mg/kg was exceeded in 18 samples. Eight of the 18 samples which exceeded the 5.436 mg/kg, were from borings located in the pit. The concentrations of those soil samples range from 5.97 to 21.3 mg/kg, and from depths of from 0.0 to 30.7 feet. The ten samples from borings located outside the pit have concentrations ranging from 5.59 to 9.22 mg/kg, and from depths ranging from 3 to 9 feet. Even though physically located outside the pit, these four samples are from borings located within 50 feet of the pit outline. Two cross-sections and four isoconcentration maps have been constructed depicting the lateral and vertical extent of the arsenic contamination, see Figures 4-6 through 4-11.

4.4.2.4 Barium

Barium was detected in all of the 79 samples. The concentration for two times the average background of 13.44 mg/kg was exceeded in 33 of the samples. Twenty-one of the 33 samples which exceeded the 13.44 mg/kg, were from borings located in the pit. The concentrations of those soil samples range from 14.1 to 290 mg/kg, and from depths of from 0.0 to 12.7 feet. The eleven samples from borings located outside the pit have concentrations ranging from 16.8 to 165 mg/kg, and from depths ranging from 0.0 to 7 feet. Even though physically located outside the pit, these two samples are from borings located within 50 feet of the pit outline.

4.4.2.5 Beryllium

Beryllium was detected in 74 of 74 samples. The concentration for two times the average background of 0.1524 mg/kg was exceeded in 18 samples. Eleven of the 18 samples which exceeded the 0.1524 mg/kg, were from borings located in the pit. The concentrations of those soil samples range from 0.159 to 0.366 mg/kg, and from depths of from 0.0 to 7 feet. The seven samples from borings located outside the pit have concentrations ranging from 0.157 to 0.351 mg/kg, and from depths ranging from 0.0 to 8 feet. Even though physically located outside the pit, these two samples are from borings located within 50 feet of the pit outline

4.4.2.6 Cadmium

Cadmium was detected in 9 of 79 samples. The concentration for two times the average background of 0.212 mg/kg was exceeded in 8 samples. Seven of the 8 samples which exceeded the 0.212 mg/kg, were from borings located in the pit. The concentrations of those soil samples range from 0.244 to 2.87 mg/kg, and from depths of from 1.0 to 16.7 feet. The sample from the boring located outside the pit, CS6G 1105 has a concentration of 0.418 mg/kg, and was from the depths of 6 to 8 feet. Even though physically located outside the pit, this sample is from a boring located within 10 feet of the pit outline.

4.4.2.7 Calcium

Calcium was detected in 74 of 74 samples. The concentration for two times the average background of 138.85 mg/kg was exceeded in 51 samples. Twenty-four of the 51 samples which exceeded the 138.85 mg/kg, were from borings located in the pit. The concentrations of those soil samples range from 142 to 19,400 mg/kg, and from depths of from 0.0 to 16.7 feet. The 27 samples from borings located outside the pit have concentrations ranging from 146 to 1020 mg/kg, and from depths ranging from 0.0 to 9 feet. Even though physically located outside the pit, these 27 samples are from borings located within 50 feet of the pit outline.

4.4.2.8 Chromium

Chromium was detected in 79 of 79 samples. The concentration for two times the average background of 21.67 mg/kg was exceeded in 21 samples. Seven of the 21 samples which exceeded the 21.67 mg/kg, were from borings located in the pit. The concentrations of those soil samples range from 22.2 to 45.9 mg/kg, and from depths of from 0.0 to 10.1 feet. The 14 samples from borings located outside the pit have concentrations ranging from 23.9 to 108 mg/kg, and from depths ranging from 0.0 to 8 feet. Even though physically located outside the pit, these 14 samples are from borings located within 50 feet of the pit outline.

4.4.2.9 Cobalt

Cobalt was detected in 71 of 74 samples. The concentration for two times the average background of 0.5127 mg/kg was exceeded in 30 samples. Fifteen of the 30 samples which exceeded the 0.5127 mg/kg were from borings located in the pit. The concentrations of those soil samples range from 0.564 to 6.7 mg/kg, and from depths of from 0.0 to 12.7 feet. The 15 samples from borings located outside the pit have concentrations ranging from 0.514 to 2.62

mg/kg, and from depths ranging from 0.0 to 10 feet. Even though physically located outside the pit, these 15 samples are from borings located within 50 feet of the pit outline.

4.4.2.10 Copper

Copper was detected in 73 of 73 samples. The concentration for two times the average background of 5.58 mg/kg was exceeded in 45 samples. Twenty-eight of the 45 samples which exceeded the 5.58 mg/kg, were from borings located in the pit. The concentrations of those soil samples range from 6.21 to 5230 mg/kg, and from depths of from 0.0 to 12.7 feet. The 17 samples from borings located outside the pit have concentrations ranging from 7.04 to 2560 mg/kg, and from depths ranging from 0.0 to 9 feet. Even though physically located outside the pit, these 17 samples are from borings located within 50 feet of the pit outline.

4.4.2.11 Cyanide

Cyanide was detected in 21 of 74 samples. The concentration for two times the average background of 99.215 µg/kg was exceeded in 15 samples. Ten of the 15 samples which exceeded the 99.215 µg/kg, were from borings located in the pit. The concentrations of those soil samples range from 101 to 703 µg/kg, and are from depths of from 0.0 to 12.7 feet. The five samples from borings located outside the pit have concentrations ranging from 117 to 687 µg/kg, and from depths ranging from 0.0 to 9.5 feet. Even though physically located outside the pit, these five samples are from borings located within 50 feet of the pit outline. Two cross-sections and three isoconcentration maps have been constructed depicting the lateral and vertical extent of the cyanide contamination, see Figures 4-12 through 4-16.

4.4.2.12 Iron

Iron was detected in all of the 74 samples. The concentration for two times the average background of 26,637 mg/kg was exceeded in 13 samples. Five of the 13 samples which exceeded the 26,637 mg/kg were from borings located in the pit. The concentrations of those soil samples range from 34,900 to 59,300 mg/kg, and were from sample depths of from 2 to 10 feet. The samples from the borings located outside the pit had a concentration range of 27,800 to 69,600 mg/kg, and were from a sample depth range of from 2 to 8 feet. Even though physically located outside the pit, these samples are from borings located within 50 feet of the pit outline.

4.4.2.13 Lead

Lead was detected in 78 of 79 samples. The concentration for two times the average background of 12.31 mg/kg was exceeded in 22 samples. Thirteen of the 22 samples which exceeded the 12.31 mg/kg were from borings located in the pit. The concentrations of those soil samples range from 13.2 to 477 mg/kg and are from depths of from 0.0 to 30.7 feet. The nine samples from the boring located outside the pit had a concentration range of 12.8 to 54.5 mg/kg, and were from sample depths of from 0.0 to 9 feet. Even though physically located outside the pit, this samples are from a boring located within 50 feet of the pit outline.

4.4.2.14 Magnesium

Magnesium was detected in all of the 74 samples. The concentration for two times the average background of 109 mg/kg was exceeded in 32 samples. Twenty of the 32 samples which exceeded the 109 mg/kg were from borings located in the pit. The concentrations of those soil samples range from 130 to 2430 mg/kg, and were taken from depths of 0.0 to 12.7 feet. The 12 samples from the borings located outside the pit had a concentration range of 110 to 309 mg/kg, and were from a sample depth range of from 0 to 10 feet. Even though physically located outside the pit, this samples are from borings located within 50 feet of the pit outline.

4.4.2.15 Manganese

Manganese was detected in all of the 74 samples. The concentration for two times the average background of 27.15 mg/kg was exceeded in 28 samples. Twenty of the 28 samples which exceeded the 27.15 mg/kg were from borings located in the pit. The concentrations of those soil samples range from 39.9 to 681 mg/kg, and were taken from depths ranging from 0.0 to 12.7 feet. The eight samples from the borings located outside the pit had a concentration range of from 30.3 to 214 mg/kg, and were taken from sample depths of 0.0 to 6 feet. Even though physically located outside the pit, these samples are from borings located within 50 feet of the pit outline.

4.4.2.16 Mercury

Mercury was detected in 33 of the 74 samples. The concentration for two times the average background of 19.3 µg/kg was exceeded in 32 samples. Twenty-one of the 32 samples which exceeded the 19.3 µg/kg were from borings located in the pit. The concentrations of those soil samples range from 19.5 to 252 µg/kg, and were taken from depths ranging from 0.0 to 30.7 feet. The eleven samples from the borings located outside the pit had a concentration range of from 26.6 to 76.7 µg/kg, and were taken from sample depths of 0.0 to 13 feet. Even though physically located outside the pit, this samples are from borings located within 50 feet of the pit outline. Two cross-sections and four isoconcentration maps have been constructed depicting the lateral and vertical extent of the mercury contamination, see Figures 4-17 through 4-22.

4.4.2.17 Nickel

Nickel was detected in 60 of the 74 samples. The concentration for two times the average background of 1.075 mg/kg was exceeded in 42 samples. Twenty-six of the 42 samples which exceeded the 1.075 mg/kg were from borings located in the pit. The concentrations of those soil samples range from 1.7 to 37.1 mg/kg, and were taken from depths ranging from 0.0 to 12.7 feet.

The 16 samples from the borings located outside the pit had a concentration range of from 1.18 to 350 mg/kg, and were taken from sample depths of 0.0 to 9.5 feet. Even though physically located outside the pit, this samples are from borings located within 50 feet of the pit outline.

4.4.2.18 Potassium

Potassium was detected in 69 of the 74 samples. The concentration for two times the average background of 67.85 mg/kg was exceeded in 41 samples. Twenty-eight of the 41 samples which exceeded the 67.85 mg/kg were from borings located in the pit. The concentrations of those soil samples range from 70.6 to 851 mg/kg, and were taken from depths ranging from 0.0 to 16.7 feet. The 13 samples from the borings located outside the pit had a concentration range of 77.5 to 250 mg/kg, and were taken from a depth range of 0.0 to 10 feet. Even though physically located outside the pit, this sample is from a boring located within 50 feet of the pit outline.

4.4.2.19 Selenium

Selenium was detected in 14 of the 79 samples. The concentration for two times the average background of 4.839 mg/kg was exceeded in 11 samples. All of the 11 samples which exceeded the 4.373 mg/kg were from borings located outside the pit. The concentrations of those soil samples ranged from 4.99 to 14.3 mg/kg, and from the depths ranging from 0.0 to 10 feet. Even though physically located outside the pit, these samples are from borings located within 50 feet of the pit outline.

4.4.2.20 Silver

Silver was detected in 15 of the 79 samples. The concentration for two times the average background of 0.335 mg/kg was exceeded in 13 samples. Eleven of the 13 samples which exceeded the 0.335 mg/kg were from borings located in the pit. The concentrations of those soil samples range from 0.381 to 3.77 mg/kg, and were taken from depths ranging from 0.0 to 30.7

feet. The two samples from the borings located outside the pit, (CS6G 0403, 5 to 7 feet; CS6G 0702, 7.5 to 9.5 feet) had concentrations of 0.42 (0403) to 0.541(0702) mg/kg, Even though physically located outside the pit, these samples are from borings located within 10 to 25 feet of the pit outline.

4.4.2.21 Sodium

Sodium was detected in 16 of the 74 samples. The concentration for two times the average background of 9.04 mg/kg was exceeded in 15 samples. Eleven of the 15 samples which exceeded the 9.04 mg/kg were from borings located in the pit. The concentrations of those soil samples range from 9.4 to 294 mg/kg, and were taken from depths ranging from 0.0 to 16.7 feet. The four samples from the borings located outside the pit had a concentration range of 9.63 to 37.2 mg/kg, and were taken from sample depths of 5.0 to 9.5 feet. Even though physically located outside the pit, these samples are from borings located within 10 to 25 feet of the pit outline.

4.4.2.22 Thallium

Thallium was detected in 9 of the 74 samples. The concentration for two times the average background of 3.70 mg/kg was exceeded in 6 samples. Four of the 6 samples which exceeded the 3.70 mg/kg were from borings located in the pit. The concentrations of thallium in those soil samples range from 3,71 to 18.1 mg/kg respectively, and were taken from depths ranging from 0 to 9.2 feet. The two samples from the borings located outside the pit (CS6G 0201, CS6G 0303) had concentrations of 4.4 (0201) and 4.2 (0303) mg/kg, and were taken from sample depths of 0.0 to 7 feet. Even though physically located outside the pit, these samples are from borings located within 10 to 25 feet of the pit outline.

4.4.2.23 Vanadium

Vanadium was detected in all of the 74 samples. The concentration for two times the average background of 68.475 mg/kg was exceeded in 15 samples. Seven of the 15 samples which exceeded the 68.475 mg/kg were from borings located in the pit. The concentrations in those soil samples range from 69.1 to 150 mg/kg, and were taken from depths ranging from 4 to 10 feet. The samples which exceeded 68.475 mg/kg from the borings located outside the pit had a concentration of range of 74.7 to 161 mg/kg and were taken from sample depths of 1 to 8 feet. Even though physically located outside the pit, these samples are from borings located within 50 feet of the pit outline.

4.4.2.24 Zinc

Zinc was detected in 73 of the 74 samples. The concentration for two times the average background of 2.736 mg/kg was exceeded in 50 samples. Thirty-four of the 50 samples which exceeded the 2.736 mg/kg were from borings located in the pit. The concentrations in those soil samples range from 2.74 to 678 mg/kg, and were taken from depths ranging from 0.0 to 16.7 feet. The sixteen samples which exceeded 68.475 mg/kg from the borings located outside the pit had a concentration range of 2.81 to 270 mg/kg and were taken from sample 0 to 9.2 feet. Even though physically located outside the pit, these samples are from borings located within 50 feet of the pit outline.

4.4.2.25 Summary of Metals in Subsurface Soils

The data indicate that the primary metals of concern (based on frequency detected and concentration detected) are antimony, arsenic, cobalt, copper, cyanide, lead, manganese, mercury and zinc. The maximum depth of metal contamination is approximately 17 feet except in CS6G-10; where in the 28.7 to 30.7 foot interval arsenic, chromium, lead, mercury and silver all exceeded two times average background concentrations. Antimony, arsenic, cyanide, and mercury concentrations have been noted on cross-sections both in the pit and out of the pit, and planar isoconcentration maps, (see Figures 4-1 through 4-22).

Low levels of arsenic were detected in a few of the soil samples collected within the pits. Arsenic can be found in coal and petroleum products. Arsenic was also a common ingredient in pesticides used in the early 1900's. The BRP6G was a farm before the SRS was created in 1951. Thus, it is possible that the low levels of arsenic detected in the borings are simply pesticide residues.

Copper appears to be a common contaminant at the Unit. Copper cables and wires potentially buried at this Unit may be the source of the copper contamination detected in the soils.

Lead was detected in 23% of the samples collected from the Unit. Lead is found in low levels throughout the environment. Two major sources of lead are automobile exhaust and lead based paints. Paints and painted waste materials disposed in the BRP6G may be a source of the lead contamination detected at the Unit.

Nickel is found in fuel oil and coal. The contamination present at the Unit could be attributed to shop wastes disposed of at the Unit. Nickel is also an important constituent in stainless steel, ranging from 1.25 to 22%. Chromium comprises 11.5 to 26% of most common stainless steel. The nickel and chromium contamination could also be caused by metal filings and turnings; elemental metals are not readily bioavailable.

Copper, chromium, and arsenic are also major constituents in wood preservatives. The scrap wood burned in the burning area may have been contaminated with wood preservatives and thus contributed to the metals contamination detected in the soils.

4.4.3 Base/Neutral and Acid Extractables, Semi-Volatiles

Semi-volatile organics were detected in soil samples from borings located both in and out of the pit. Table 4.12 lists a summary of all the detections which exceeded two times average background concentrations. A full listing of all the soil detections and their respective concentrations is enclosed in the appendix. A detail of the detections is listed below.

4.4.3.1 2-Methylnapthalene

2-Methylnapthalene was detected in 8 of 74 samples. All of the eight samples had concentrations which were above the two times average background level of 1.608 µg/kg. Seven of the samples were from borings located in the pit. The concentrations ranged from 5.74 to 1210 µg/kg and the depths ranged from 0.0 to 14.7 feet. The one sample, (1501) from a boring located outside the pit (CS6G 15) had a concentration of 9.27 µg/kg, and was taken from the depths of from 0.0 to 1 foot. This boring is located within 25 feet of the pit boundary.

4.4.3.2 Acenapthene

Acenapthene was detected in 3 of 74 samples. All of the three samples had concentrations which were above the two times average background level of 1.6991 µg/kg, and all three were from borings located within the pit confines. The samples were CS6G 1404, CS6G 1405 and CS6G 0902. The concentrations and respective depths were 1405; 22 µg/kg from 6 to 8 feet; 0902, 166 µg/kg from 3.6 to 5.6 feet; and 1404; 6830 µg/kg from 4 to 6 feet.

4.4.3.3 Acenapthylene

Acenapthylene was detected in 2 of 74 samples. Both of the samples had concentrations which were above the two times average background level of 0.904 µg/kg, and both were from borings located outside the pit. The samples were CS6G 1104 and CS6G 1501. The concentrations and respective depths were 1104; 5.97 µg/kg from 4 to 6 feet; and 1501; 10.3 µg/kg from 0.0 to 1 foot. These borings are located within 25 feet of the pit boundary.

4.4.3.4 Anthracene

Anthracene was detected in 5 of 74 samples. All of the five samples had concentrations which were above the two times average background level of 0.452 µg/kg. Four of the samples were from borings located in the pit. The concentrations ranged from 12.6 to 17,200 µg/kg and the depths ranged from 3.6 to 9.2 feet. The one sample from a boring located outside the pit (CS6G 1501) had a concentration of 14.6 µg/kg, and was taken from the depths of from 0.0 to 1 foot. This boring is located within 25 feet of the pit boundary.

4.4.3.5 Benzo(a)anthracene

Benzo(a)anthracene was detected in 2 of 74 samples. Both of the samples had concentrations which were above the two times average background level of 1.356 µg/kg. Also, both of the samples were from borings located in the pit. The concentrations ranged from 3140 µg/kg (CS6G 0902, from 3.6 to 5.6 feet) to 74,000 µg/kg (CS6G 1404, from 4 to 6 feet).

4.4.3.6 Benzo(a)pyrene

Benzo(a)pyrene was detected in 5 of 74 samples. All of the five samples had concentrations which were above the two times average background level of 1.138 µg/kg. Also, all of the samples were from borings located in the pit. The concentrations ranged from 9.54 to 85,800 µg/kg and the depths ranged from 0.0 to 9.6 feet.

4.4.3.7 Benzo(b)fluoranthene

Benzo(b)fluoranthene was detected in 8 of 74 samples. All of the eight samples had concentrations which were above the two times average background level of 1.076 µg/kg. Six of the samples were from borings located in the pit. The concentrations ranged from 5.54 to 119,000 µg/kg and the depths ranged from 0.0 to 10 feet. Two samples are from borings located outside the pit (CS6G 0401, and 1501) had concentration of 9.19 and 27.1 µg/kg respectively, and were taken from the depths ranging from 0.0 to 2 feet. These borings are located within 25 feet of the pit boundary.

4.4.3.8 Benzo(g,h,i)perylene

Benzo(g,h,i)perylene was detected in 6 of 74 samples. All of the six samples had concentrations which were above the two times average background level of 0.452 µg/kg. Five of the samples were from borings located in the pit. The concentrations ranged from 9.34 to 30,600 µg/kg and the depths ranged from 3.6 to 9.6 feet. One sample, from a boring located outside the pit (CS6G 0401), had a concentration of 21.9 µg/kg, and was taken from the depths of from 0.0 to 2 feet. This boring is located within ten feet of the pit boundary.

4.4.3.9 Benzo(k)fluoranthene

Benzo(k)fluoranthene was detected in 6 of 74 samples. All of the six samples had concentrations which were above the two times average background level of 1.138 µg/kg. Five of the samples were from borings located in the pit. The concentrations ranged from 4.24 to 41,500 µg/kg and the depths ranged from 0.0 to 9.6 feet. One sample, from a boring located outside the pit (CS6G 1501), had a concentration of 18.5 µg/kg, and was taken from the depths of from 0.0 to 1 foot This boring is located within 25 feet of the pit boundary.

4.4.3.10 Benzoic acid

Benzoic acid was detected in 11 of 74 samples. Ten of the eleven samples had concentrations which were above the two times average background level of 13.17 µg/kg. Six of the samples were from borings located in the pit. The concentrations ranged from 17 to 57.9 µg/kg and the depths ranged from 0.0 to 2 feet. Four samples were from borings located outside the pit. Their concentrations ranged from 22.4 to 50 µg/kg, and were taken from the depths ranging from 1 to 6 feet. These borings are located within 50 feet of the pit boundary.

4.4.3.11 Bis(2-ethylhexyl) phthalate

Bis(2-ethylhexyl) phthalate was detected in 2 of 74 samples. Both of the samples had concentrations which were above the two times average background level of 4.624 µg/kg. One of the samples was from a boring located in the pit. The concentrations was 37.2 µg/kg in CS6G 0903, from 5.6 to 7.6 feet. The other sample was from a boring located outside the pit, CS6G 0701. The concentration was 78.1 µg/kg, and was taken from the depths of from 0.0 to 2 feet. This boring is located within ten feet of the pit boundary.

4.4.3.12 Chrysene

Chrysene was detected in 2 of 74 samples. Both of the samples had concentrations which were above the two times average background level of 0.825 µg/kg. Also, both of the samples were from borings located in the pit. The concentrations ranged from 3990 (CS6G 0902, from 3.6 to 5.6 feet) to 60,200 µg/kg (CS6G 1404, from 4 to 6 feet).

4.4.3.13 Di-n-butyl phthalate

Di-n-butyl phthalate was detected in 36 of 74 samples. None of the 36 samples had a concentration which was above the two times average background level of 49.8 µg/kg.

4.4.3.14 Dibenz(a,h)anthracene

Dibenz(a,h)anthracene was detected in 2 of 74 samples. Both of the samples had concentrations which were above the two times average background level of 0.584 µg/kg. Also, both of the samples were from borings located in the pit. The concentrations ranged from 1090 (CS6G 0902, from 3.6 to 5.6 feet) to 10,400 µg/kg (CS6G 1404, from 4 to 6 feet).

4.4.3.15 Dibenzofuran

Dibenzofuran was detected in 7 of 74 samples. All of the seven samples had concentrations which were above the two times average background level of 1.522 µg/kg. Four of the samples were from borings located in the pit. The concentrations ranged from 7.71 to 3750 µg/kg and the depths ranged from 2 to 8 feet. Three samples were from borings located outside the pit. Their concentrations ranged from 3.72 to 9.63 µg/kg, and were taken from the depths ranging from 0.0 to 6 feet. These borings are located within 25 feet of the pit boundary.

4.4.3.16 Diethyl phthalate

Diethyl phthalate was detected in 18 of 74 samples. Seven of the 18 samples had concentrations which were above the two times average background level of 8.109 µg/kg. Two of the samples were from borings located in the pit. The concentrations ranged from 8.31 (CS6G 1203, from 2 to 4 feet), to 78 µg/kg (CS6G 0602, from 10.7 to 12.7 feet). Five samples were from borings located outside the pit. Their concentrations ranged from 8.18 to 22.7 µg/kg, and were taken from the depths ranging from 0.0 to 6 feet. These borings are located within 25 feet of the pit boundary.

4.4.3.17 Dimethyl phthalate

Dimethyl phthalate was detected in 2 of 74 samples. Both of the two samples had concentrations which were above the two times average background level of 0.583 µg/kg. One of the samples was from a boring located in the pit. The concentration of that sample was 8.56 µg/kg (CS6G 1501, from 0.0 to 1 foot). One of the samples was from a boring located outside the pit. The concentration of that sample was 8.58 µg/kg (CS6G 1104, from 4 to 6 feet). This boring is located within ten feet of the pit boundary.

4.4.3.18 Fluoranthene

Fluoranthene was detected in 22 of 74 samples. All of the 22 samples had concentrations which were above the two times average background level of 1.125 µg/kg. Fifteen of the samples were from borings located in the pit. The concentrations ranged from 4.27 to 108,000 µg/kg. The depths of the samples ranged from 0.0 to 14.7 feet. Seven samples were from borings located outside the pit. Their concentrations ranged from 4.7 to 24.7 µg/kg, and were taken from the depths ranging from 0.0 to 7 feet. These borings are located within 25 feet of the pit boundary. Two cross-sections and three planar isoconcentration maps have been constructed depicting fluoranthene concentrations, see Figures 4-23 through 4-27.

4.4.3.19 Fluorene

Fluorene was detected in 5 of 74 samples. All of the five samples had concentrations which were above the two times average background level of 1.453 µg/kg. Four of the samples were from borings located in the pit. The concentrations ranged from 9.79 to 8,080 µg/kg. The depths of the samples ranged from 4 to 14.7 feet. One sample was from a boring located outside the pit, CS6G 1501. The concentrations was 4.28 µg/kg, and was taken from the depths ranging from 0.0 to 1 feet. This boring is located within 25 feet of the pit boundary.

4.4.3.20 Hexachlorobenzene

Hexachlorobenzene was detected in 2 of 81 samples. Both of the samples had concentrations which were above the two times average background level of 0.94 µg/kg. Also, both samples were from borings located outside the pit. Their concentrations ranged from 10.4 (CS6G 1104 from 4 to 6 feet), to 12.1 µg/kg (CS6G 1501 from 0 to 1 foot). These borings are located within 25 feet of the pit boundary.

4.4.3.21 Ideno(1,2,3-c,d)pyrene

Ideno(1,2,3-c,d)pyrene was detected in 6 of 74 samples. All of the six samples had concentrations which were above the two times average background level of 0.94 µg/kg. Four of the samples were from borings located in the pit. The concentrations ranged from 11 to 31,300 µg/kg. The depths of the samples ranged from 4 to 9.6 feet. Two samples were from borings located outside the pit. Their concentrations ranged from 8.84 (CS6G 0401, from 0 to 2 feet) to 9.98 (CS6G 1102, from 1 to 2 feet) µg/kg, These borings are located within ten feet of the pit boundary.

4.4.3.22 N-Nitrodiphenylamine

N-Nitrodiphenylamine was detected in 2 of 74 samples. Both of the samples had concentrations which were above the two times average background level of 1.076 µg/kg. Both samples were from borings located outside the pit. Their concentrations ranged from 4.64 (CS6G 1501, from 0 to 1 foot) to 5.97 (CS6G 1104, from 4 to 6 feet) µg/kg. These borings are located within 25 feet of the pit boundary.

4.4.3.23 Naphthalene

Naphthalene was detected in 3 of 74 samples. All of the samples had concentrations which were above the two times average background level of 1.608 µg/kg. All three of the samples were from borings located inside the pit. Their concentrations ranged from 45.9, (CS6G 1405, from 6 to 8 feet) to 55.8, (CS6G 0502, from 7.2 to 9.2 feet), to 168, (CS6G 0602, from 10.7 to 12.7 feet) µg/kg.

4.4.3.24 Pentachlorophenol

Pentachlorophenol was detected in 1 of the 81 samples. This sample had a concentration of 50.6 µg/kg, which was above the two times average background level of 13.019 µg/kg. The sample, (0703), was from a boring located outside the pit, CS6G-07, and from a depth of 9.5 to 11 feet. This boring is located within ten feet of the pit boundary.

4.4.3.25 Phenanthrene

Phenanthrene was detected in 5 of 74 samples. All of the five samples had concentrations which were above the two times average background level of 0.639 µg/kg. All of the samples were from borings located in the pit. The concentrations ranged from 53.3 to 59,100 µg/kg. The depths of the samples ranged from 4 to 14.7 feet.

4.4.3.26 Phenanthrenecarboxylic acid

Phenanthrenecarboxylic acid was detected in 6 of 6 samples. One of the six samples had concentrations which were above the two times average background level of 600 µg/kg. The one that was above the two times average background was from boring located in the pit. The concentration was 1100 µg/kg, and the depth of the sample was from 0.0 to 1 foot.

4.4.3.27 Pyrene

Pyrene was detected in 30 of 74 samples. Twenty-one of the 30 samples had concentrations which were above the two times average background level of 7.55 µg/kg. Sixteen of the samples were from borings located in the pit. The concentrations ranged from 7.71 to 83,700 µg/kg. The depths of the samples ranged from 0.0 to 14.7 feet. Five samples were from borings located outside the pit. Their concentrations ranged from 8.78 to 50.2 µg/kg. The depths of the samples ranged from 0.0 to 10 feet. These borings are located within 25 feet of the pit boundary. Two cross-sections and three planar isoconcentration maps have been constructed depicting the concentrations of this contaminant in the borings, (see Figure 4-28 through 4-32).

4.4.3.28 4-Chloro-m-cresol

4-Chloro-m-cresol was detected in 2 of 74 samples. Both of the samples had concentrations which were above the two times average background level of 1.331 µg/kg. Also, both of the samples were from a boring located outside the pit. The concentrations ranged from 5.31 (CS6G 0701, from 0 to 2 feet) to 70.8 (CS6G 0703, from 9.5 to 11 feet) µg/kg. This boring is located within ten feet of the pit boundary.

4.4.3.29 4-Chlorophenyl phenyl ether

4-Chlorophenyl phenyl ether was detected in 2 of 74 samples. Both of the samples had concentrations which were above the two times average background level of 1.197 µg/kg. Also, both of the samples were from borings located outside the pit. The concentrations ranged from 7.49 (CS6G 1501, from 0 to 1 foot) to 7.84 (CS6G 1104, from 4 to 6 feet) µg/kg. These borings are located within 25 feet of the pit boundary.

4.4.3.30 1,4-Dichlorobenzene, 2,4-Dinitrotoluene, 2-Chlorophenol

1,4-Dichlorobenzene, 2,4-Dinitrotoluene, 2-Chlorophenol were each detected in 1 of 81, 81, and 74 samples, respectively. Each of the samples had concentrations which were above their respective two times average background levels of 5.852 µg/kg, 0.639 µg/kg, and 2.8 µg/kg. Each of the samples were also from a boring located outside the pit. The concentrations ranged from 34 µg/kg (CS6G 1103, from 2 to 4 feet) for 1,4-Dichlorobenzene; to 28.9 µg/kg (CS6G 0703, from 9.5 to 11 feet) for 2,4-Dinitrotoluene; to 19 µg/kg (CS6G 0703, from 9.5 to 11 feet) for 2-Chlorophenol. Both of these borings are located within 25 feet of the pit boundary.

4.4.3.31 Summary of Semi-Volatiles

Semi-volatile organic compounds are found in wood preservatives commonly called "creosote." Because of their relative thermal stability, PAHs may have been concentrated in the ash from waste wood, particularly telephone poles and railroad ties.

Asphalt rubble may also be a source of semi-volatiles, including poly-aromatic hydrocarbons. The black, highly viscous binder commonly known as "asphalt" contains organic compounds ranging in molecular weight from 300 to 5000. Although natural asphalt deposits occur in many parts of the world, most of the asphalt used in the United States is produced as a residue of petroleum refining. Asphalts have found many applications because of their adhesive qualities, high viscosity, and relative chemical inertness. Aromatic hydrocarbons, consisting primarily of benzene and naphthalene structures, constitute about 50% of the lower molecular weight (300-1500) fractions of asphalt. Small amounts (about 5%) of this fraction have three or more fused aromatic rings (anthracene and phenanthrene structures). Cross-sections and planar isoconcentration maps depicting fluoranthene and pyrene concentrations have been constructed, (see Figures 4-23 and 4-32).

4.4.4 Volatile Organics

Volatile organic compounds were detected in soil samples collected from borings located both in the pit and out of the pit at the BRP6G. A summary of the detections above two times the average background concentrations can be found in Table 4.12.

4.4.4.1 Acetone

Acetone was detected in 63 of 74 samples. Ten of the 63 samples noted concentrations which were above the two times average background level of 28.869 µg/kg. Six of the samples which were greater than two times background were from borings located in the pit. The concentrations ranged from 36.5 to 788 µg/kg. The depths of the samples ranged from 1 to 10 feet. Four samples above two times background were from borings located outside the pit. Their concentrations ranged from 29.7 to 62.5 µg/kg. The depths of the samples ranged from 0.0 to 6 feet. These borings are located within 50 feet of the pit boundary.

4.4.4.2 Carbon disulfide

Carbon disulfide was detected in 17 of 74 samples. Three of the 17 samples noted concentrations which were above the two times average background level of 1.049 µg/kg. One of the samples which was greater than two times background was from a boring located in the pit. The concentration was 6.89 µg/kg (CS6G 0104, from 7 to 9 feet). Two samples above two times background were from a boring located outside the pit. Their concentrations ranged from 1.06 (0203) to 2.67 (0204) µg/kg. The depths of the samples ranged from 5 to 9 feet. This boring is located within ten feet of the pit boundary.

4.4.4.3 Chloroform

Chloroform was detected in 38 of 86 samples. Twenty of the 38 samples noted concentrations which were above the two times average background level of 0.856 µg/kg. Thirteen of the samples which were greater than two times background were from borings located in the pit. The concentrations ranged 0.945 to 4.61 µg/kg. The depths of the samples ranged from 0.0 to 15 feet. Seven samples above two times background were from borings located outside the pit. Their concentrations ranged from 1.17 to 3.11 µg/kg. The depths of the samples ranged from 0.0 to 12 feet. These borings are located within 50 feet of the pit boundary. Two cross-sections and three planar isoconcentration maps have been constructed depicting the concentrations of this contaminant in the borings, (see Figure 4-33 through 4-37).

4.4.4.4 Dichloromethane (Methylene chloride)

Dichloromethane (Methylene chloride) was detected in 28 samples. Six of the 28 samples had concentrations which were above the two times average background level of 1.678 µg/kg. All six samples above two times background were from borings located outside the pit. Their concentrations ranged from 1.79 to 3.68 µg/kg. The depths of the samples ranged from 1 to 12 feet. These borings are located within 50 feet of the pit boundary.

4.4.4.5 Ethylbenzene

Ethylbenzene was detected in 21 of 79 samples. Seventeen of the 21 samples had concentrations which were above the two times average background level of 0.069 µg/kg. Five of the samples which were greater than two times background were from borings located in the pit. The concentrations ranged 0.075 to 0.184 µg/kg. The depths of the samples ranged from 0 to 6 feet. Twelve samples above two times background were from borings located outside the pit. Their concentrations ranged from 0.0698 to 0.47 µg/kg. The depths of the samples ranged from 0 to 9 feet. These borings are located within 50 feet of the pit boundary. Two cross-sections and two isoconcentration planar maps noting ethylbenzene concentrations have been constructed, (see Figures 4-38 through 4-41).

4.4.4.6 Methyl ethyl ketone

Methyl ethyl ketone was detected in 16 of 81 samples. Eight of the 16 samples had concentrations which were above the two times average background level of 0.346 µg/kg. Three of the samples which were greater than two times background were from borings located in the pit. The concentrations ranged 1.46 to 3.07 µg/kg. The depths of the samples ranged from 2 to 8 feet. Five samples above two times background were from borings located outside the pit. Their concentrations ranged from 0.365 to 1.68 µg/kg. The depths of the samples ranged from 2 to 10 feet. These borings are located within 50 feet of the pit boundary. Two cross-sections and three isoconcentration planar maps noting methyl ethyl ketone concentrations have been constructed, (see Figures 4-42 through 4-46).

4.4.4.7 Methyl isobutyl ketone

Methyl isobutyl ketone was detected in one of 74 samples. This sample (CS6G 0501 from 0 to 2 feet) had a concentration of 0.337 µg/kg , which was above the two times average background level of 0.236 µg/kg. CS6G 0501 was from a boring located in the pit.

4.4.4.8 Tetrachloroethylene

Tetrachloroethylene was detected in 2 of 86 samples. Both of the samples had concentrations which were above the two times average background level of 0.059 µg/kg. Both of the samples which were greater than two times background were from a boring located in the pit. The concentrations ranged 0.0824 µg/kg (CS6G 2202, from 1 to 2 feet), to 0.148 µg/kg (CS6G 2201, from 0 to 1 foot).

4.4.4.9 Toluene

Toluene was detected in 28 of 86 samples. Six of the 28 samples had concentrations which were above the two times average background level of 0.755 µg/kg. Four of the samples which were greater than two times background were from borings located in the pit. The concentrations ranged 2.33 to 4.11 µg/kg. The depths of the samples ranged from 0.0 to 2 feet. Two samples above two times background were from borings located outside the pit. Their concentrations ranged from 0.989 to 1.26 µg/kg. The depths of the samples ranged from 1 to 4 feet. These borings are located within 50 feet of the pit boundary. Two cross-sections and three isoconcentration planar maps noting toluene concentrations have been constructed, (see Figures 4-47 through 4-51).

4.4.4.10 Trichloroethylene

Trichloroethylene was detected in 2 of 86 samples. Both of the samples had concentrations which were above the two times average background level of 0.052 µg/kg. Also, both of the samples which were greater than two times background were from a boring located in the pit. The concentrations ranged 0.2 µg/kg (CS6G 2202, from 1 to 2 feet), to 0.261 µg/kg (CS6G 2201, from 0 to 1 foot).

4.4.4.11 Xylene

Xylene was detected in 45 of 74 samples. Twelve of the 45 samples had concentrations which were above the two times average background level of 0.357 µg/kg. Three of the samples which were greater than two times background were from borings located in the pit. The concentrations ranged 0.459 to 1.24 µg/kg. The depths of the samples ranged from 0.0 to 9 feet. Ten samples above two times background were from borings located outside the pit. Their concentrations ranged from 0.372 to 3.97 µg/kg. The depths of the samples ranged from 0 to 9 feet. These borings are located within 50 feet of the pit boundary. Two cross-sections and three isoconcentration planar maps noting toluene concentrations have been constructed, (see Figures 4-52 through 4-56).

4.4.4.12 Summary of Volatile Organics in Subsurface Soils

Chloroform, ethylbenzene, methyl ethyl ketone, toluene, and xylene were the most frequently detected volatile organic compounds present in the samples collected from the BRP6G. The maximum concentration of these contaminants detected in the subsurface soils exceeded the two times average background concentration. Cross-sections and planar isoconcentration maps noting concentrations found in the subsurface soil borings for the above contaminants have been constructed, (see Figures 4-33 through 4-56).

4.4.5 Pesticides, PCBs, Dioxins and Furans

4.4.5.1 Dieldrin

Dieldrin was detected in 5 of 74 samples. Three of the 5 samples had concentrations which were above the two times average background level of 1.3 µg/kg. Two of the samples which were greater than two times background were from borings located in the pit. The concentrations ranged 1.52 (CS6G 2202, from 1 to 2 feet) to 4.8 (CS6G 2201, from 0.0 to 1 foot) µg/kg. One samples above two times background was from a boring located outside the pit. The concentration of that sample was 2.34 µg/kg. The depths of the samples ranged from 1 to 2 feet. The boring is located within 50 feet of the boundary of the pit.

4.4.5.2 Octachlorodibenzo-p-dioxin

Octachlorodibenzo-p-dioxin was detected in 28 of 83 samples. Thirteen of the 28 samples had concentrations which were above the two times average background level of 1.287 µg/kg. Eight of the samples which were greater than two times background were from borings located in the pit. The concentrations ranged 1.86 to 19.4 µg/kg. The depths of the samples ranged from 0.0 to 8 feet. Five samples above two times background were from borings located outside the pit. The concentrations of those samples ranged from 2.41 to 7.59 µg/kg. The depths of the samples ranged from 0.0 to 4 feet. These borings are located within 50 feet of the boundary of the pit. Two cross-sections of the soil borings and two planar isoconcentration maps noting the octachlorodibenzo-p-dioxin concentrations have been constructed, (see Figures 4-57 and 4-60).

4.4.5.3 p,p'-DDE

The analyte p,p'-DDE was detected in 12 of 74 samples. Ten of the 12 samples had concentrations which were above the two times average background level of 1.211 µg/kg. Seven of the samples which were greater than two times background were from borings located in the pit. The concentrations ranged 1.53 to 9.09 µg/kg. The depths of the samples ranged from 0.0 to 5 feet. Three samples above two times background were from borings located outside the pit. The concentrations of those samples ranged from 1.4 to 2.31 µg/kg. The depths of the samples ranged from 0.0 to 2 feet. These borings are located within 50 feet of the boundary of the pit. Two cross-sections of the soil borings and one planar isoconcentration map noting the p,p'-DDE concentrations have been constructed, (see Figures 4-61 and 4-63).

4.4.5.4 p,p'-DDT

The analyte p,p'-DDT was detected in 2 of 74 samples. Both of the samples had concentrations which were above the two times average background level of 2.759 µg/kg. One of the samples (CS6G 0601 from 0 to 2 feet) which was greater than two times background was from a boring located in the pit. The concentration was 5.5 µg/kg. The one sample above two times background from a boring located outside the pit was CS6G 1701. The concentration of that sample was 3.08 µg/kg and was from the depth of from 0.0 to 1 foot. The boring is located within ten feet of the boundary of the pit.

4.4.5.5 Aroclor, PCB 1254

Aroclor, PCB 1254 was detected in 2 of 74 samples. Both of the samples had concentrations which were above the two times average background level of 22.7 µg/kg. One of the samples (CS6G 1201 from 0 to 1 foot) which was greater than two times background was from a boring located in the pit. The concentration was 115 µg/kg. The one sample above two times background from a boring located outside the pit was CS6G 1102. The concentration of that sample was 25.9 µg/kg and was from the depth of from 1 to 2 feet. The boring is located within ten feet of the boundary of the pit.

4.4.5.6 Methoxychlor

Methoxychlor was detected in 2 of 81 samples. One of the samples had a concentration which was above the two times average background level of 9.49 µg/kg. This sample (CS6G 1603 from 2 to 4 feet) was from a boring located outside the pit. The concentration was 10 µg/kg. The boring is located within 50 feet of the boundary of the pit.

4.4.5.7 Endosulfan I, Endrin, and PCB 1260

Endosulfan I, Endrin, and PCB 1260 were each only detected once. Endosulfan I was detected above the two times average background concentration of 0.987 µg/kg in CS6G 1501 from a depth of 0 to 1 foot. The concentration recorded was 4.69 µg/kg. Endrin was detected above the two times average background concentration of 0.945 µg/kg in CS6G 2202 from a depth of 1 to 2 feet. The concentration recorded was 3.15 µg/kg. PCB 1260 was detected above the two times average background concentration of 22.7 µg/kg in CS6G 1102 from a depth of 1 to 2 feet. The concentration recorded was 31.2 µg/kg. CS6G-11 and CS6G-15 are borings located outside the confines of the pit. They are, however, within 25 feet of the boundary of the pit.

4.4.5.8 Summary of Pesticides, PCB's, Dioxins and Furans

Octachlorodibenzo-p-dioxin was detected above two times average background concentrations in thirteen samples in depths from 0.0 to 8 feet. Octachlorodibenzo-p-dioxin concentrations have been depicted on cross-sections of borings located both inside and outside the pit, and planar isoconcentration maps (see Figures 4-57 and 4-60).

Both p-p' DDE and p-p' DDT noted concentrations which exceeded their respective two times average background concentrations. p-p' DDE exceeded two times average background ten times in the depth range of 0.0 to 5 feet; and p-p' DDT exceeded two times average background twice with a depth range of 0.0 to 2 feet. This is a relatively shallow depth range, which stands to reason since DDT was used as an agricultural pesticide in the United States until it was banned in 1972. DDD was a contaminant in DDT and was also used as a pesticide itself. DDE is a degradation product of DDT. It is likely that the low levels of DDT and DDE, compounds detected in the soil samples from the BRP6G, are a residual from past pesticide uses. Concentrations for p,p'-DDE have been depicted on cross-sections of borings located both inside and outside the pit, and a planar isoconcentration map (see Figures 4-57 and 4-60).

4.4.6 Radionuclide Indicators

Radionuclide indicators were used to screen all soil samples for the presence of radioactivity. Values for gross alpha did not have a concentration for which an exceedance of two times the average background value of 30.566 pCi/g was found. The highest value noted was 29.4 pCi/g from CS6G 1104 from the depth of 4 to 6 feet.

The only sample which noted an elevated nonvolatile beta concentration, above two times average background of 17.874 pCi/g, was CS6G 1601 with 715 pCi/g from the 0 to 1 foot level. CS6G-16 is located outside the boundary of the pit. CS6G-16 is approximately 50 from the boundary of the pit.

4.4.7 Subsurface Soil Summary

The primary contaminants of interest in the subsurface soils are listed below. These contaminants were selected based on their frequency of detection and their respective concentrations. For a listing of all the contaminants, see Table 4.7.

- Metals (antimony, arsenic, chromium, cobalt, cyanide, mercury, nickel and zinc)
- Semi-volatiles; fluoranthene and pyrene
- Volatile Organics (acetone, chloroform, ethylbenzene, methyl ethyl ketone, toluene and xylenes)
- Octachlorodibenzo-p-dioxin, DDE

Cross-sections and planar maps depicting the concentrations of antimony, arsenic, cyanide, mercury, fluoranthene, pyrene, chloroform ethylbenzene, methyl ethyl ketone, toluene xylene, octachlorodibenzo-p-dioxin, and p,p'-DDE have been prepared, (see Figures 4-1 through 4-63). The cross-sections are divided by borings which were drilled in the area of the pit and those which were drilled in the area outside the confines of the pit boundary. The furthest away from the pit boundary, other than background sampling, that a boring was performed was approximately 50 feet. An analyte having a very large concentration, or having a large frequency of occurrence above two times average background, was chosen for these cross-sections. The same analyte is depicted in a planar fashion on map divided as to depth. The first map was constructed from data collected from 0-5 feet. The second map was constructed from data collected from 5-10 feet, except for p,p'-DDE, which went to twelve feet for the last control point. The third map was constructed from data collected from 10-20 feet. And the deepest map was constructed from data collected from deeper than 20 feet. In some cases data did not exist deeper than a particular depth and therefore, no maps were made.

4.5 Sediment and Surface Water

Sediment and/or surface water samples were collected from eight locations (CS6G-23 through CS6G-25, and CS6G-29 through CS6G-33). Sampling locations CS6G-23 through CS6G-25 were located in the drainage ditch situated between the railroad tracks and the embankment and south from the pit. Only sediment samples were taken at these locations as surface water was nonexistent. Sampling locations CS6G-29 through CS6G-33 were located along a drainage ditch located approximately 61 m (200 ft) southeast of the pit. Both surface water and sediment samples were collected at these five sampling locations.

4.5.1 Background

Sediment contaminant concentrations will be compared to two times the average background samples that were collected at sampling locations designated in Section 4.5. There are no upgradient surface water sources for background samples.

4.5.2 Metals

The following metals were detected in each of the surface water samples (CS6G-29 to CS6G-33) at the given range of concentration:

Metals	Detected Range (µg/L)
Barium	23.9-34.4
Copper	64.4-249
Iron	211-718
Lead	1.59-5.75
Manganese	24.6-40.5
Mercury	0.075-0.219
Sodium	2,000-2,180

Nickel was detected at sampling locations CS6G-30 and CS6G-31 at concentrations of 2.04 µg/L and 2.180 µg/L, respectively.

Copper was detected in all eight sediment samples and exceeded the two times average background concentration of 7.286 mg/kg at all sampling locations. Nickel was detected at four sampling locations (CS6G-23, -24, -25, and -31) in concentrations ranging from 3.01 to 104 mg/kg. The following metals were also detected but with less frequency: barium, cadmium, calcium, chromium, cobalt, lead, magnesium, manganese, potassium, silver, and zinc. Table 4.13 summarizes all metals detected above two times average background, sampling locations where detected, and analyte concentrations.

4.5.3 Semi-Volatile Organics

Di-n-butyl phthalate was detected in surface water samples at CS6G-30 and -31 with concentrations of 0.46 µg/L and 0.55 µg/L, respectively.

Pyrene was detected in the CS6G-32 surface water sample at a concentration of 0.234 µg/L.

A broad range of semi-volatiles were detected in the sediment samples. At sampling location CS6G-24, six semi-volatiles were detected. Sampling location CS6G-33 had a detection of eight semi-volatiles above background. Table 4.13 summarizes all the semi-volatiles that were detected above two times average background, sampling locations where detected, and respective analyte concentrations.

4.5.4 Volatile Organics

Benzyl alcohol was detected in surface water samples at sampling locations CS6G-30 and CS6G-31 at concentrations of 1.52 µg/L and 0.548 µg/L, respectively. Dichloromethane (Methylene chloride) was detected in surface water samples at CS6G-31 through CS6G-33. Concentrations of methylene chloride ranged from 0.37 µg/L to 1.25 µg/L. Tetrachloroethylene was detected in surface water samples at CS6G-29, CS6G-30, and CS6G-33. Toluene was detected at sampling locations CS6G-31 to CS6G-33 with a range from 0.13 µg/L to 0.17 µg/L. Trichloroethylene was detected in the surface water samples at CS6G-30 and CS6G-33 at concentrations of 0.05 µg/L and 0.31 µg/L, respectively.

Chloroform was detected at four sampling locations (CS6G-23, 24, 29, and 31) above the background concentration of 0.062 µg/kg. Methylene chloride was detected above background at sampling locations CS6G-31 and CS6G-33. Tetrachloroethylene and trichloroethylene were detected above background at sampling location CS6G-29. Table 4.13 lists a summary of volatile organics detected above their respective two times background concentration.

4.5.5 Pesticides/PCBs

No pesticides, PCBs, or dioxins/furans were detected in the surface water samples.

Octachlorodibenzo-p-dioxin isomers were detected above background concentrations in the sediment samples collected from CS6G-24.

4.5.6 Radionuclides/Radionuclide Indicators

The surface water samples were analyzed for the following radionuclide indicators: gross alpha, nonvolatile beta, and tritium. Gross alpha concentrations ranged from 0.703 to 7.83 pCi/L; nonvolatile beta concentration ranged from 1.11 to 4.88 pCi/L; and tritium concentrations ranged from 2,160 to 2,420 pCi/L.

The sediment samples were analyzed for gross alpha and nonvolatile beta. Gross alpha exceeded two time the average background concentration of 7.566 pCi/g. Gross alpha was detected in CS6G-24, CS6G-32, and CS6G-33 at concentrations of 11, 8.15, and 7.9 pCi/g, respectively.

4.5.7 Surface Water and Sediment Summary

There are no surface water impoundments in the vicinity of the BRP6G. Any water located in drainage ditches is solely from surface stormwater runoff. Because of dry weather at the time of the field investigation, no background water samples could be taken at sampling locations CS6G-26, CS6G-27, and CS6G-28. Drainage water samples were collected in the downgradient drainage ditch at five sampling locations CS6G-29 through CS6G-33. These samples indicated the presence of metals, semi-volatile organics, volatile organics, and radionuclides.

The sediment samples indicated the presence of various metals, small amounts of volatile organics, semi volatile organics, gross alpha radionuclides, and octachlorodibenzo-p-dioxin. Sediment data greater than two times the average background are summarized in Table 4.13.

The source of surface water in the drainage ditch is not entirely from runoff exiting the BRP6G site. In addition to the BRP6G site contributing to this surface water runoff, there are drainage areas upgradient of the site that contribute to the same drainage ditch. Upgradient surface water runoff originates from a large construction materials lay-down yard and Ford Building area. These two drainage basins are considerably larger than the BRP6G site and contribute a much greater volume of surface runoff water and sediment to the drainage ditch where surface water and sediment samples were taken. Because of the uncertainty of the origin of the analytes detected in the surface water and sediment, this data can not be utilized to effectively characterized the BRP6G site.

4.6 Groundwater

Groundwater samples were collected from the three existing wells (CBR-1D, CBR-2D, and CBR-3D). Data utilized for this report from the existing wells was from the first quarter of 1993 to the first quarter of 1995. Well CBR-1D is upgradient of the BRP6G and is considered the background well. Wells CBR-4, CBR-5, and CBR-6 were installed in December 1994. Two sampling events occurred for these wells. The first sampling event occurred in early December after installation. The second event occurred December 28, 1994. No other data is available for wells CBR-4, CBR-5, and CBR-6. Concentrations of analytes were compared to MCLs where available, and where no MCL exists to 2x average background concentrations. The results are annotated in Table 4-14.

4.6.1 Metals

The following metals, with concentration range, were detected in the groundwater samples:

- Aluminum (55.6 - 41,400 µg/L) in wells CBR-2D, CBR-3D, CBR-4, CBR-5, and CBR-6. Maximum concentration of 41,400 µg/L occurred at well CBR-4.
- Antimony at a concentration of 5.0 µg/L was detect in well CBR-2D. Antimony was not detected in the background well CBR-1D.
- Arsenic at a concentration of 5.1 µg/L was detect in well CBR-4. Arsenic was not detected in the background well CBR-1D.
- Barium (27.7 - 53.1 µg/L) in wells CBR-2D, CBR-3D, CBR-4, CBR-5, and CBR-6.
- Beryllium (0.191 - 0.409 µg/L) in wells CBR-2D, CBR-3D, CBR-4, CBR-5, and CBR-6.
- Cadmium (4.07 µg/L) in well CBR-2D. There were not detects for cadmium in the background well.
- Calcium (363 - 4,090 µg/L) in wells CBR-2D, -03D, -04, -05, and CBR-06.
- Chromium (4.4 - 67 µg/L) in wells CBR-3D and CBR-4. There were no detects for Chromium in the background well.
- Cobalt (1.05 - 1.99 µg/L) in wells CBR-2D, CBR-3D, CBR-4, CBR-5 and CBR-6.
- Copper (1.16 - 26.3. µg/L) in wells CBR-2D, CBR-3D, CBR-4, CBR-5, and CBR-6.
- Cyanide (0.81 - 1.26 µg/L) in wells CBR-3D, CBR-4, CBR-5, and CBR-6.
- Iron (74.3 - 94,900 µg/L) in wells CBR-2D, CBR-3D, CBR-4, CBR-5, and CBR-6. Maximum concentration of 94,900 µg/L occurred in well CBR-4.
- Lead (3.24 - 89.1. µg/L) in wells CBR-2D, CBR-3D, CBR-4, CBR-5, and CBR-6.

- Magnesium (771 - 1,280 µg/L) in wells CBR-2D, CBR-3D, CBR-4, CBR-5, and CBR-6.
- Manganese (2.6 - 297 µg/L) in wells CBR-2D, CBR-3D, CBR-4, CBR-5, and CBR-6.
- Mercury (0.181 µg/L) occurred in well CBR-5.
- Nickel (2.64 - 3.06 µg/L)in wells CBR-4 and CBR-3D, respectively.
- Potassium (540 - 1190 µg/L) at wells CBR-2D, CBR-3D, CBR-4, CBR-5, and CBR-6.
- Sodium (2300 - 6610 µg/L) at wells CBR-2D, CBR-3D, CBR-4, CBR-5, and CBR-6.
- Vanadium (0.402 - 224 µg/L) at wells CBR-2D, CBR-3D, CBR-4, CBR-5, and CBR-6.
- Zinc(5.9 - 51.2 µg/L) at wells CBR-2D, CBR-3D, CBR-4, CBR-5, and CBR-6.

4.6.2 Semivolatile Organics or Base/Neutral and Acid Extractables (BNAs)

The only semi-volatile organic detected in background well CBR-1D was Pyrene at a concentration of 0.20 µg/L.

1,2,4-Trichlorobenzene was only detected in well CBR-4 at a concentration of 0.12 µg/L.

Bis(2-ethylhexyl) phthalate was detected in wells CBR-2D, (0.58 µg/L), CBR-4 (6.11 µg/L), and CBR-6 (3.87) µg/L.

Butylbenzyl phthalate was detected at a small concentration of 0.33 µg/L in well CBR-2D.

Di-n-butyl phthalate was detected in small quantities in CBR-5 (0.891) and CBR-6 (0.598) µg/L.

Diethyl phthalate was detected in small quantities in CBR-5 (0.228) and CBR-6 (0.176) µg/L.

Fluorene was detected in well CBR-2D at 0.91 µg/L.

Pyrene was detected in small quantities in wells CBR-2D, CBR-4, and CBR-6. The largest concentration occurred in well CBR-2D at a concentration of 0.29 µg/L.

4.6.3 Volatile Organics

The following volatile organics were detected in background well CBR-1D:

- Chloroform at (0.36 µg/L)
- Methylene Chloride at (1.2 µg/L)
- Toluene at (0.18 µg/L)

2-Methyl-4,6-dinitrophenol was detected in well CBR-2D at a concentration of 1.34 µg/L.

Acetone was only detected in well CBR-2D at a concentration of 4.05 µg/L.

Benzene was detected in well CBR-4 at a small concentration of 0.07 µg/L.

Bromodichloromethane was detected in wells CBR-4 and CBR-5 at concentrations of 0.3 µg/L and 0.2 µg/L respectively.

Carbon Disulfide was detected in wells CBR-4, CBR-5, and CBR-6. Concentrations ranged from 2.8 to 11.8 µg/L with the largest concentration occurring at well CBR-6.

Chloroform occurred in all wells except CBR-6. Concentrations ranged from 0.34 to 1.15 µg/L with the largest concentration occurring at CBR-5.

Dibromochloromethane occurred in wells CBR-4 and CBR-5. Concentrations were 0.18 µg/L and 0.16 µg/L respectively.

Ethylbenzene only occurred in wells CBR-3D at a concentration of 0.082 µg/L.

Methyl Chloride occurred in wells CBR-2D, and CBR-3D. Concentrations were 0.41, 5.31 µg/L, respectively

Methylene Chloride occurred in wells CBR-3D, CBR-5, and CBR-6. Concentrations were 0.36, 0.39 , 0.36 µg/L, respectively

Toluene was found in all wells in small concentrations. CBR-2D (0.17), CBR-3D (0.16), CBR-4 (0.2), CBR-5 (0.12), and CBR-6 (0.12) µg/L.

Trichloroethylene was found in well CBR-5 at a small concentration of 0.06 µg/L.

4.6.4 Pesticides and PCBs

Pesticides and PCBs were not detected in any wells nor in any background sample.

4.6.5 Radionuclides and Radionuclide Indicators

Gross alpha was detected in background well CBR-1D at a concentration of 0.962 pCi/L. Well CBR-2D exhibited a concentration of 1.00 pCi/L, CBR-3D had a concentration of 0.892 pCi/L.

Nonvolatile beta was detected in wells CBR-2D and CBR-3D. Their concentrations were 2.60 pCi/L and 1.83 pCi/L, respectively. Nonvolatile beta was not detected in wells CBR-4, CBR-5, and CBR-6.

Radium (Total alpha emitting) was detected in the background well CBR-1D at a concentration of 0.7 pCi/L. Radium (Total alpha emitting) was detected in wells CBR-2D (1.3) and CBR-3D (1.1) pCi/L.

Tritium was detected in background well CBR-1D at a concentration of 5,230 pCi/L. Wells CBR-2D, CBR-3D, CBR-4, CBR-5, and CBR-6 had detections of Tritium with a range from 1,150 pCi/L to 12,100 pCi/L. The largest concentration of 12,100 pCi/L occurred in CBR-5.

Well CBR-2D had detects of Radium-226 and Radium-228. Their concentrations were 0.23 pCi/L and 4.7 pCi/L, respectively.

4.6.6 Groundwater Summary

Metals were detected in the groundwater monitoring wells. Aluminum, iron, manganese, and vanadium exceeded Secondary Drinking Water Standards. Only lead exceeded its at the tap regulatory limit. Only carbon disulfide in the volatile group exceeded any standard. Its concentration was above EPA Method 8240 with its concentration of 11.8 µg/L; the standard is 10 µg/L. Bis(2-ethylhexyl) phthalate exceeded Primary Drinking Water Standards with it concentration of 6.11 µg/L; the standard is 6.0 µg/L. No pesticides, PCB's, dioxins, or furans were detected. No Radionuclides had concentrations which exceeded any regulatory limits.

4.7 ASCAD Applications

The purpose of the Approved Standardized Corrective Action Design process (ASCAD) at SRS is to focus data collection on generic remedial technologies, eliminate/reduce redundant documentation, obtain/facilitate pre-approved remedial decisions, and standardize remedial designs. The ASCAD approach reduces time and cost for remediating waste units by grouping similar waste units, focusing characterization and technology development on waste unit groups, and providing standardized designs which are modified based on site specific requirements.

ASCAD is an innovative process which will provide a regulatory framework for streamlining the waste unit remediation process. By stimulating technological development and creating a vehicle for the commercialization of pre-approved designs through market share incentives, this process can be applied in the remediation of waste units throughout federal facilities and across the country.

Because this unit is one of the lead sites for Burning/Rubble Pits, the following characterization recommendations are made for secondary units:

(1) For the BRP6G, the analytical data showed that metal, VOC, and Semi-volatile constituents were most frequently detected in both soil and groundwater samples. With similar waste disposal histories, the other burning/rubble pits are likely to follow this scenario with similar constituents and concentrations. At the BRP6G, the constituents were concentrated in samples located at the base of the pit in the soils. In the other burning/rubble pits, the sample collected during characterization can be focused similarly.

(2) Groundwater and surface water analysis for PCB's, pesticides, dioxins, and furans could be, performed on a limited basis, because none of these were detected in samples at BRP6G.

(3) Groundwater analysis for radionuclides should be performed without speciation, unless indicator concentrations warrant.

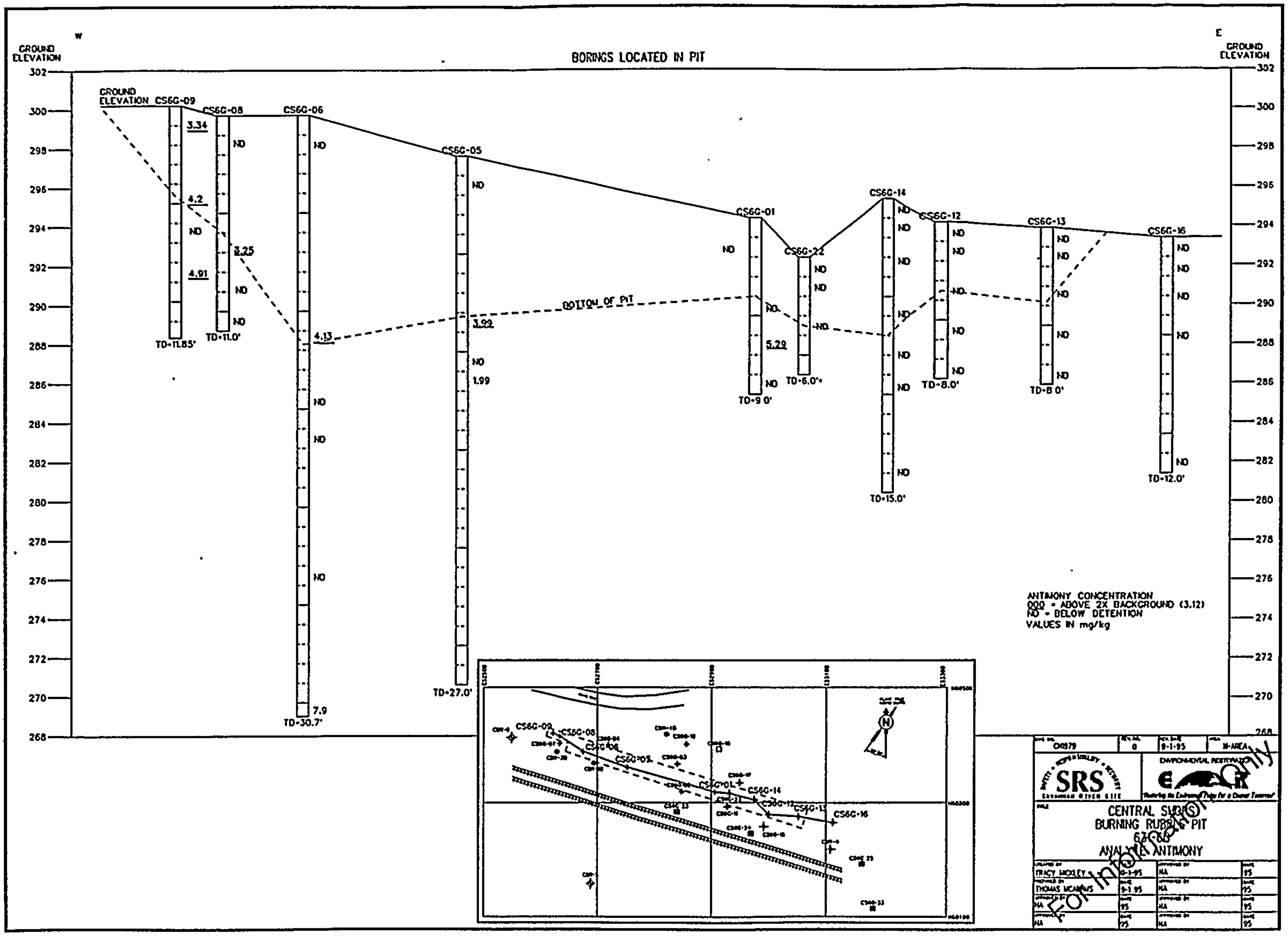

Figure 4-1 West-East Cross-Section Inside Pit Depicting Antimony Concentrations

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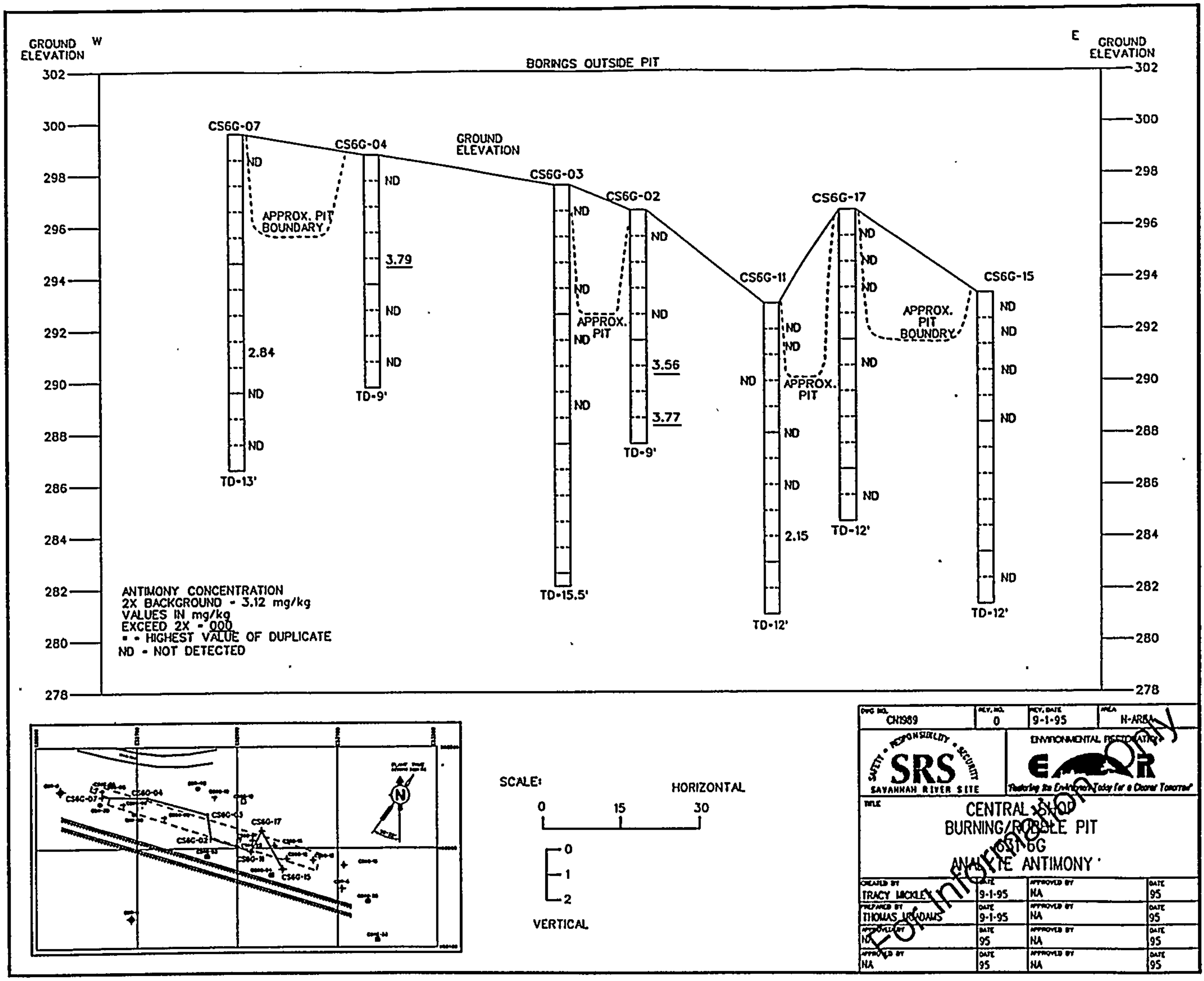

Figure 4-2 West-East Cross-Section Outside Pit Depicting Antimony Concentrations

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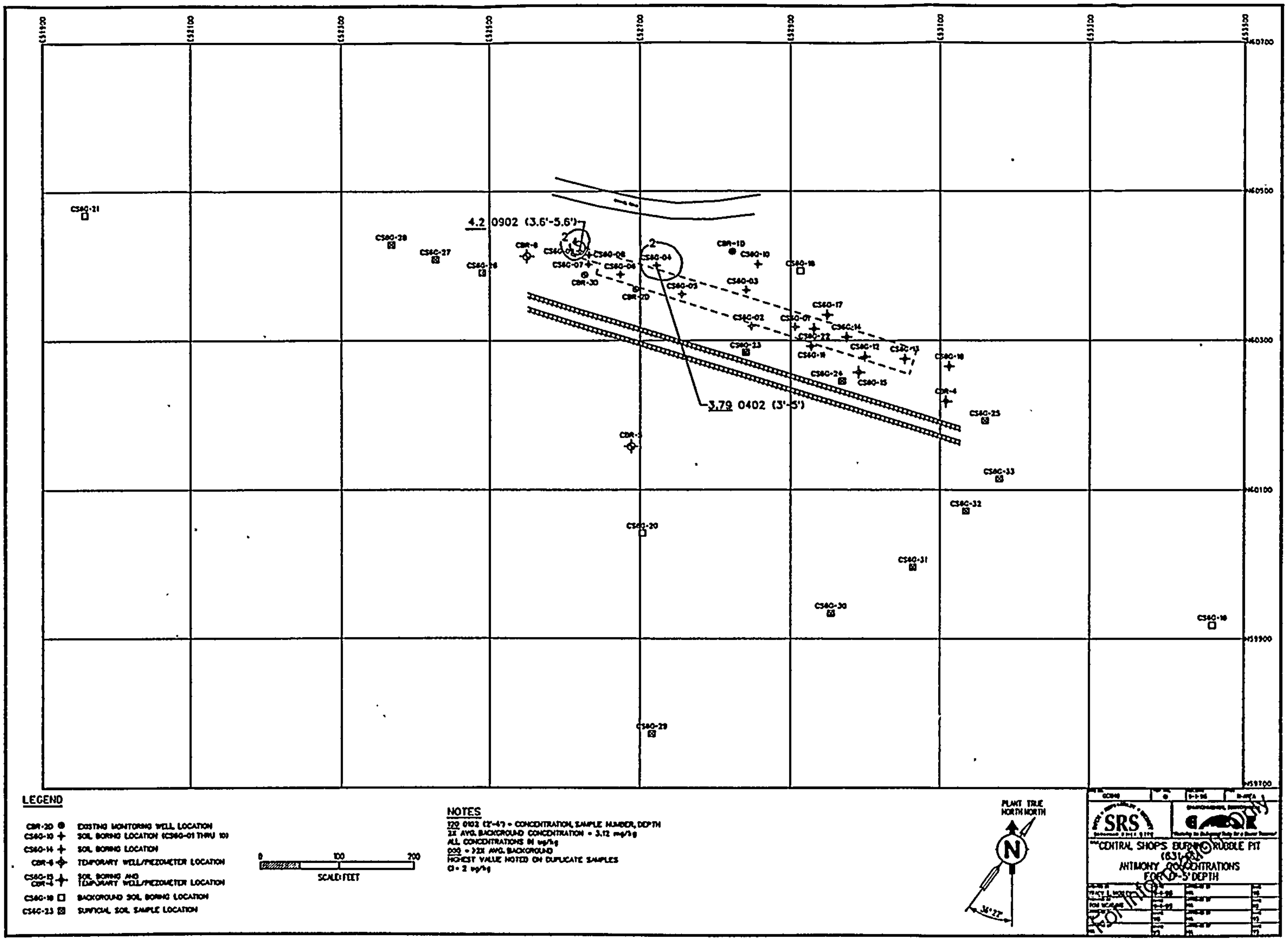

Figure 4-3 Isoconcentration Map of Antimony Depicting Concentrations From 0-5'

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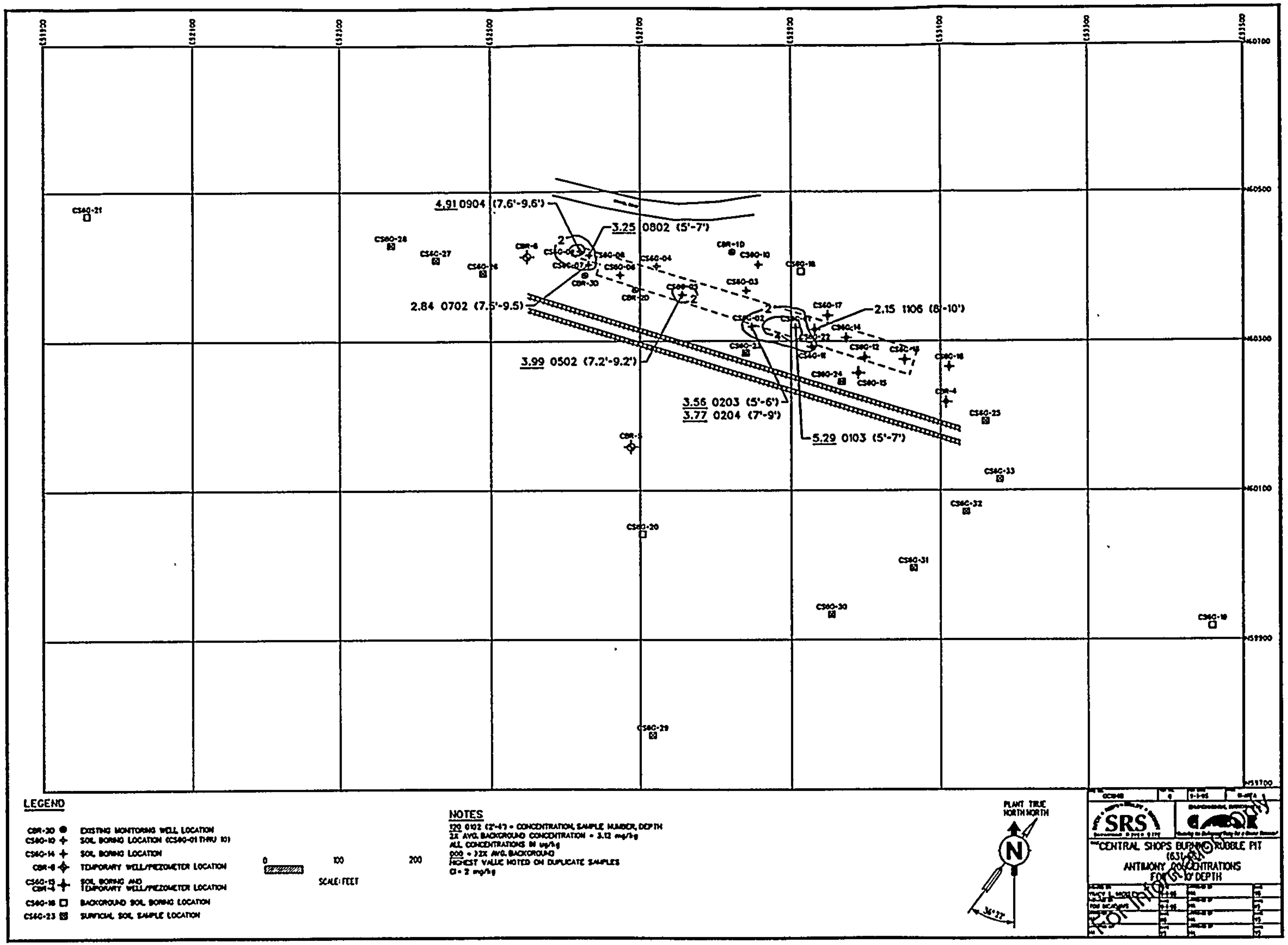

Figure 4-4 Isoconcentration Map of Antimony Depicting Concentrations From 5-10'

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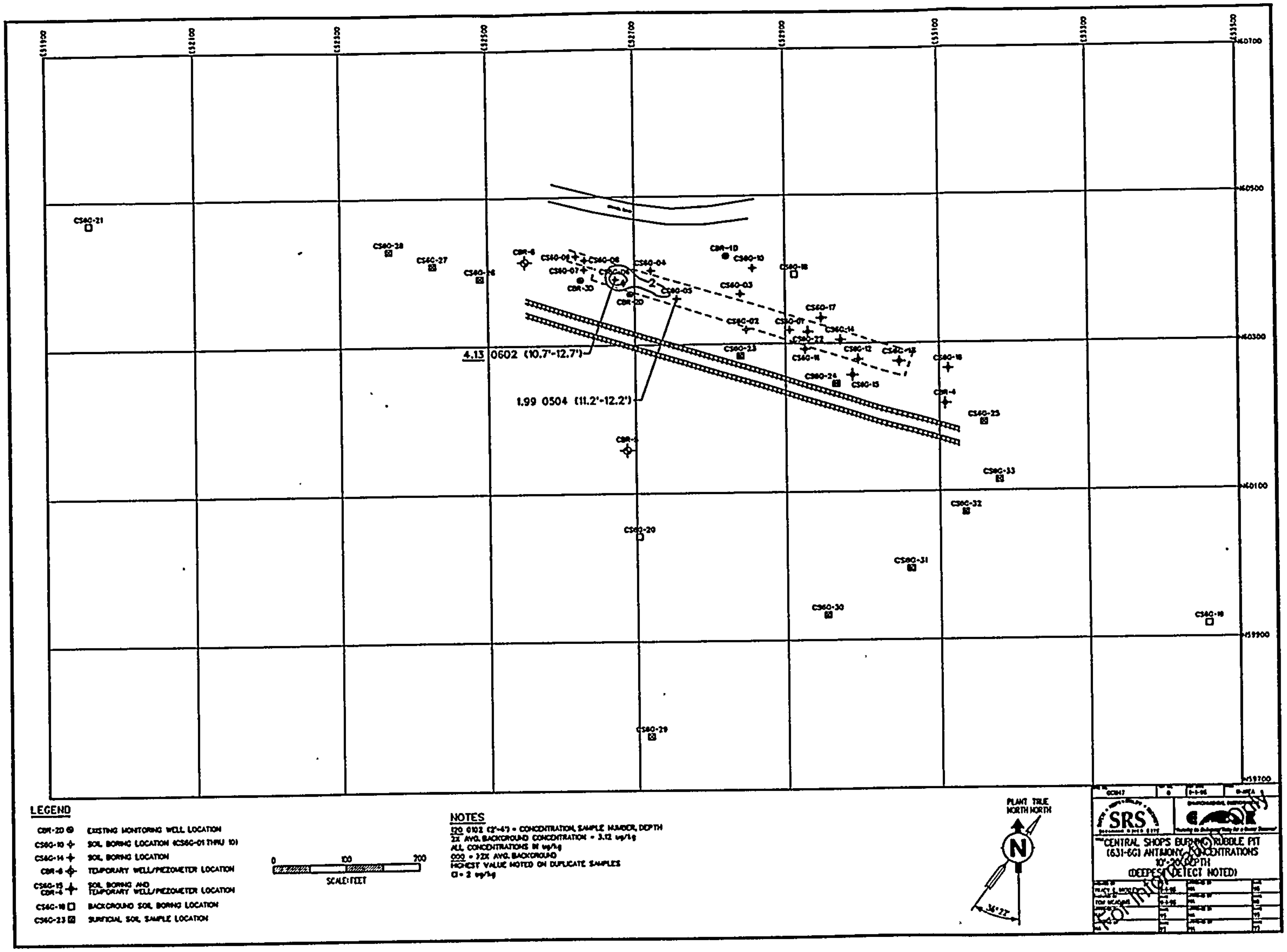

Figure 4-5 Isoconcentration Map of Antimony Depicting Concentrations From 10-20'

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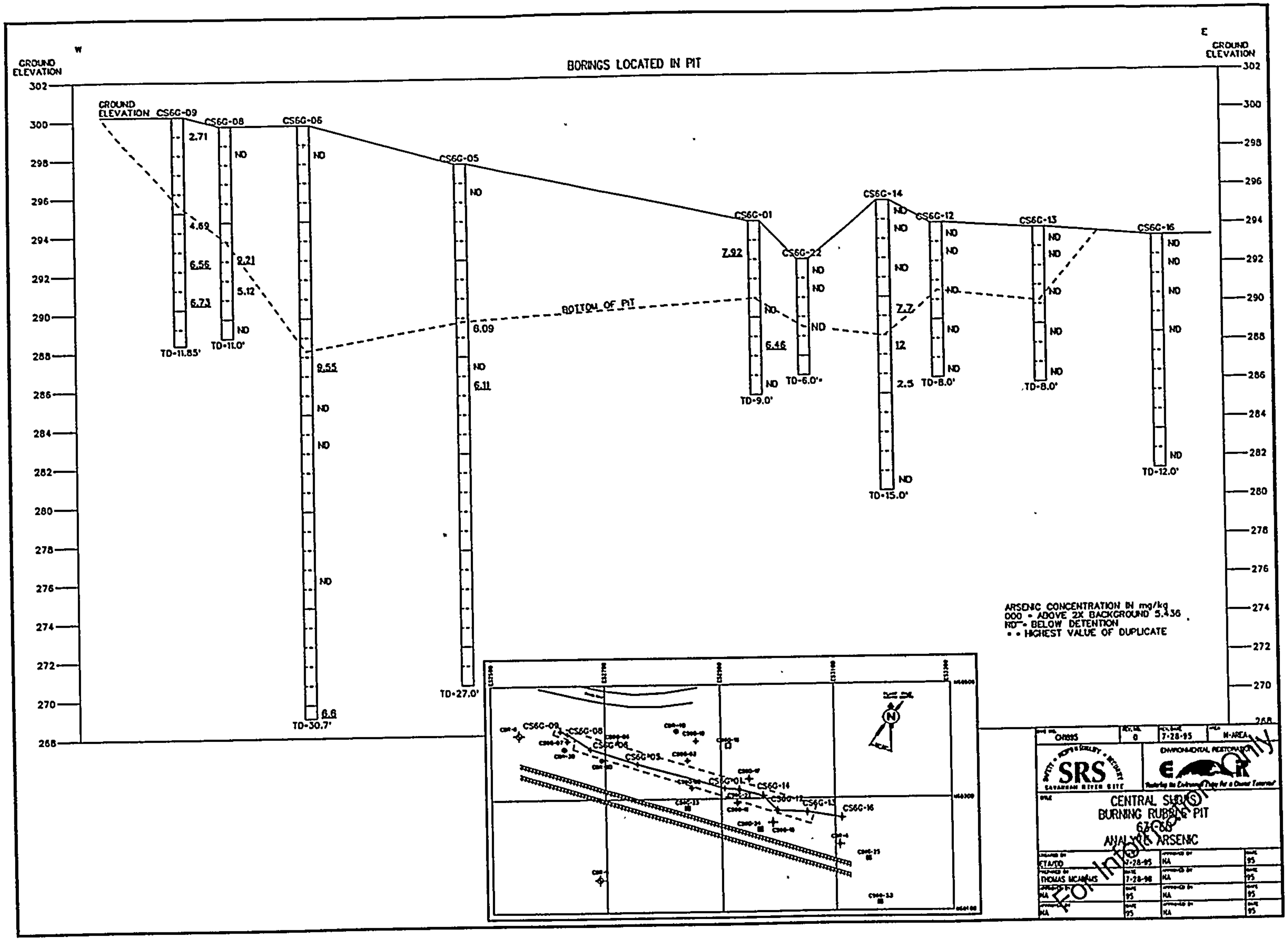

Figure 4-6 West-East Cross Section Inside Pit Depicting Arsenic Concentrations

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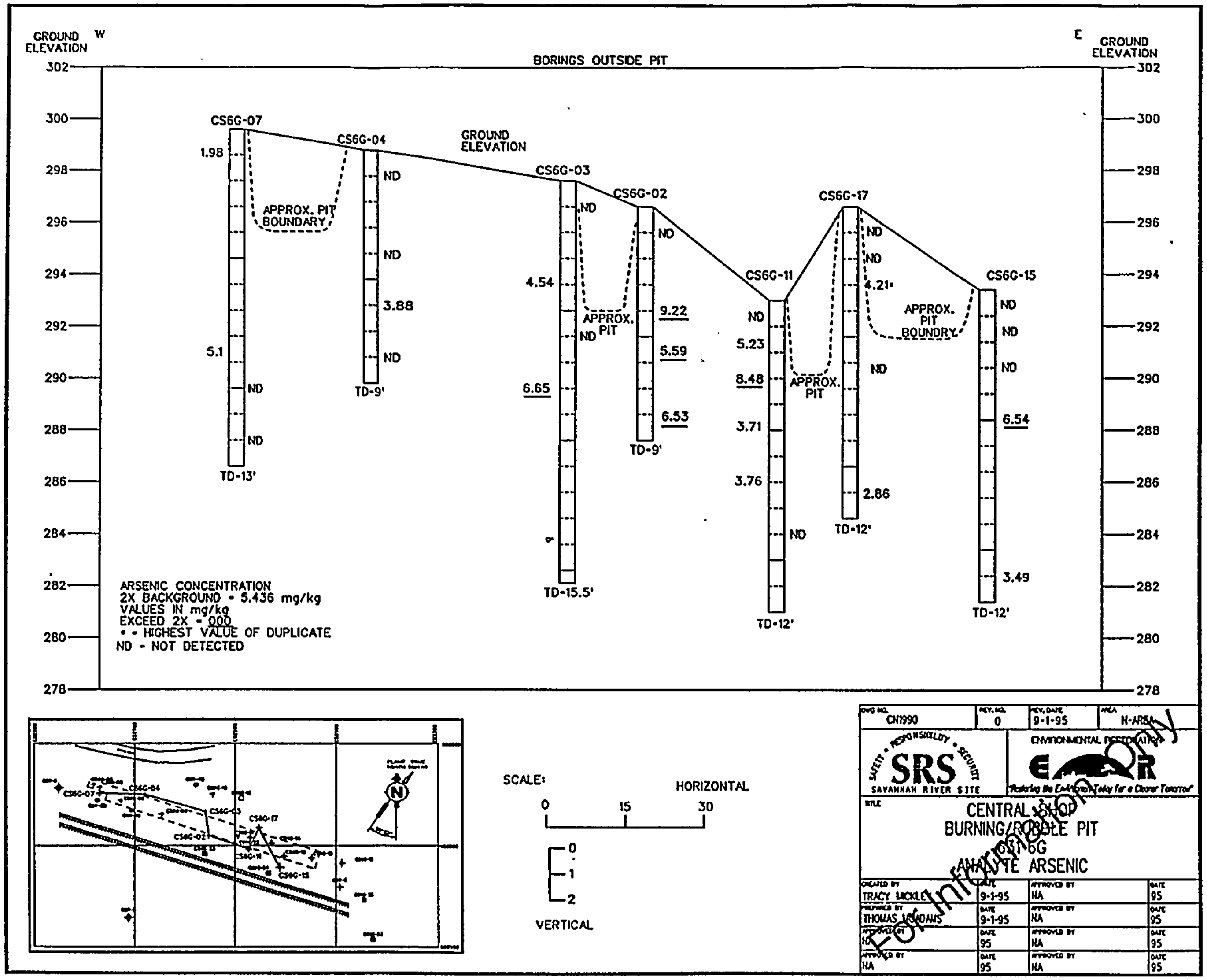

Figure 4-7 West-East Cross-Section Outside Pit Depicting Arsenic Concentrations

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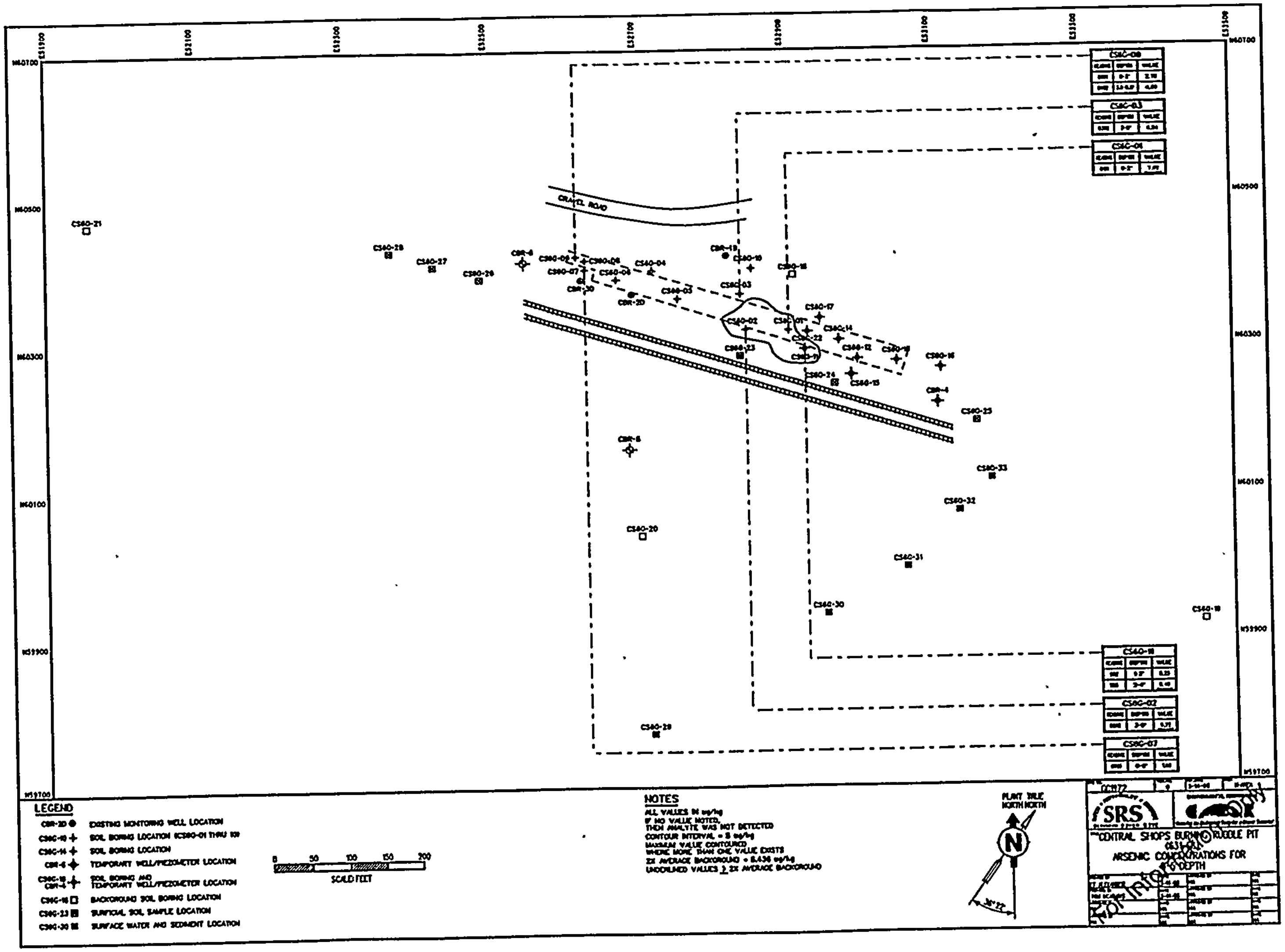

Figure 4-8 Isoconcentration Map of Arsenic Depicting Concentrations From 0-5'

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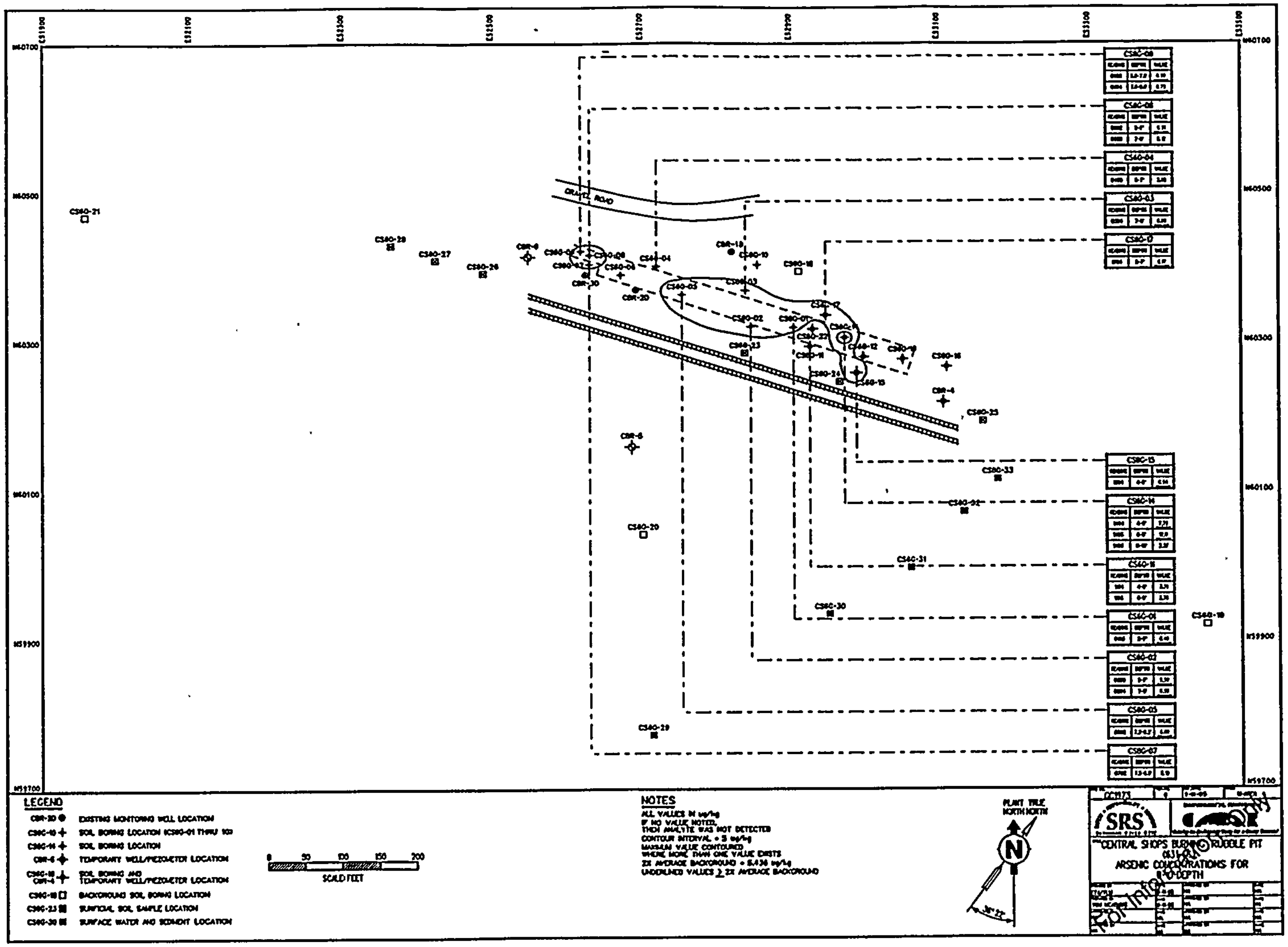

Figure 4-9 Isoconcentration Map of Arsenic Depicting Concentrations From 5-10'

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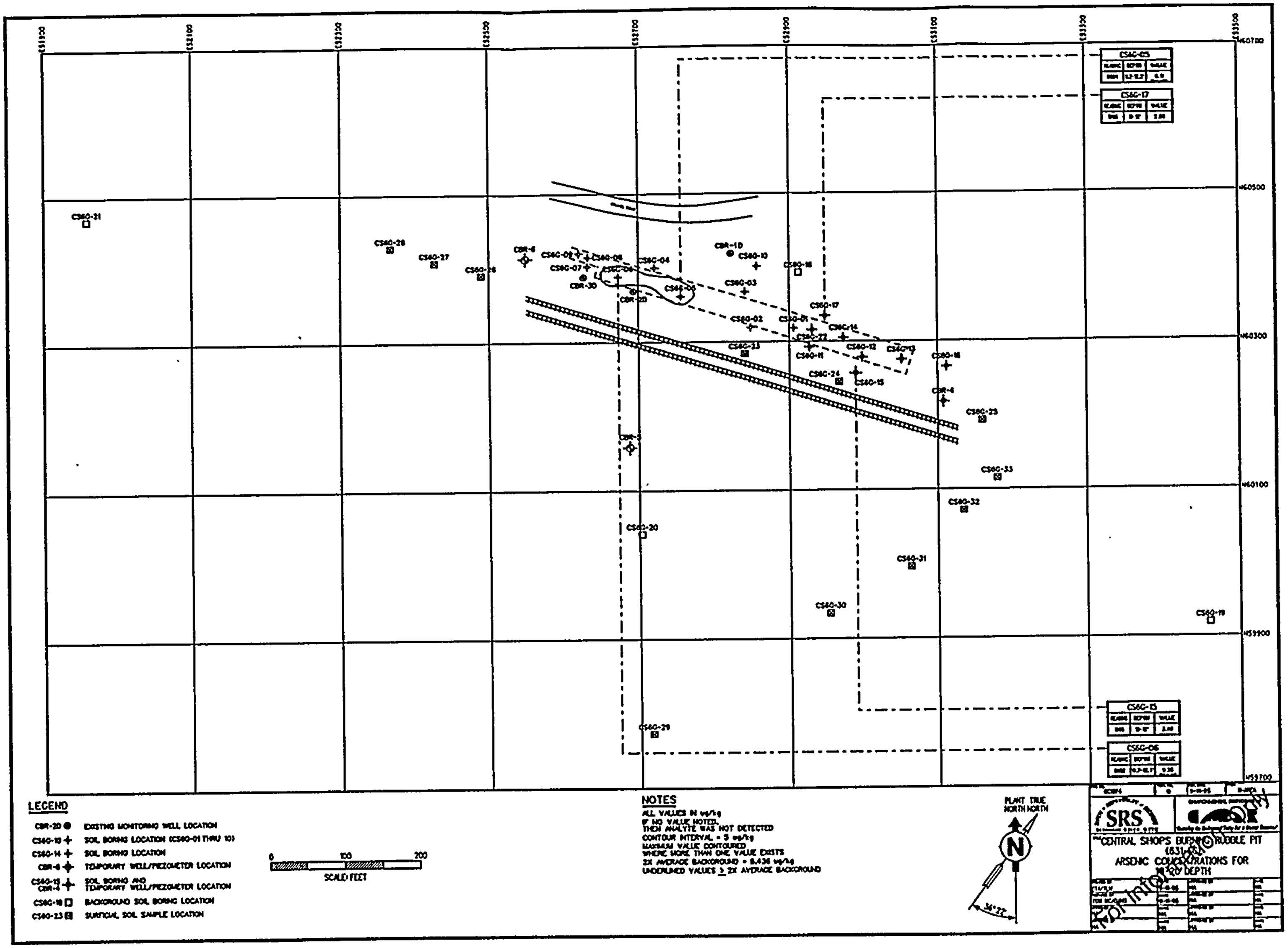

Figure 4-10 Isoconcentration Map of Arsenic Depicting Concentrations From 10-20'

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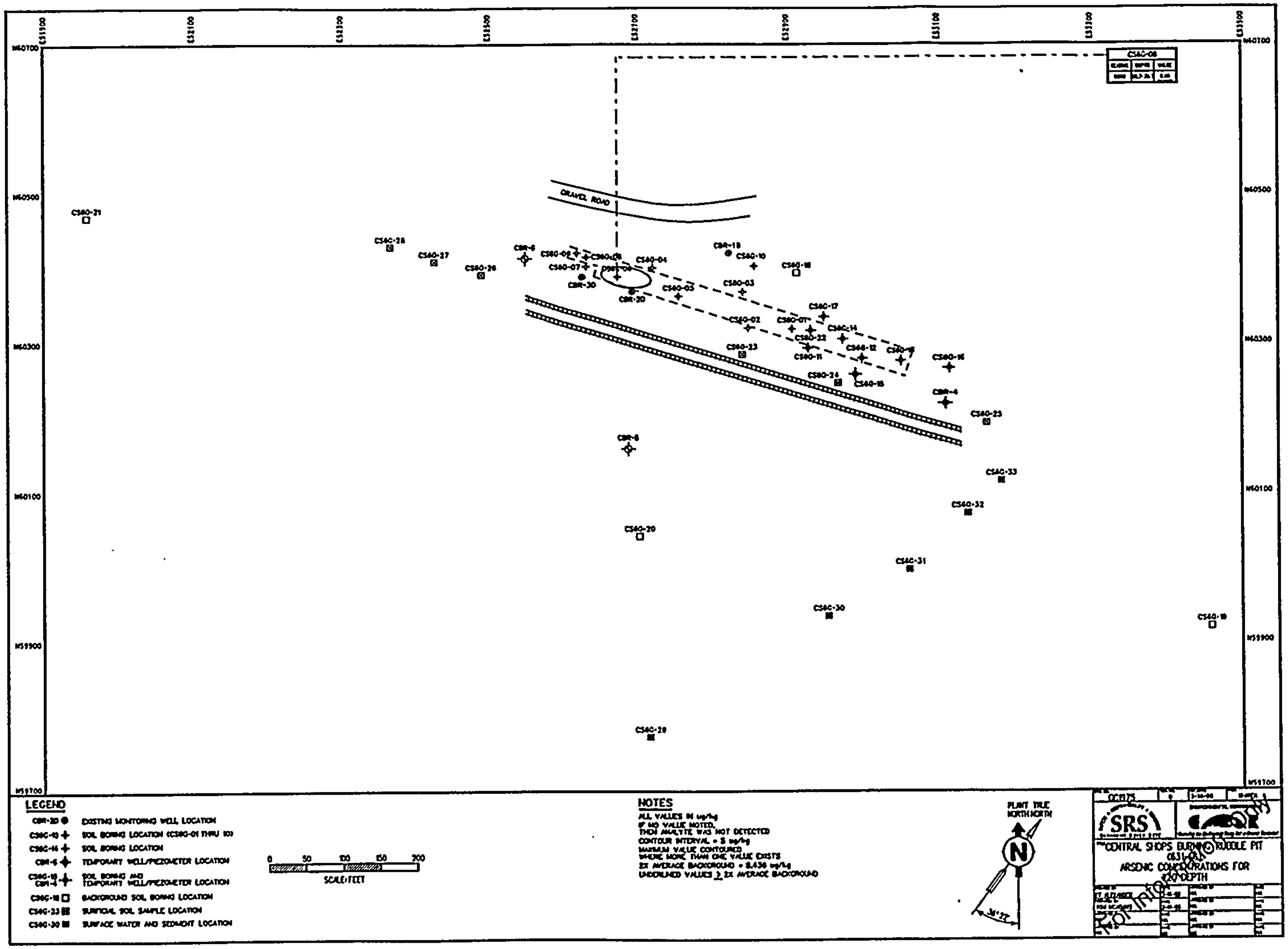

Figure 4-11 Isoconcentration Map of Arsenic Depicting Concentrations From > 20'

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PLATE 1-2
CENTRAL SHOPS BURNING RUBBLE PIT
AERIAL PHOTOGRAPH VINTAGE 1955

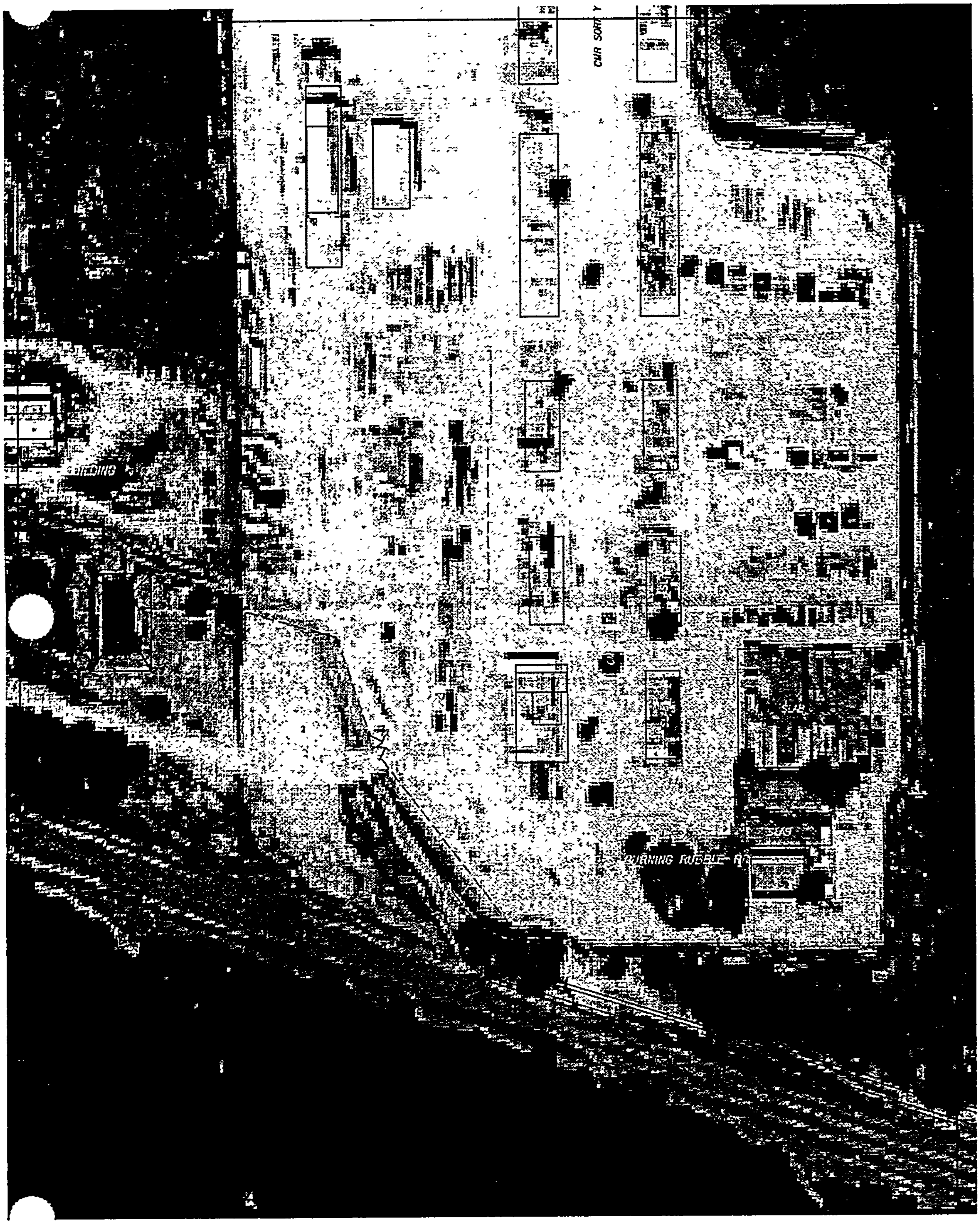

PLATE 1-3
CENTRAL SHOPS BURNING RUBBLE PIT
AERIAL PHOTOGRAPH VINTAGE 1990

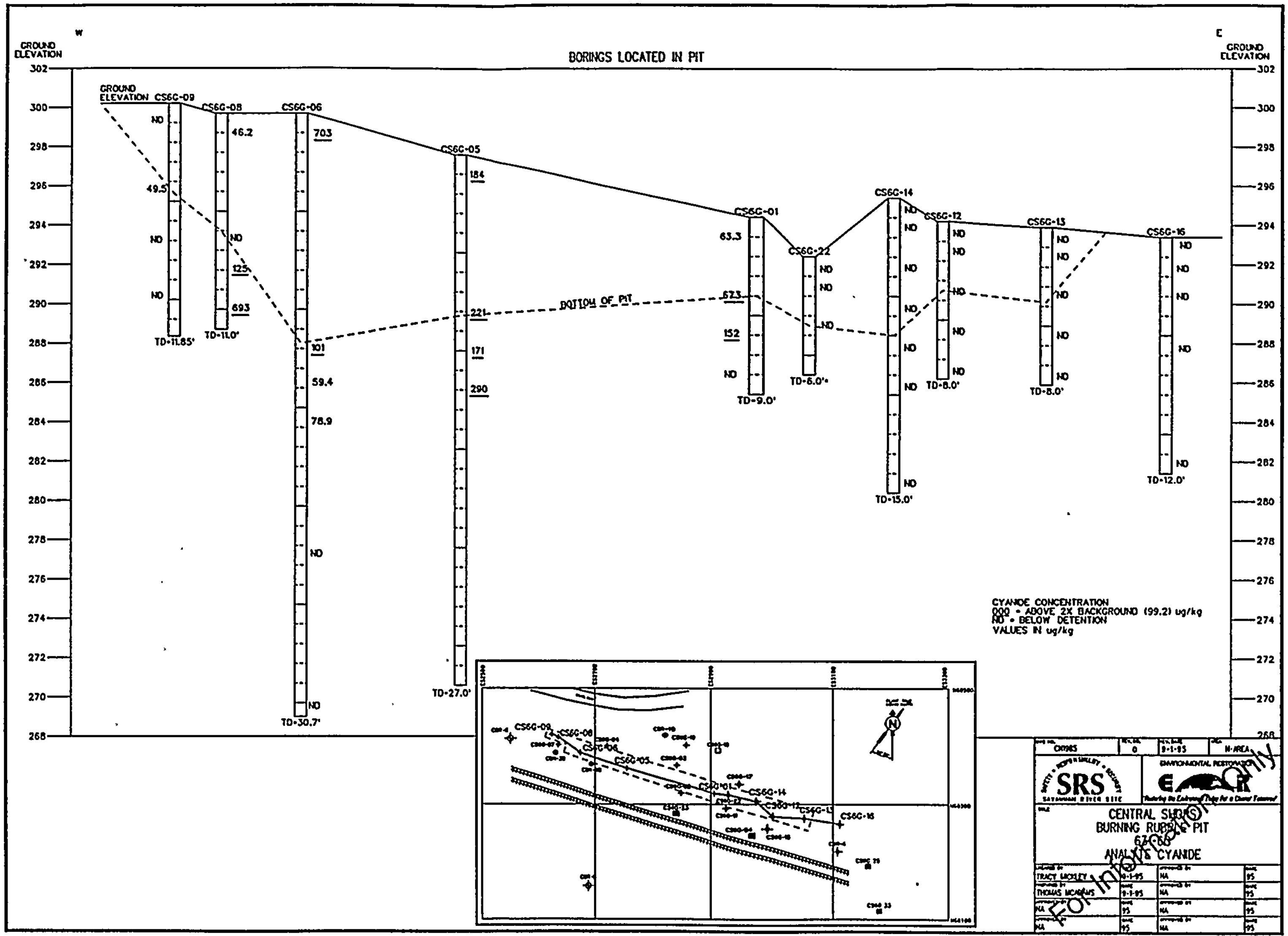

Figure 4-12 West-East Cross-Section Inside Pit Depicting Cyanide Concentrations

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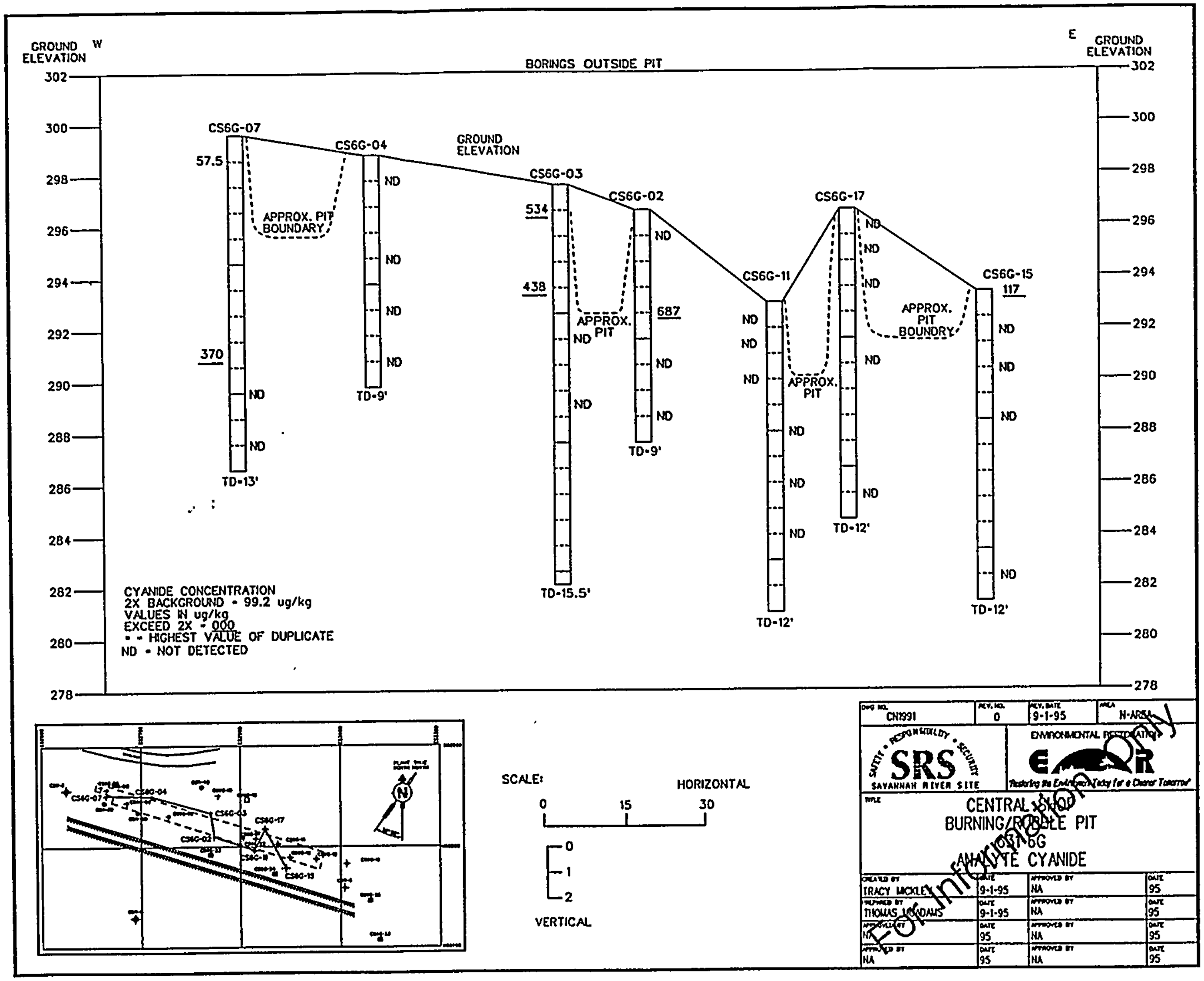

Figure 4-13 West-East Cross-Section Outside Pit Depicting Cyanide Concentrations

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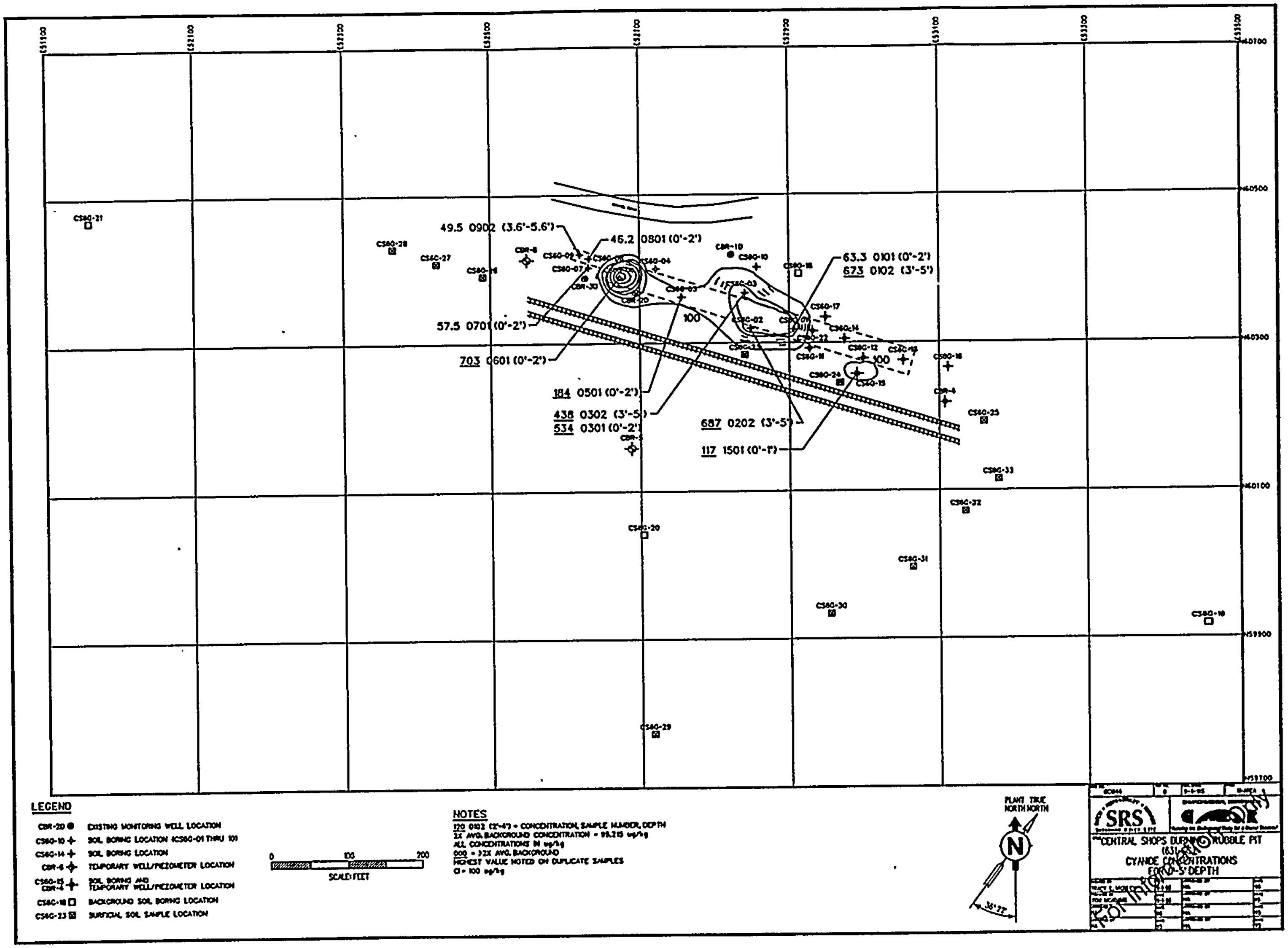

Figure 4-14 Isoconcentration Map of Cyanide Depicting Concentrations From 0-5'

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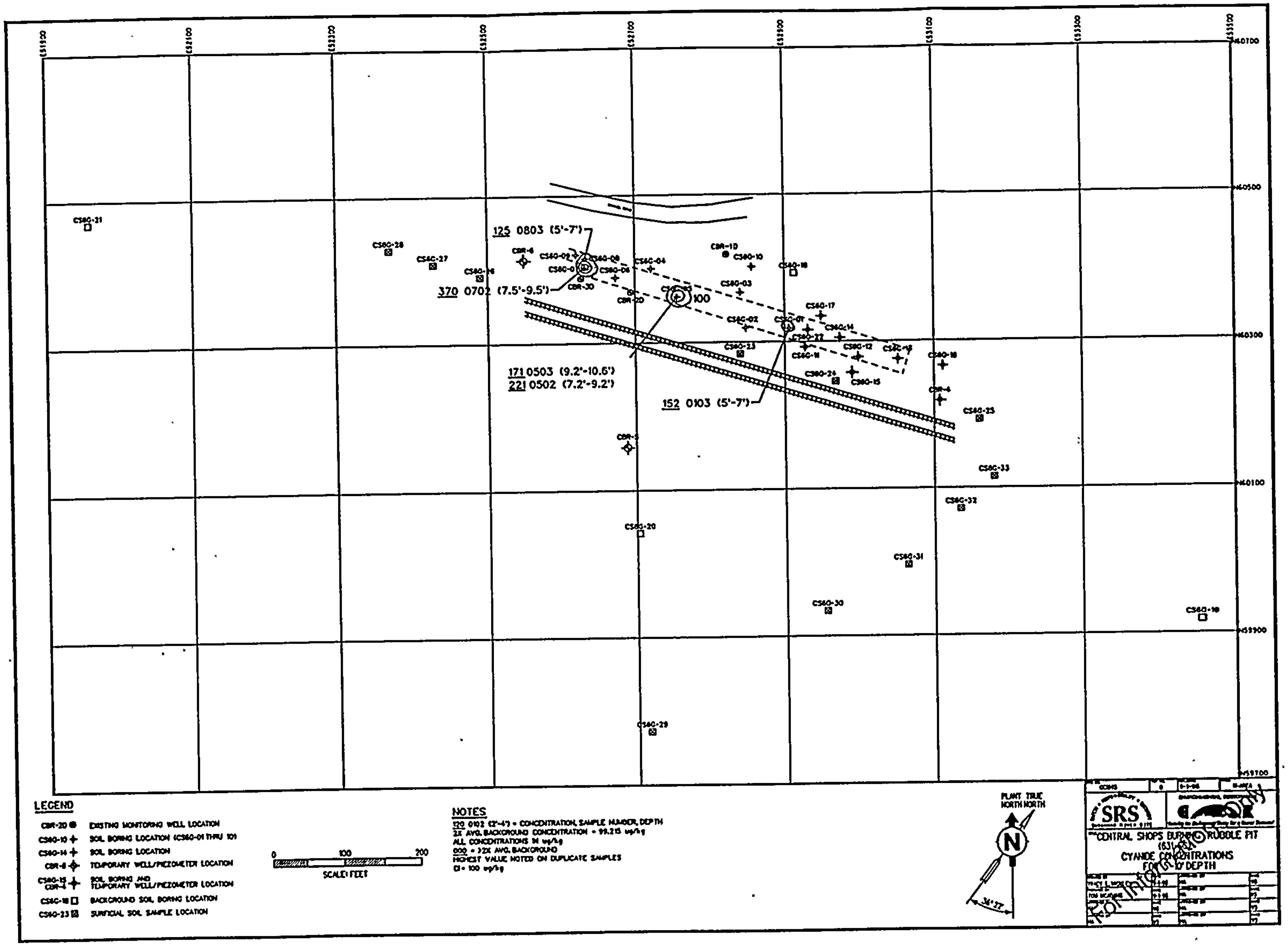

Figure 4-15 Isoconcentration Map of Cyanide Depicting Concentrations From 5-10'

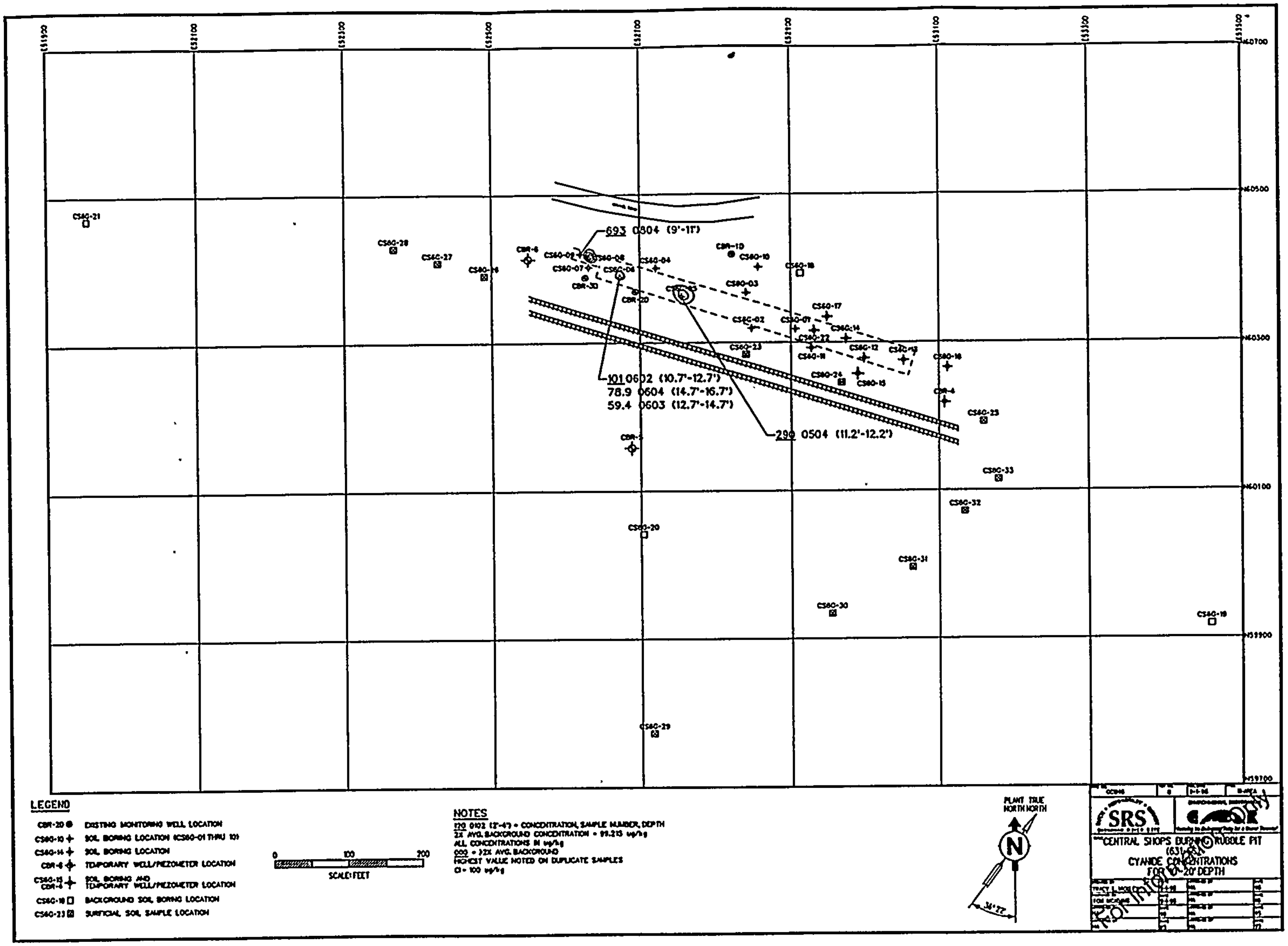

Figure 4-16 Isoconcentration Map of Cyanide Depicting Concentrations From 10-20'

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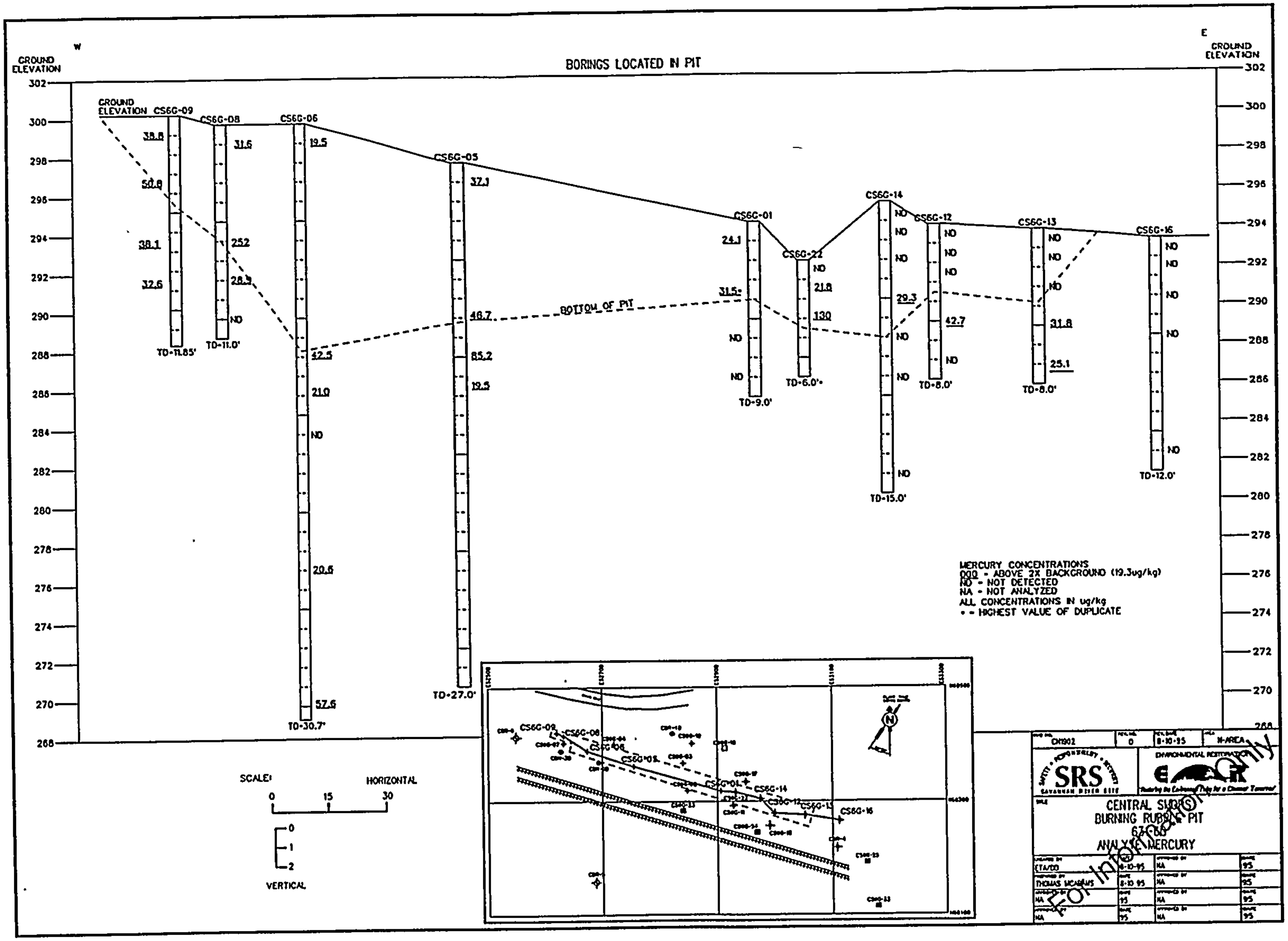

Figure 4-17 West-East Cross-Section Inside Pit Depicting Mercury Concentrations

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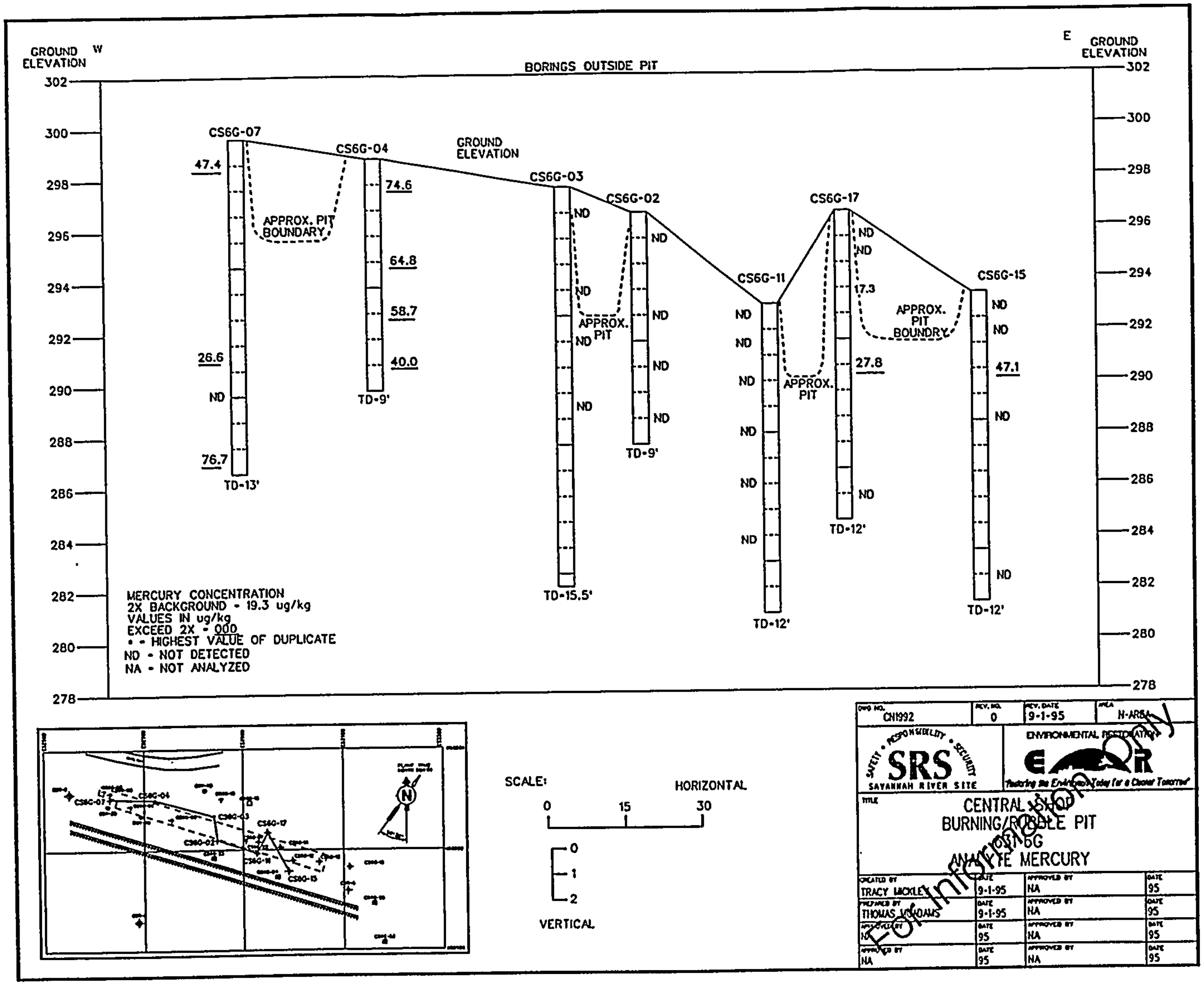

Figure 4-18 West-East Cross-Section Outside Pit Depicting Mercury Concentrations

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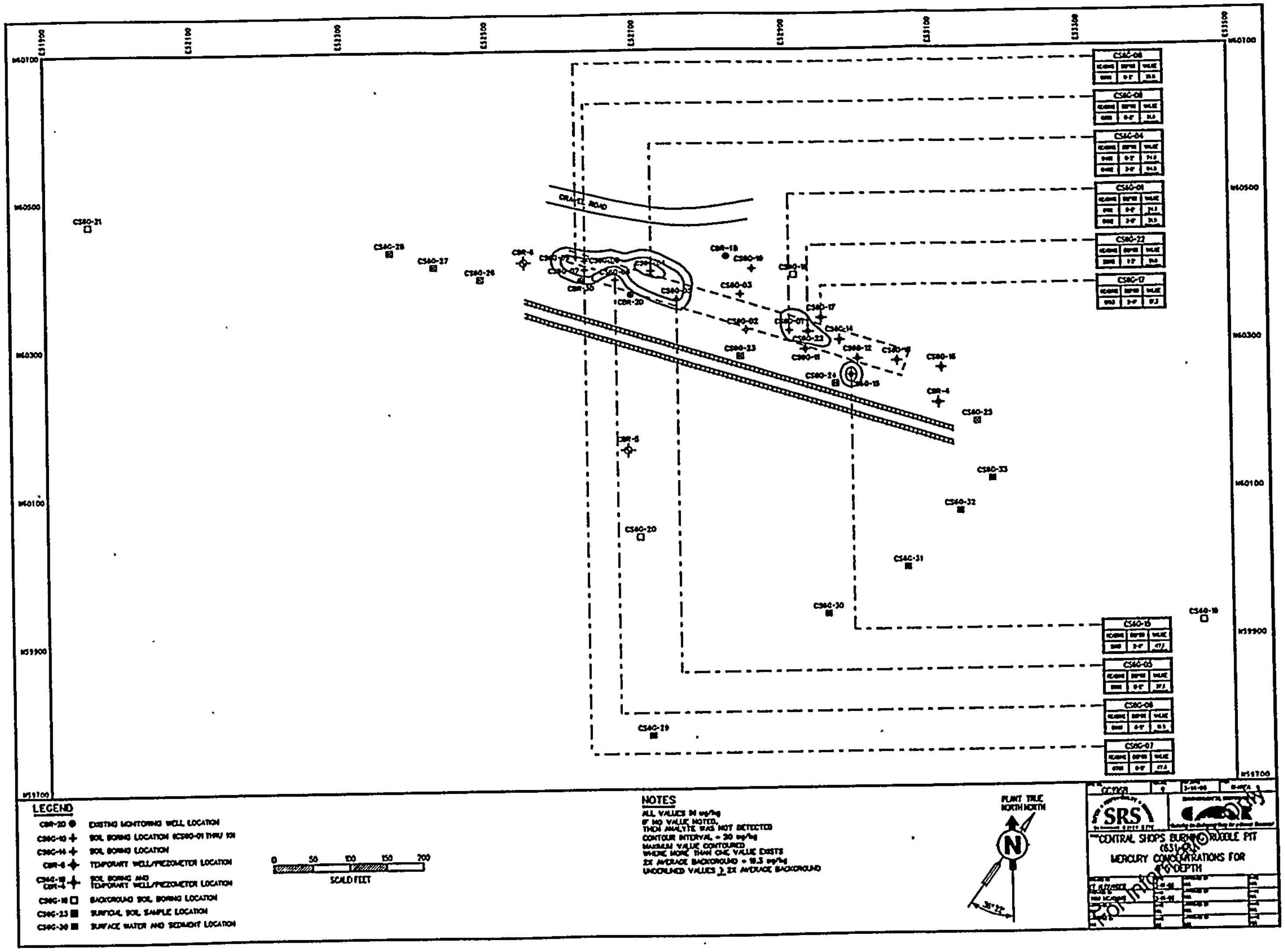

Figure 4-19 Isoconcentration Map of Mercury Depicting Concentrations From 0-5'

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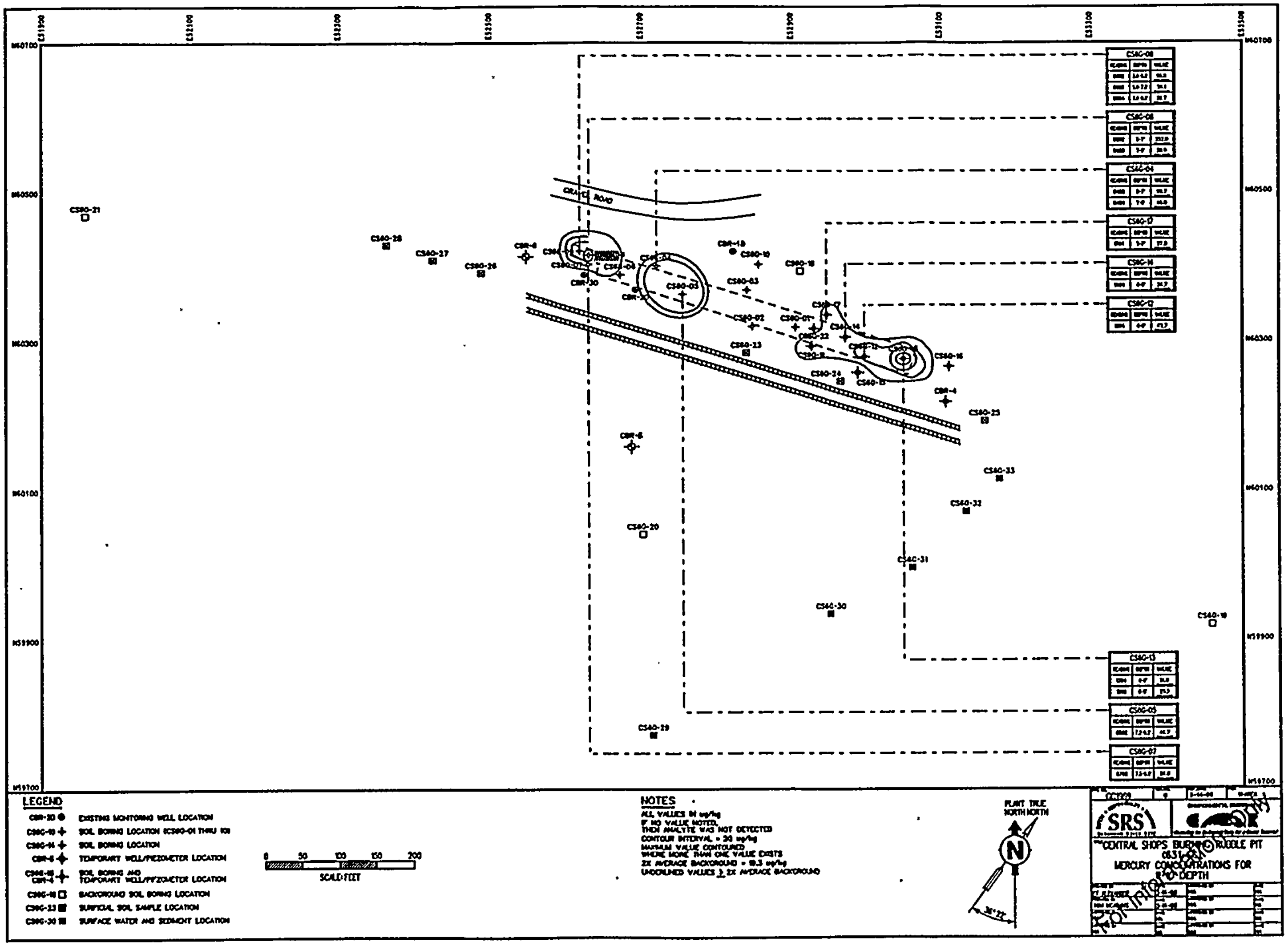

Figure 4-20 Isoconcentration Map of Mercury Depicting Concentrations From 5-10'

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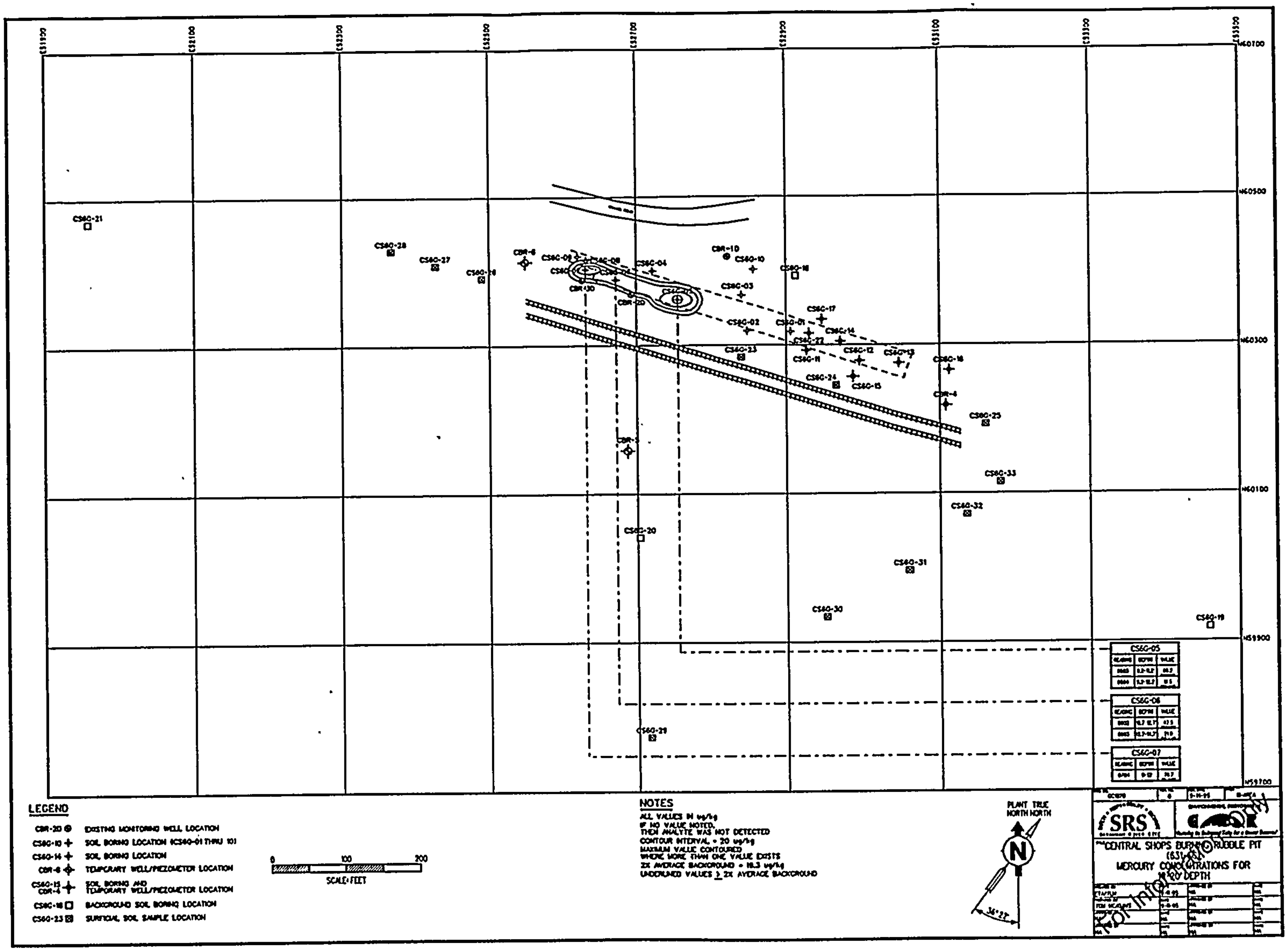

Figure 4-21 Isoconcentration Map of Mercury Depicting Concentrations From 10-20'

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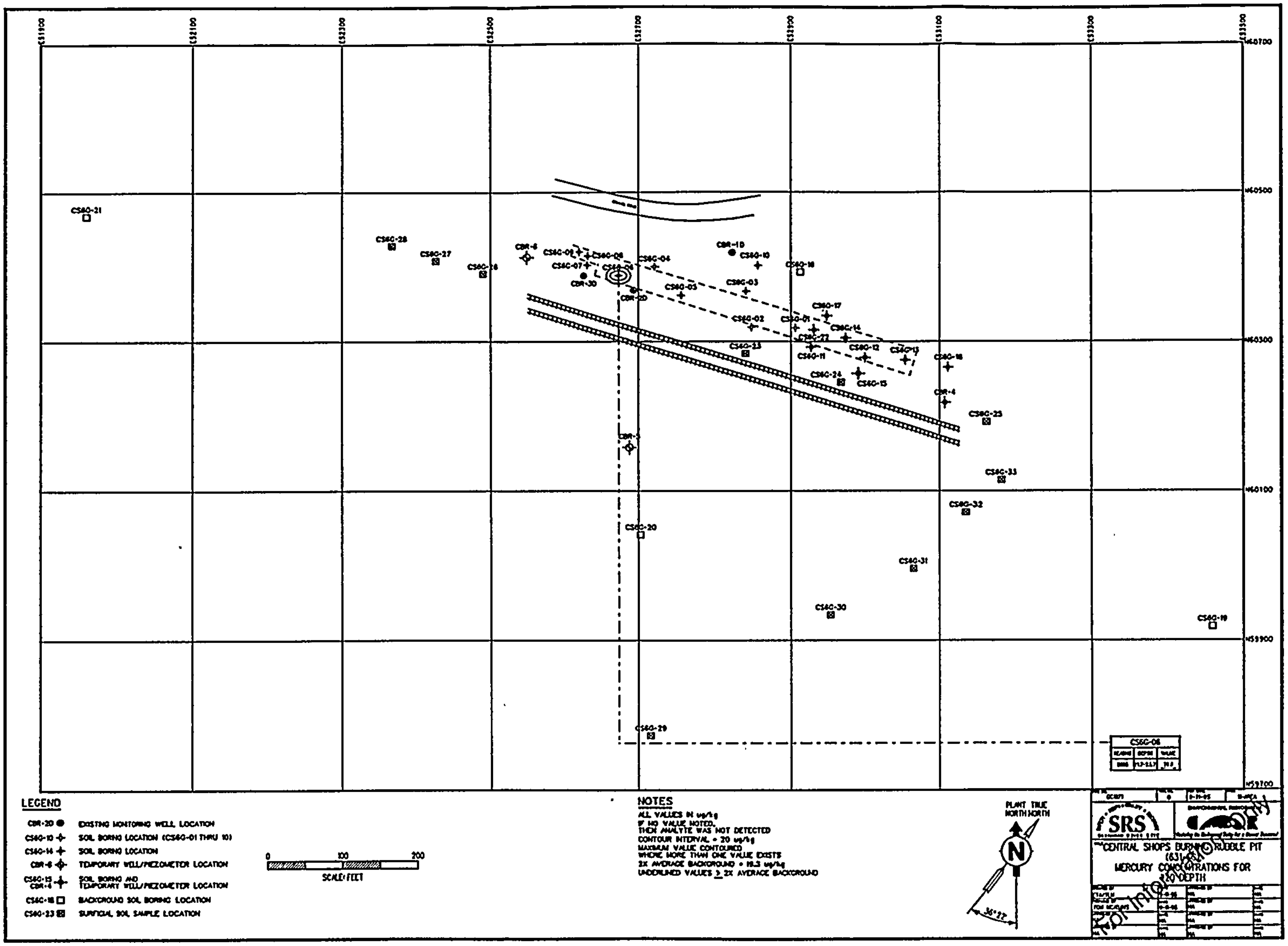

Figure 4-22 Isoconcentration Map of Mercury Depicting Concentrations From > 20'

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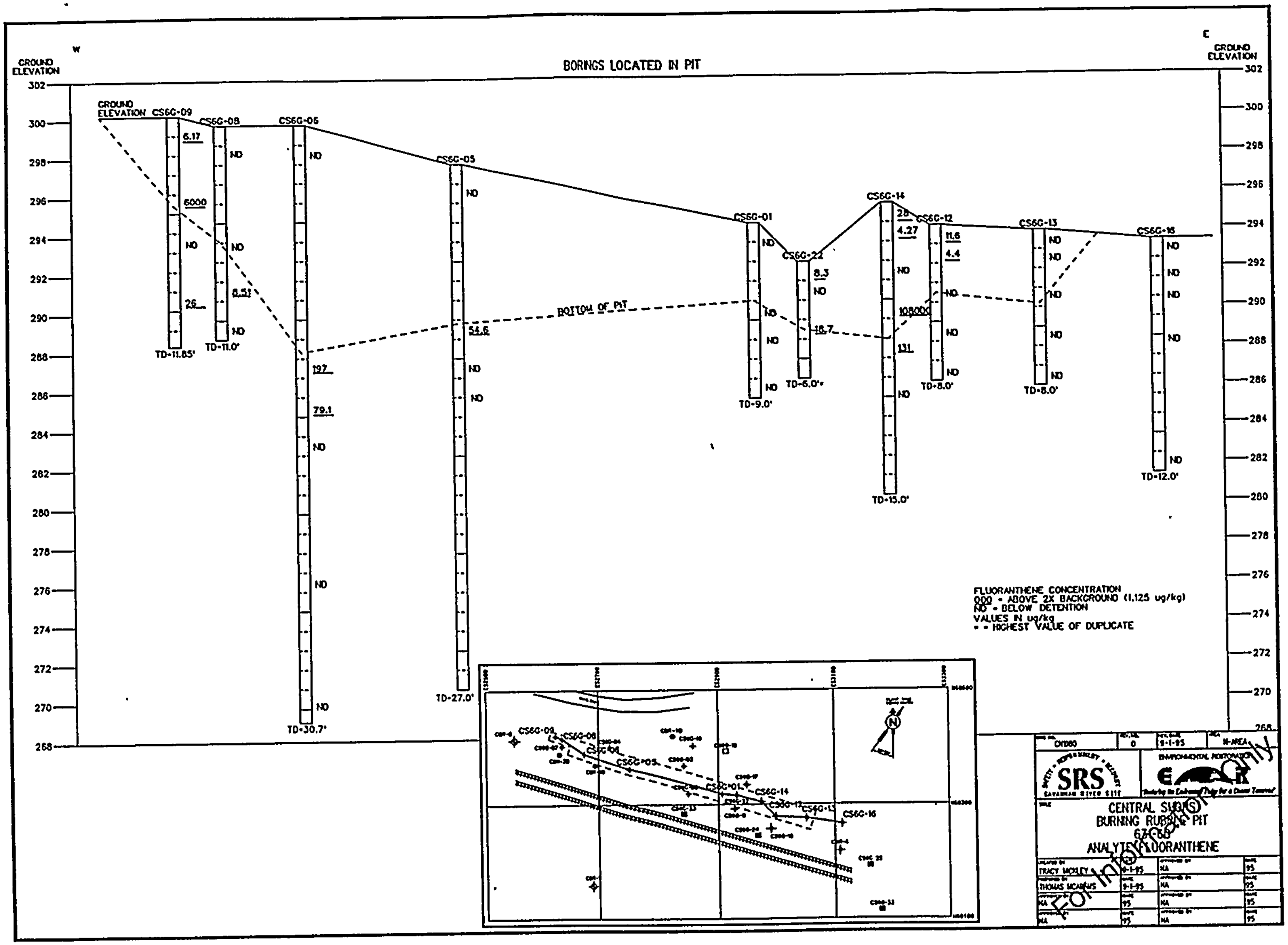

Figure 4-23 West-East Cross-Section Inside Pit Depicting Fluoranthene Concentrations

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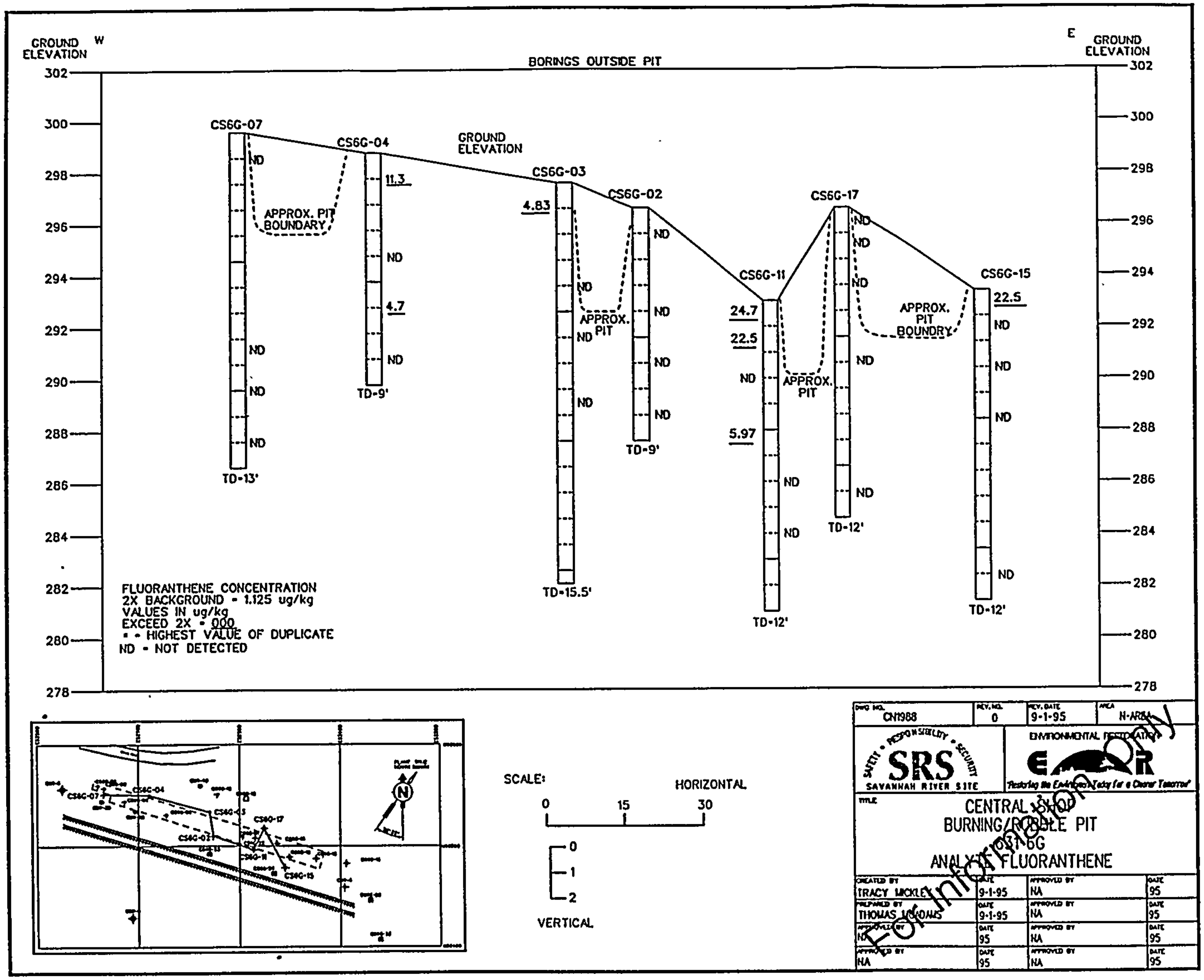

Figure 4-24 West-East Cross-Section Outside Pit Depicting Fluoranthene Concentrations

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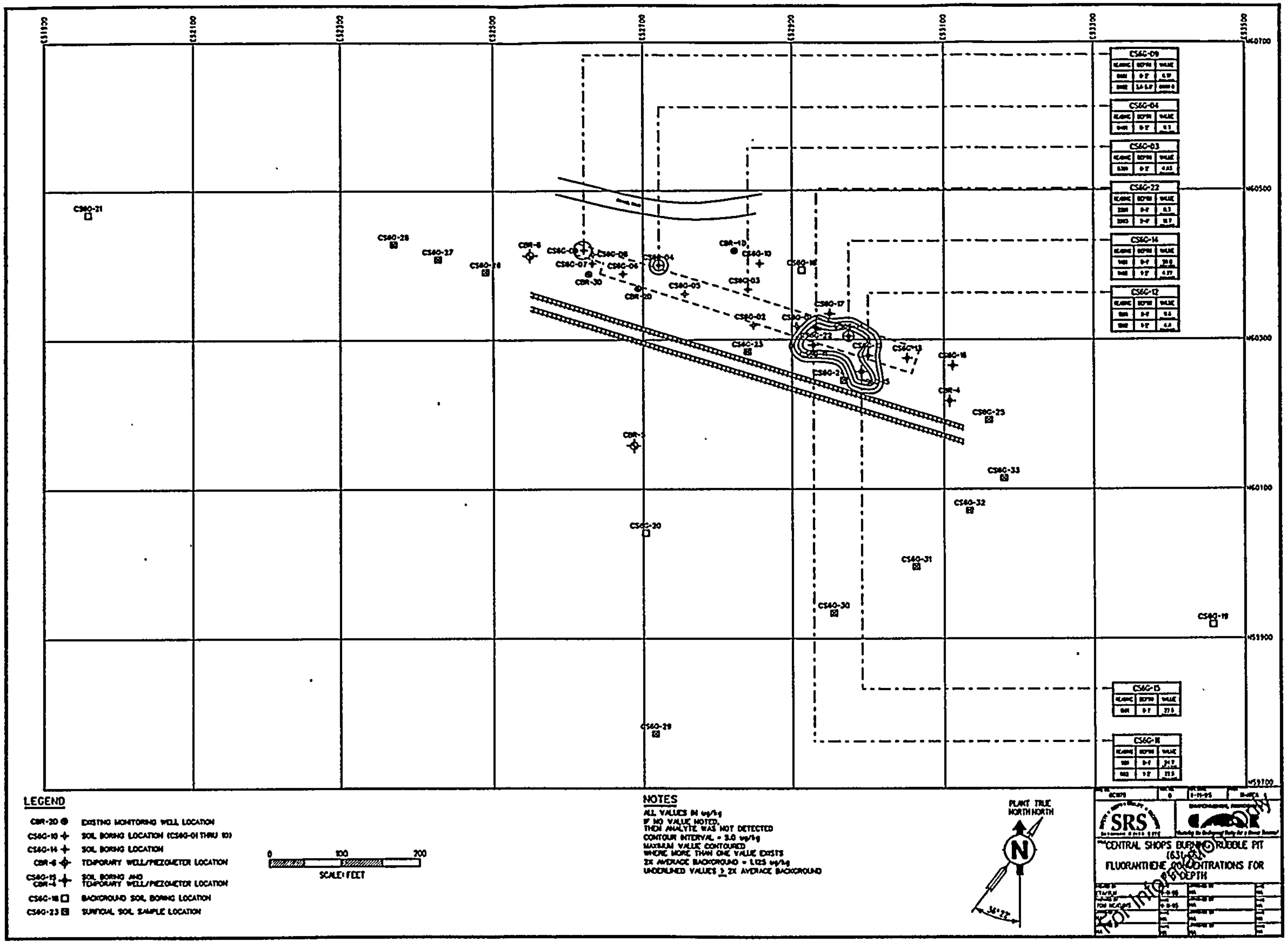

Figure 4-25 Isoconcentration Map of Fluoranthene Depicting Concentrations From 0-5'

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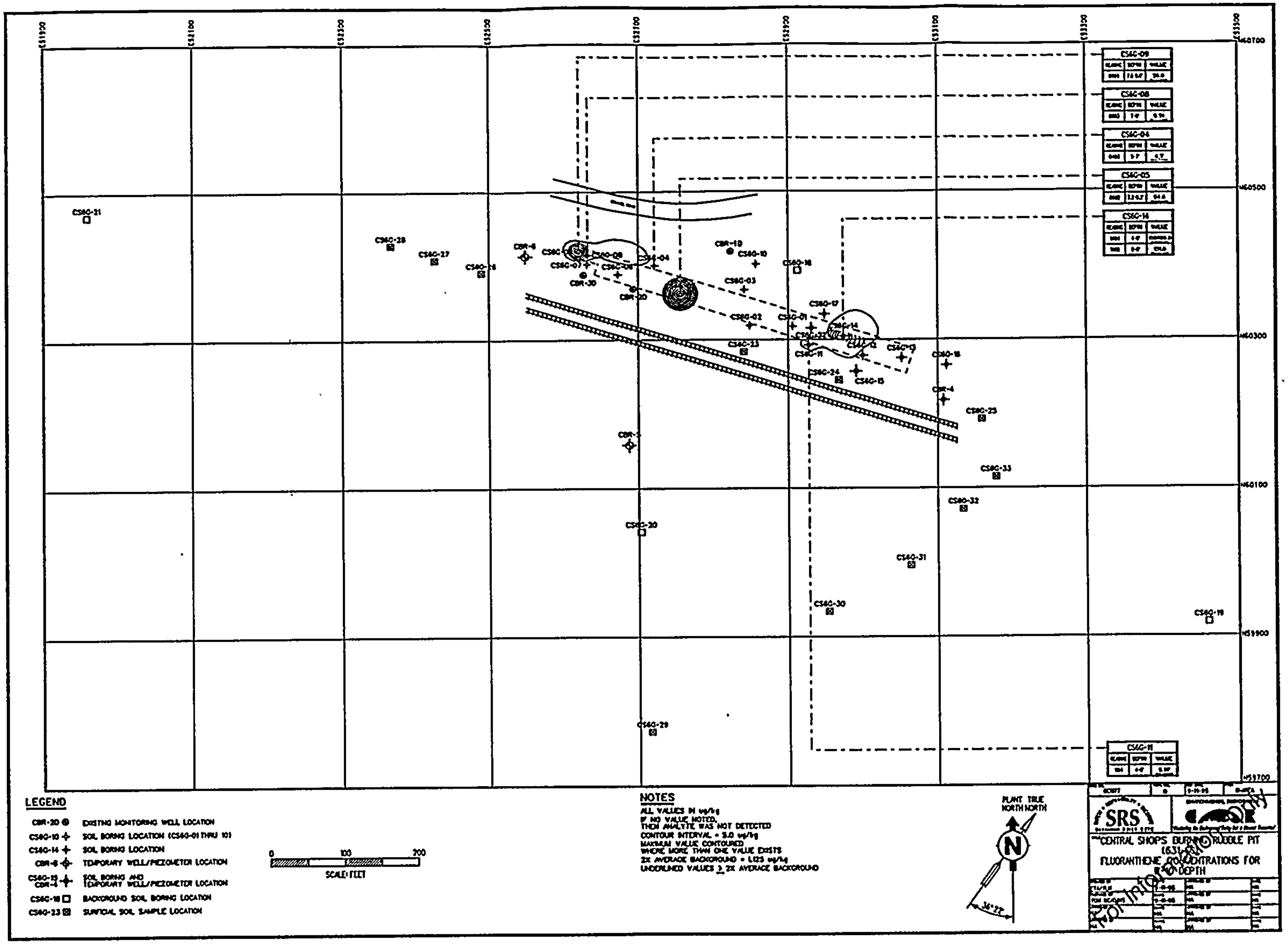

Figure 4-26 Isoconcentration Map of Fluoranthene Depicting Concentrations From 5-10'

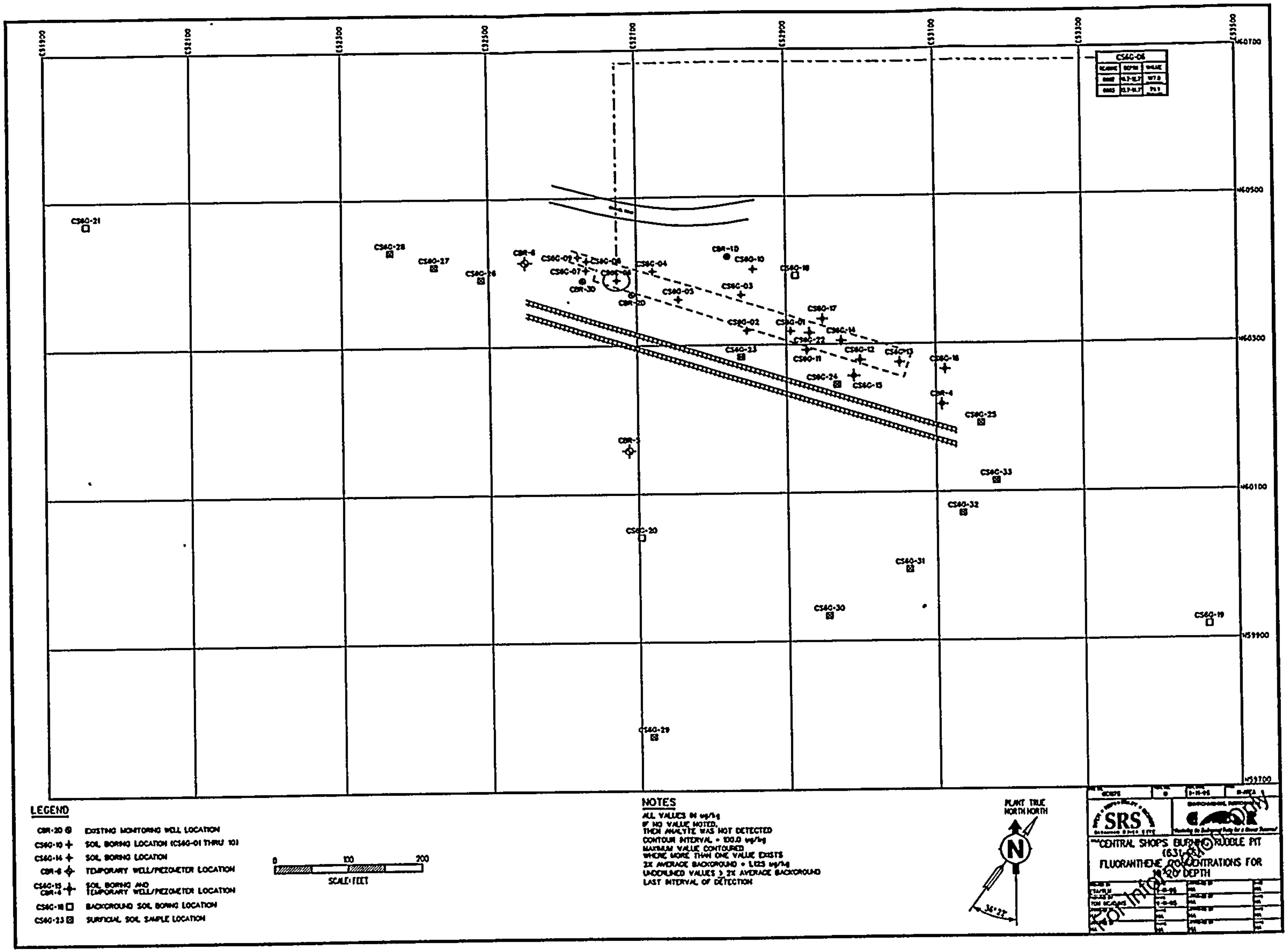

Figure 4-27 Isoconcentration Map of Fluoranthene Depicting Concentrations From 10-20'

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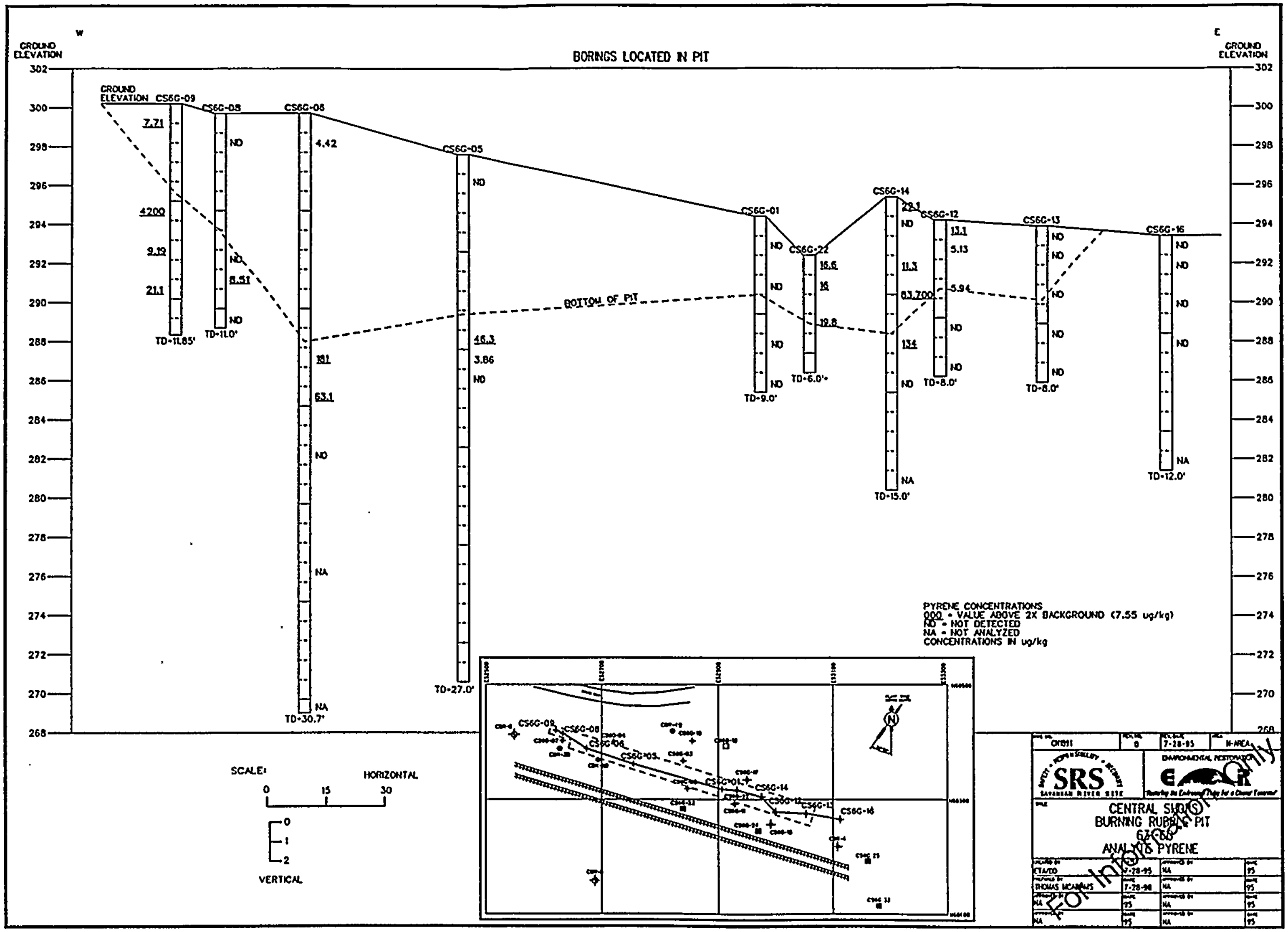

Figure 4-28 West-East Cross-Section Inside Pit Depicting Pyrene Concentrations

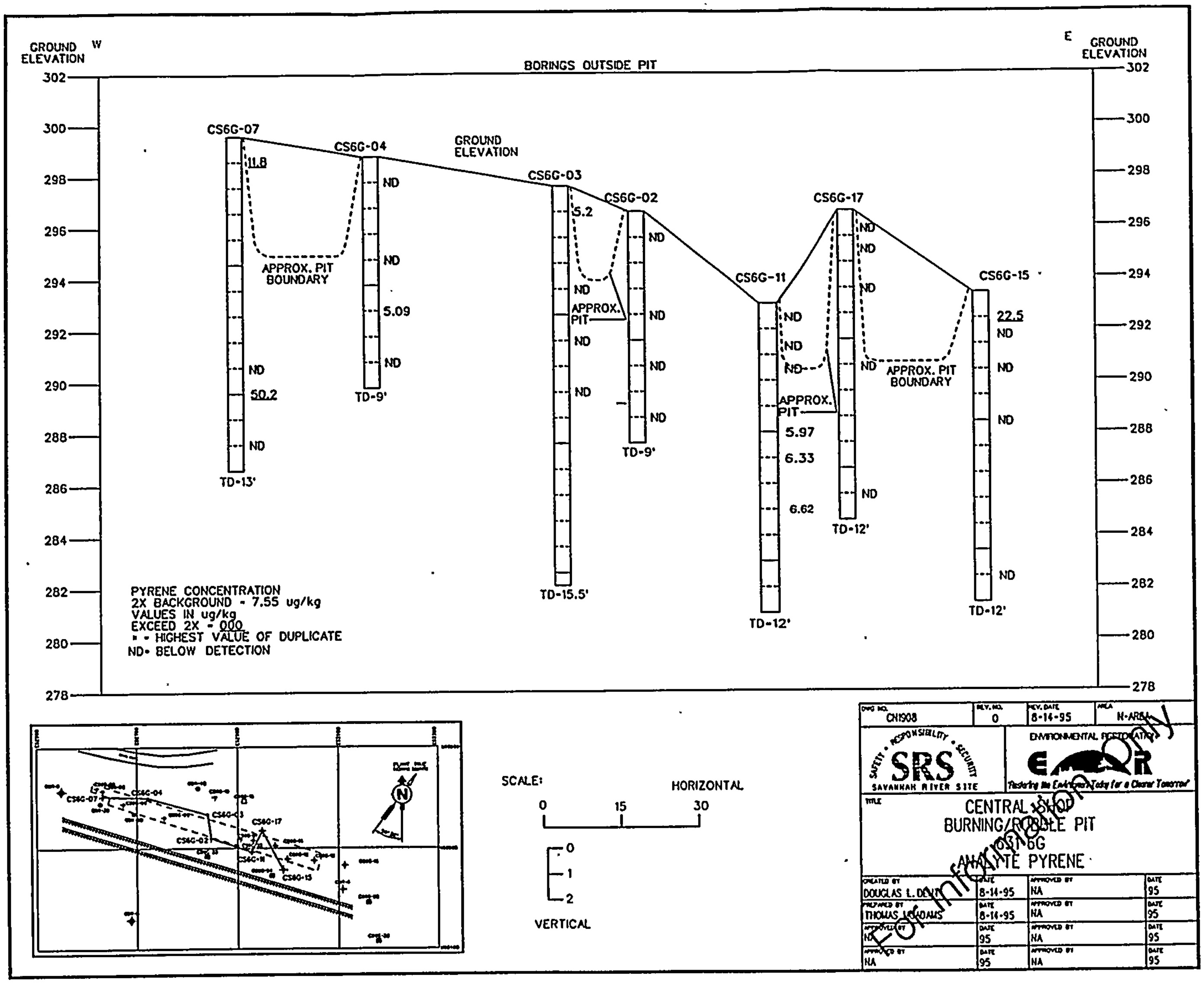

Figure 4-29 West-East Cross-Section Outside Pit Depicting Pyrene Concentrations

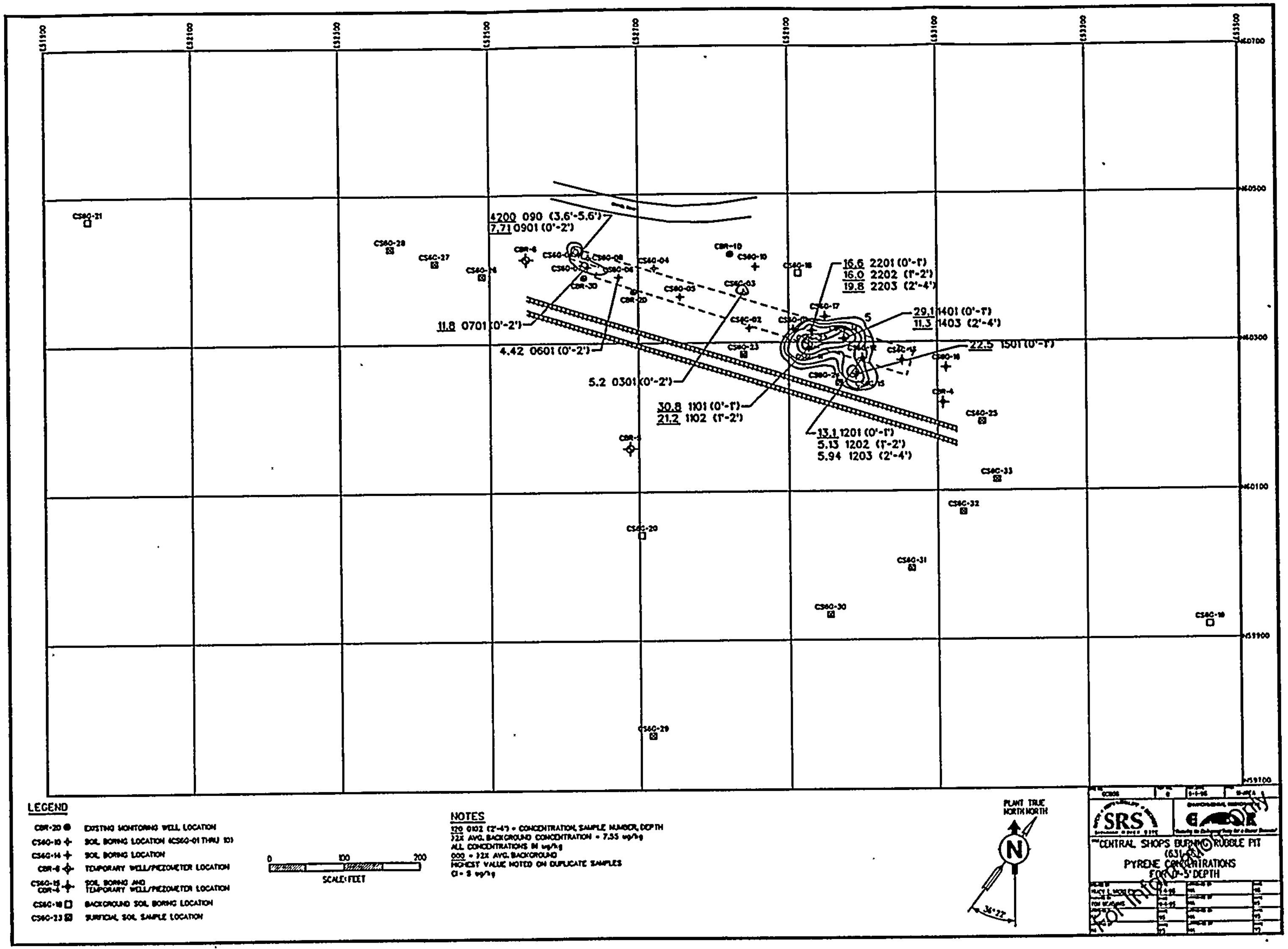

Figure 4-30 Isoconcentration Map of Pyrene Depicting Concentrations From 0-5'

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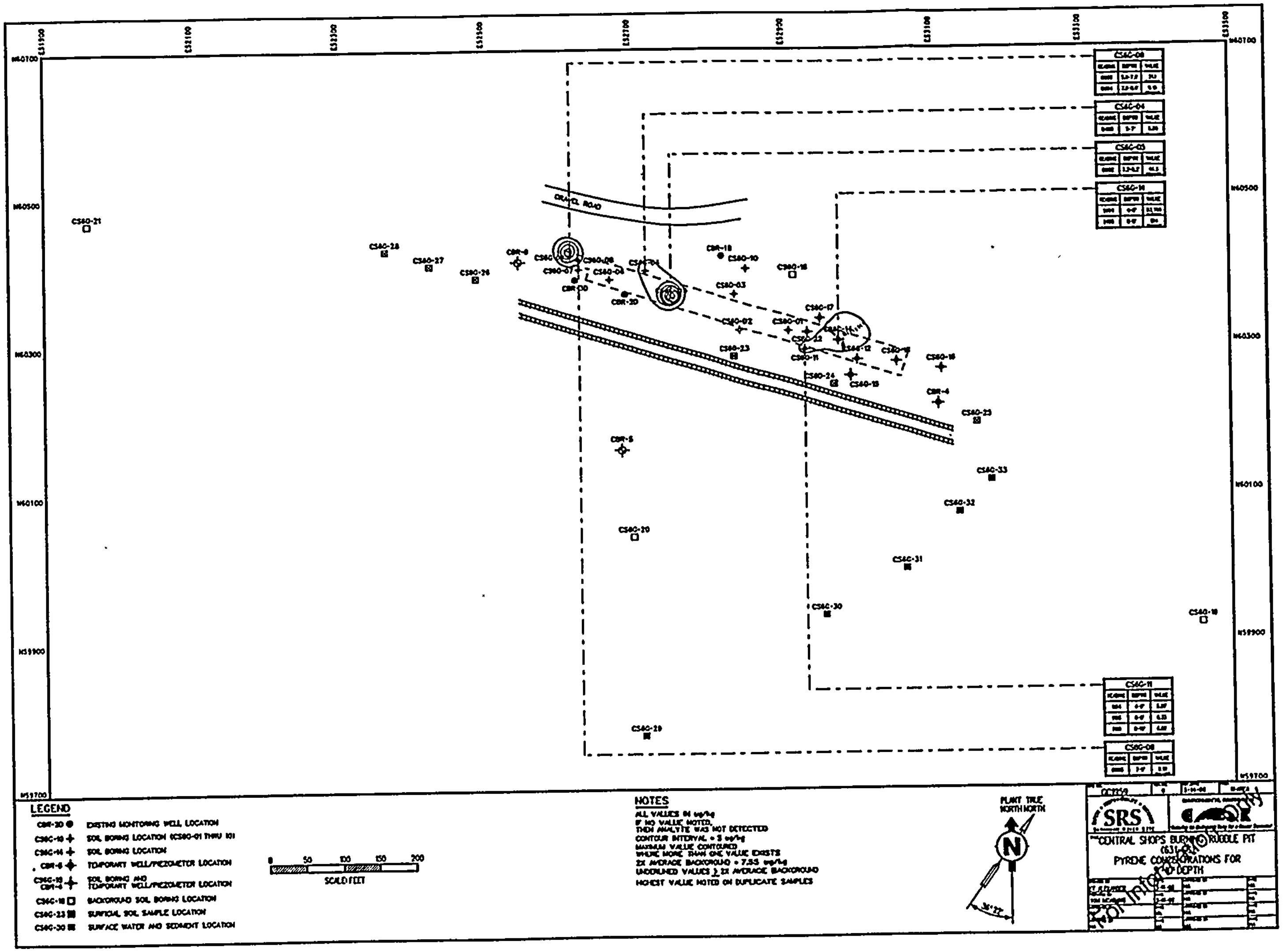

Figure 4-31 Isoconcentration Map of Pyrene Depicting Concentrations From 5-10'

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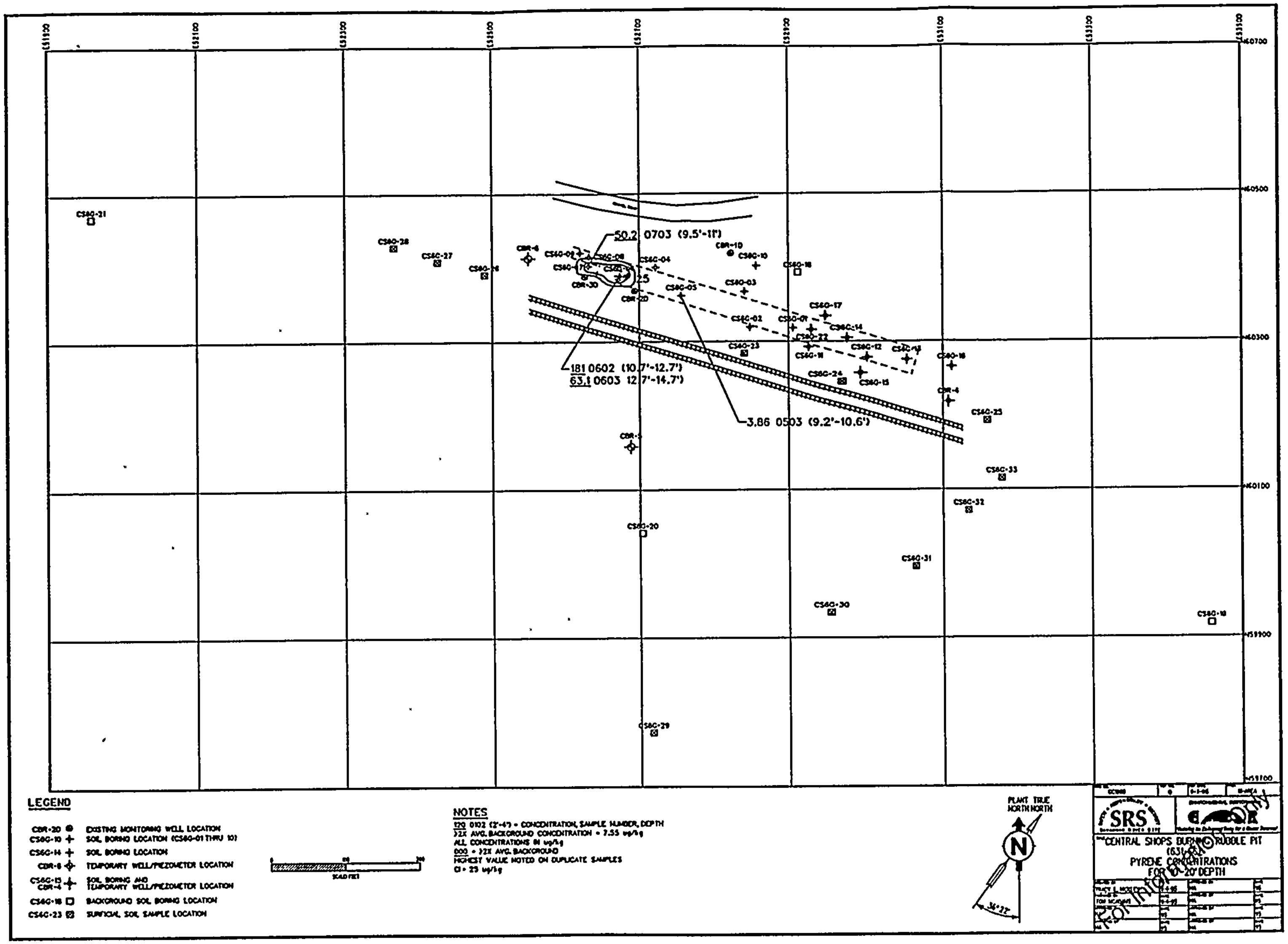

Figure 4-32 Isoconcentration Map of Pyrene Depicting Concentrations From 10-20'

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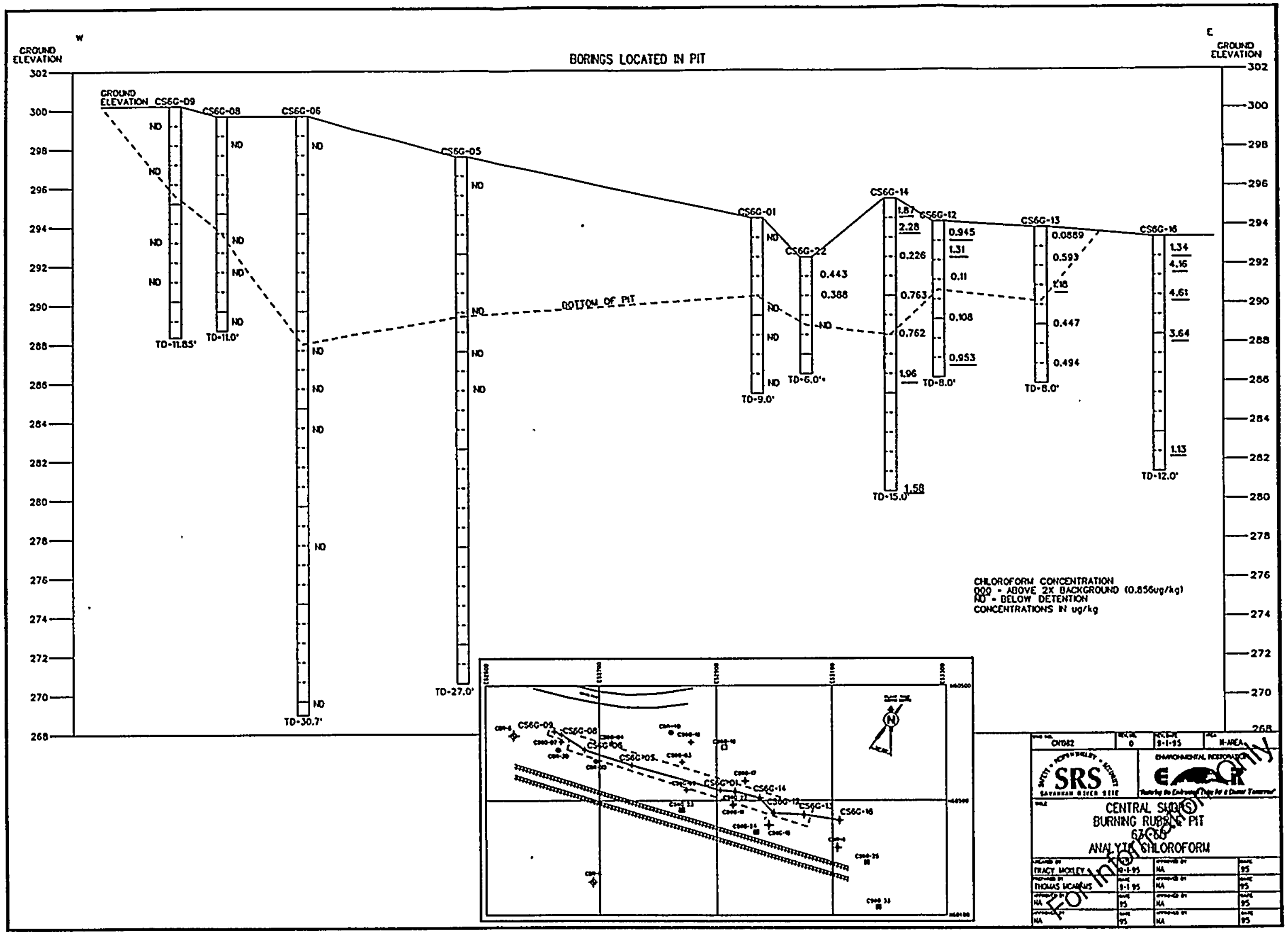

Figure 4-33 West-East Cross-Section Inside Pit Depicting Chloroform Concentrations

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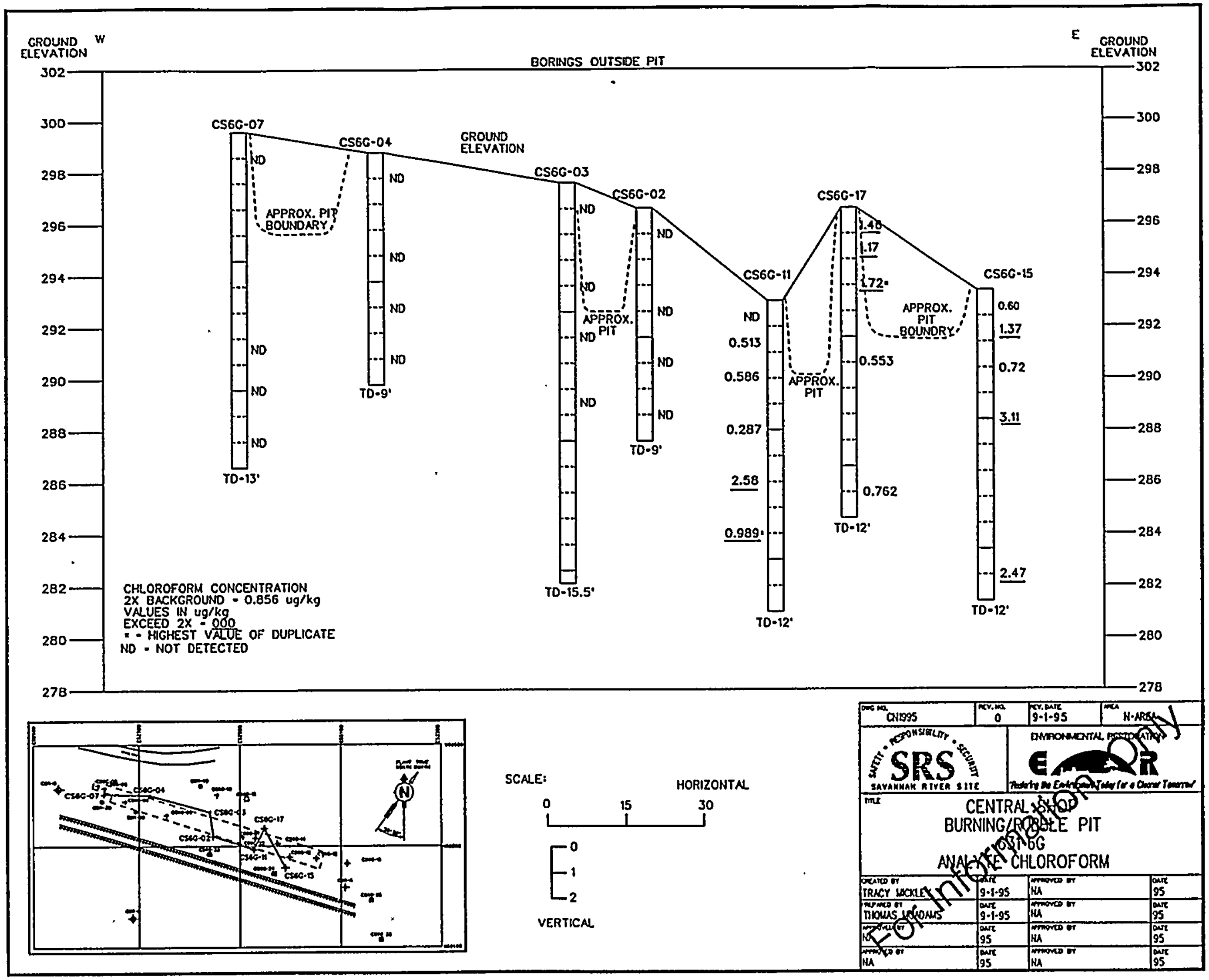

Figure 4-34 West-East Cross-Section Outside Pit Depicting Chloroform Concentrations

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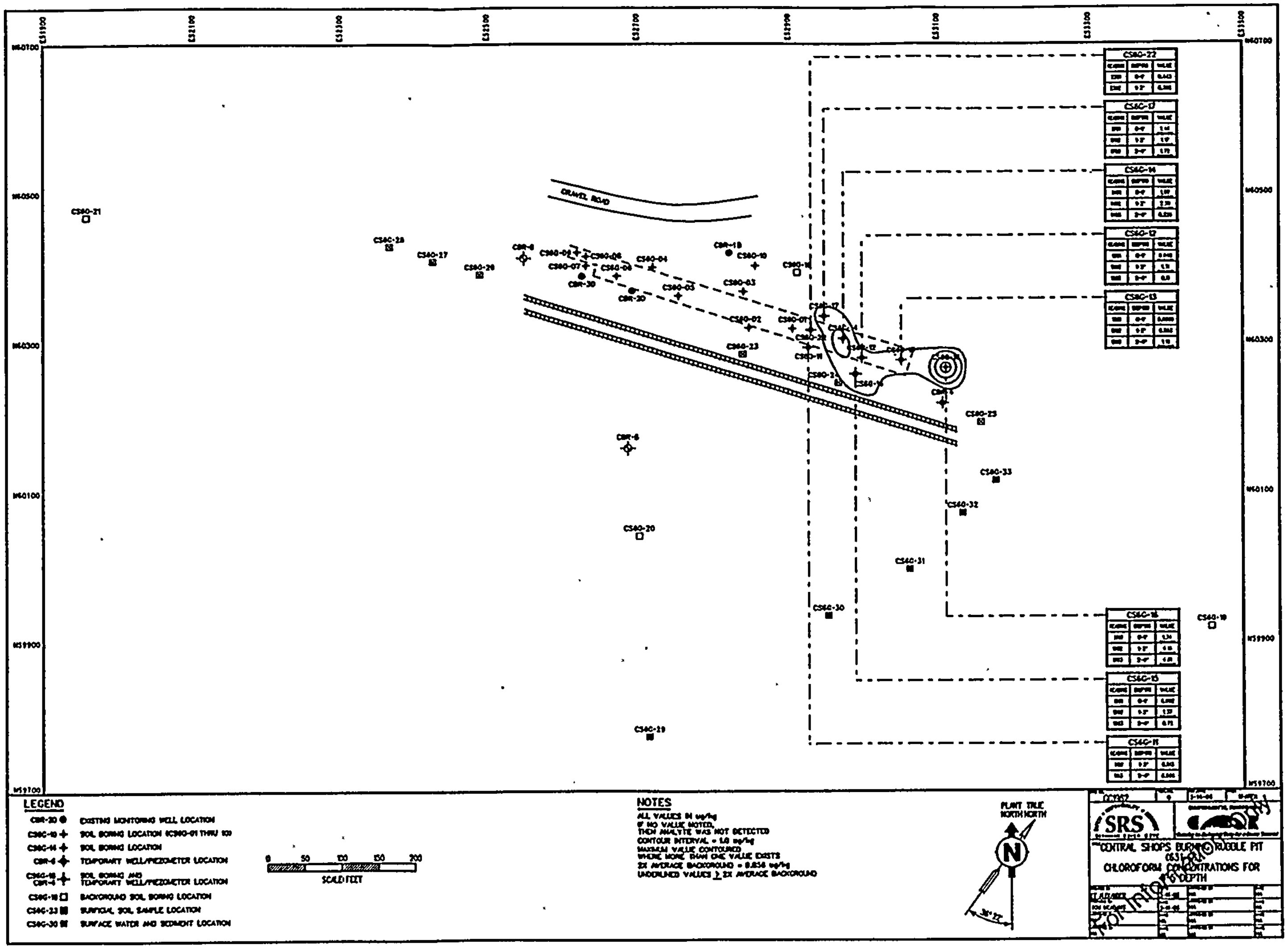

Figure 4-35 Isoconcentration Map of Chloroform Depicting Concentrations From 0-5'

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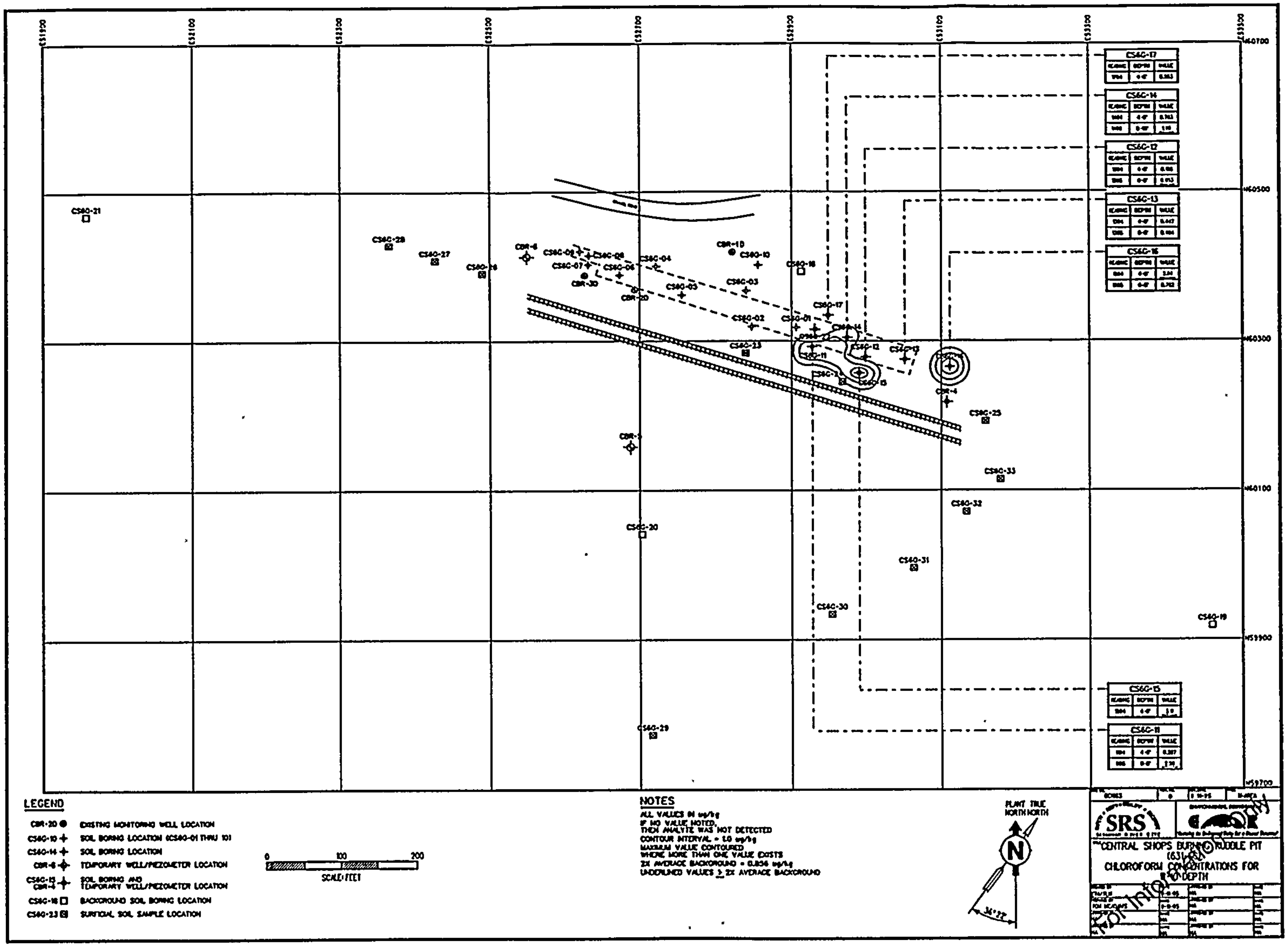

Figure 4-36 Isoconcentration Map of Chloroform Depicting Concentrations From 5-10'

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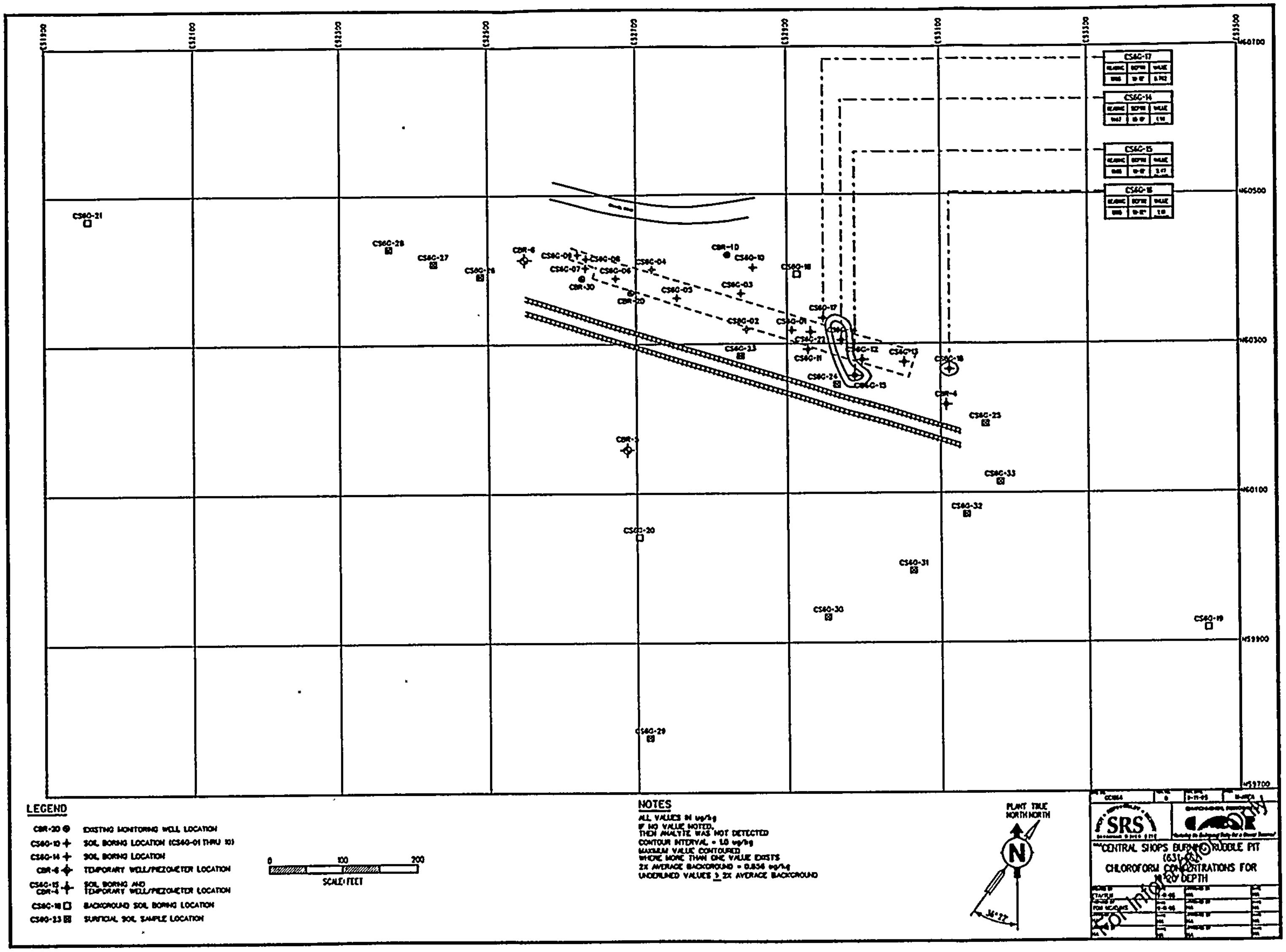

Figure 4-37 Isoconcentration Map of Chloroform Depicting Concentrations From 10-20'

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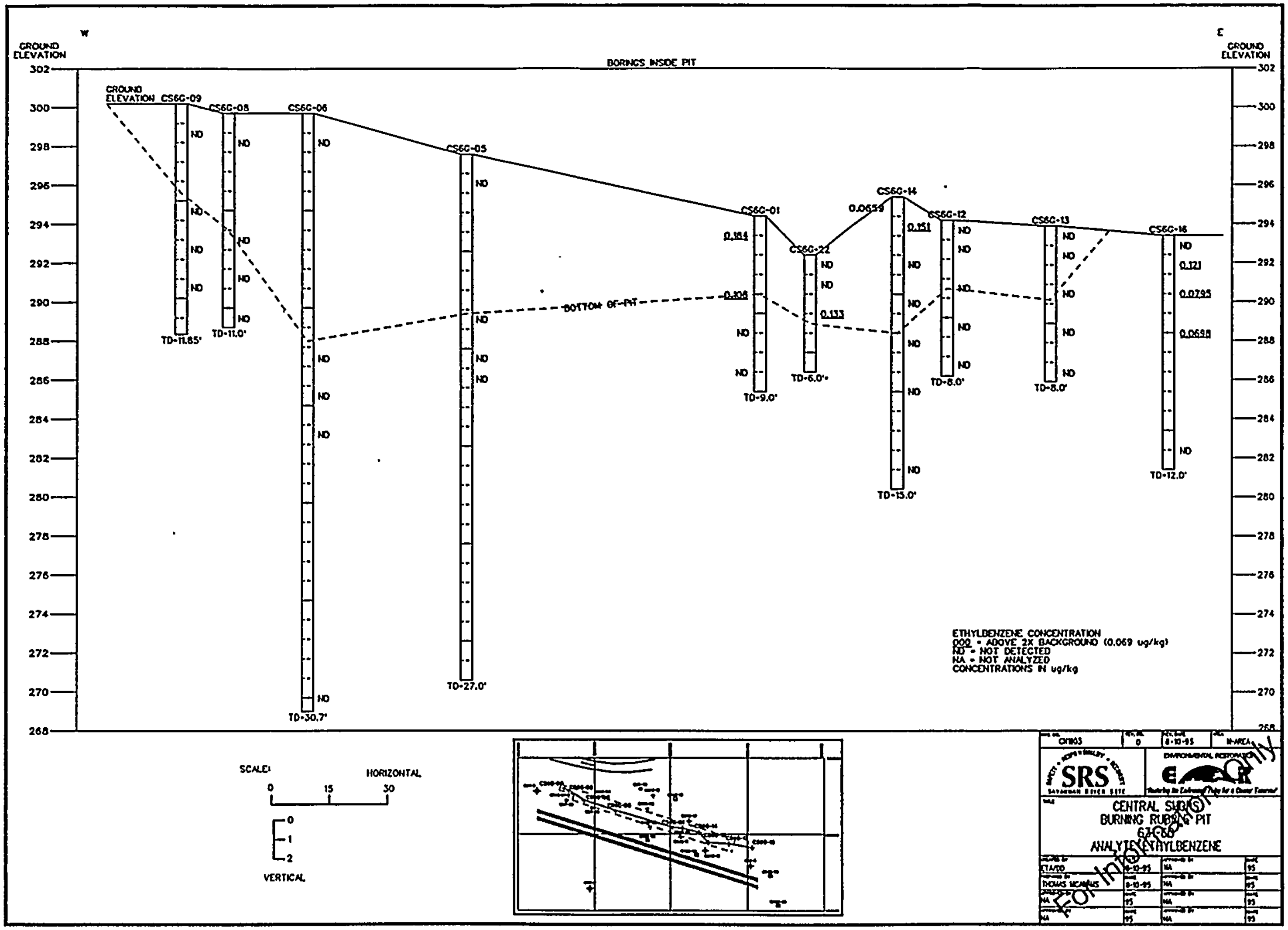

Figure 4-38 West-East Cross-Section Inside Pit Depicting Ethyl benzene Concentrations

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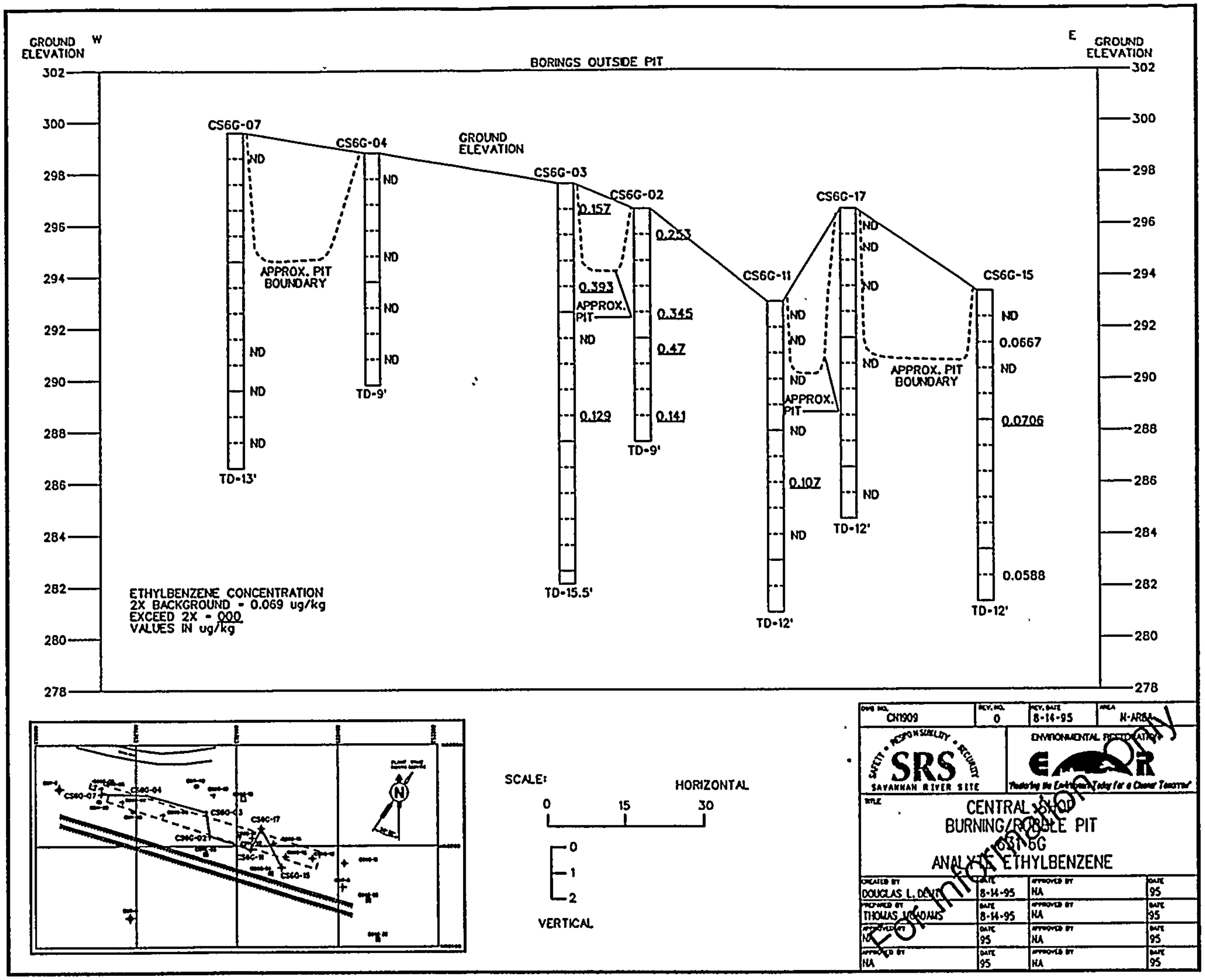

Figure 4-39 West-East Cross-Section Outside Pit Depicting Ethyl benzene Concentrations

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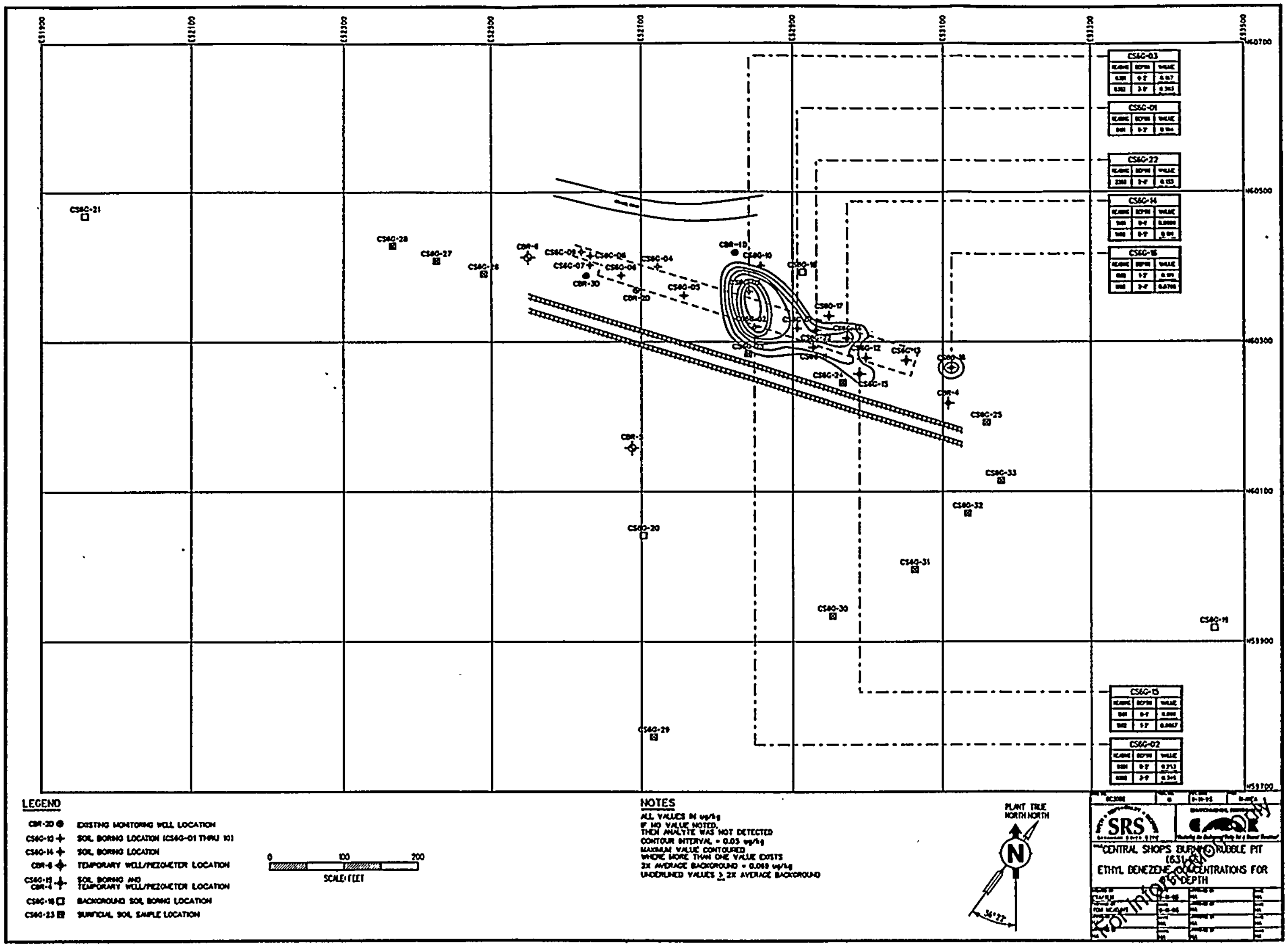

Figure 4-40 Isoconcentration Map of Ethyl benzene Depicting Concentrations From 0-5'

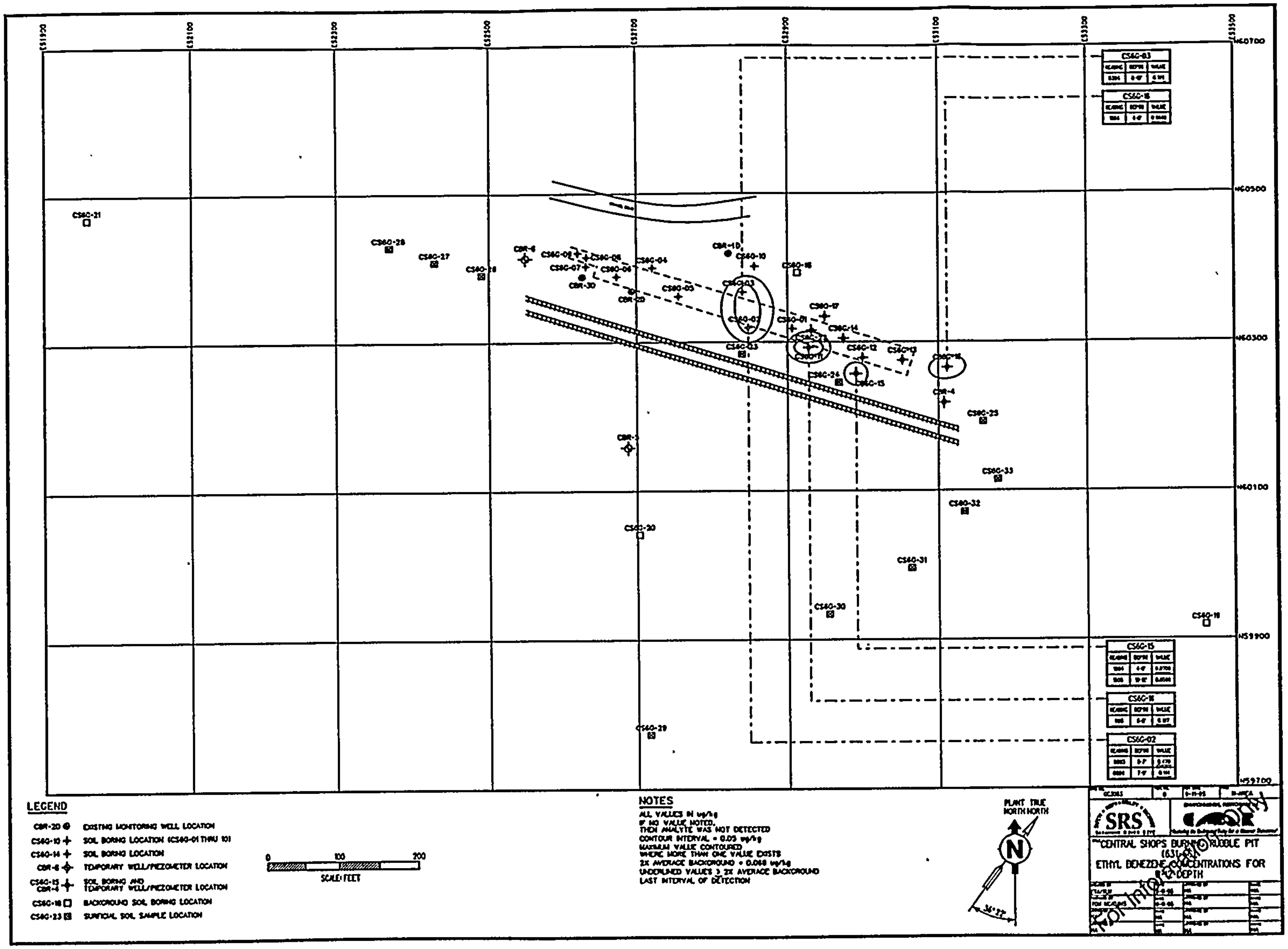

Figure 4-41 Isoconcentration Map of Ethyl benzene Depicting Concentrations From 5-12'

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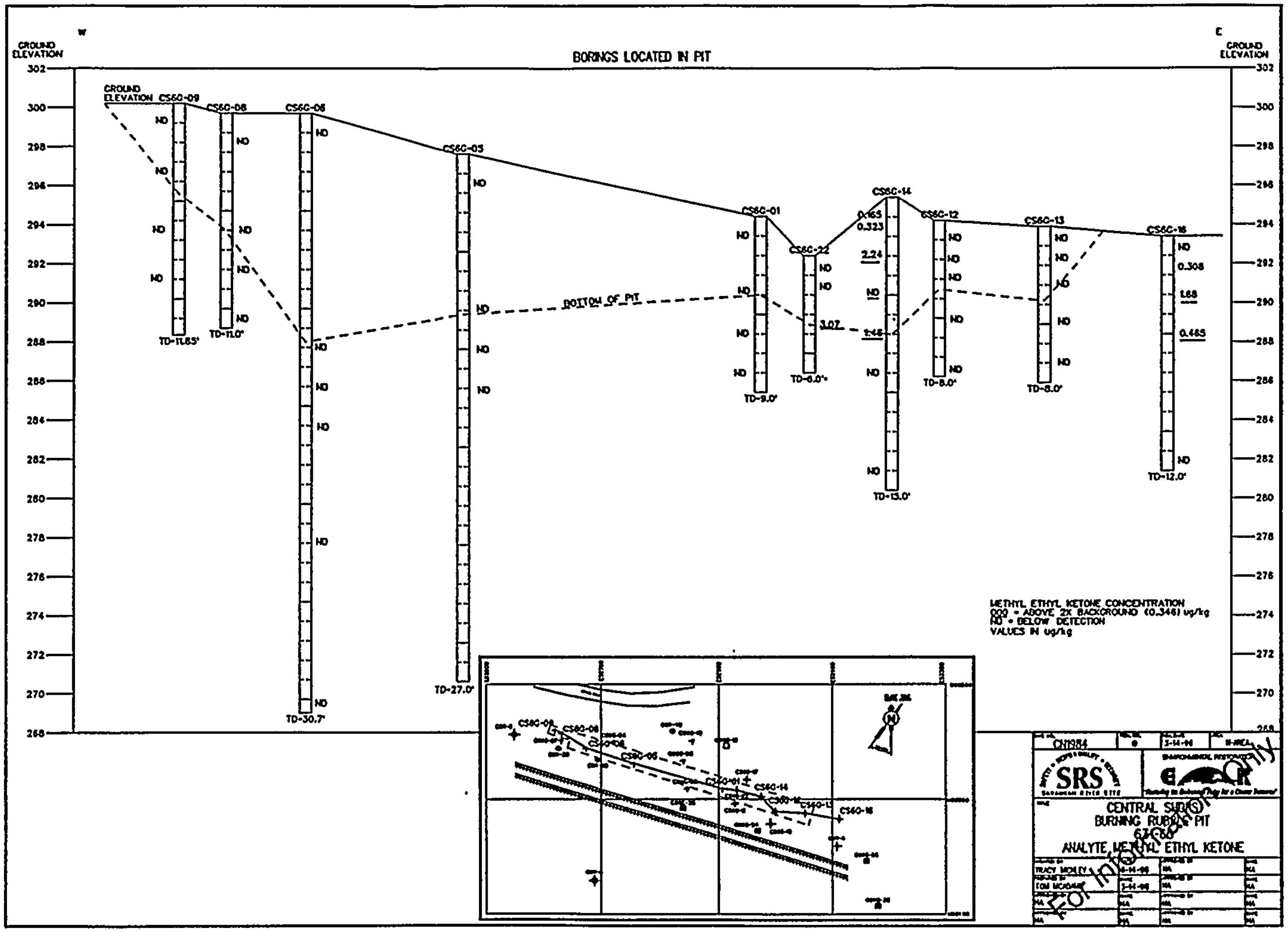

Figure 4-42 West-East Cross-Section Inside Pit Depicting Methyl ethyl ketone Concentrations

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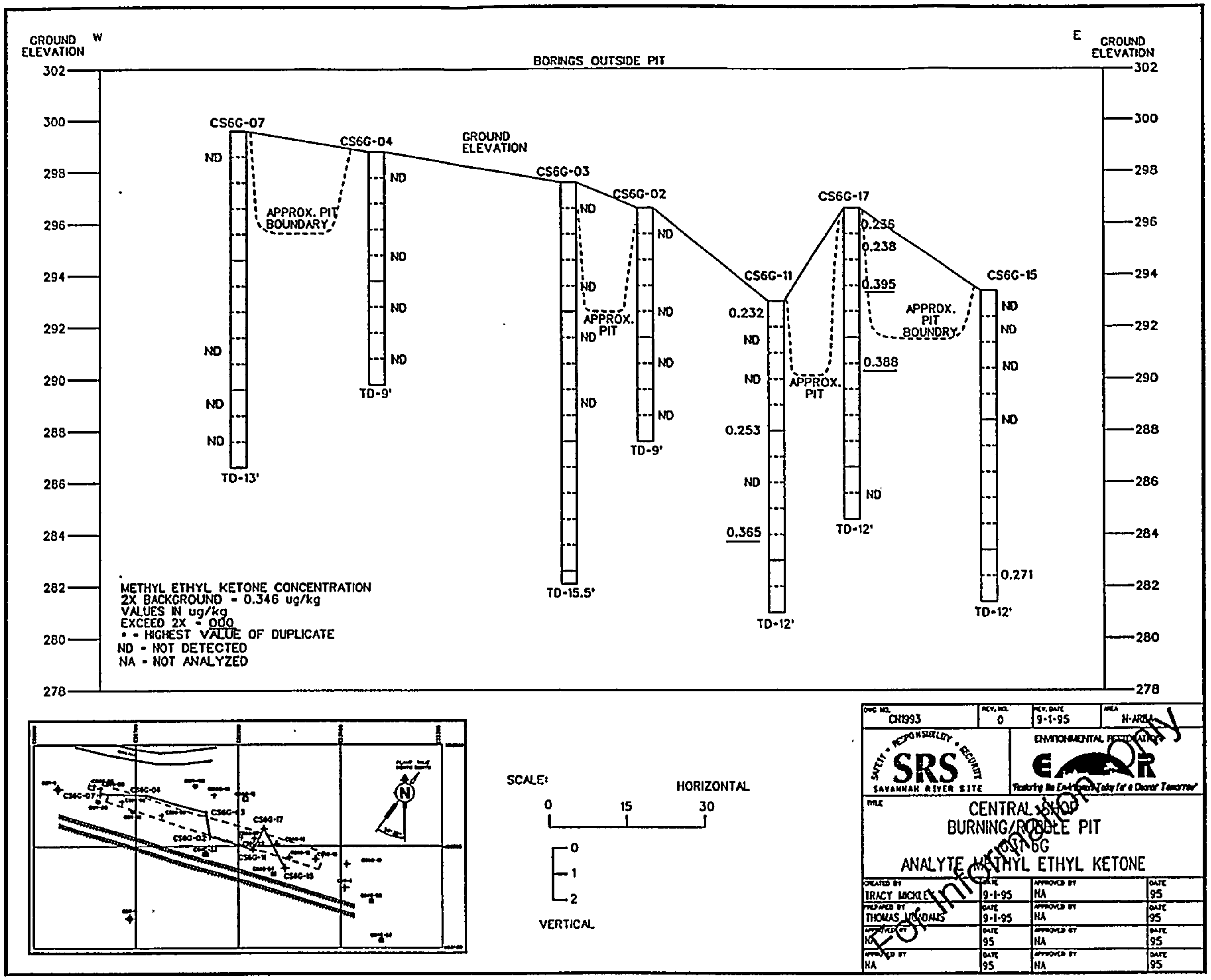

Figure 4-43 West-East Cross-Section Outside Pit Depicting Methyl ethyl ketone Concentrations

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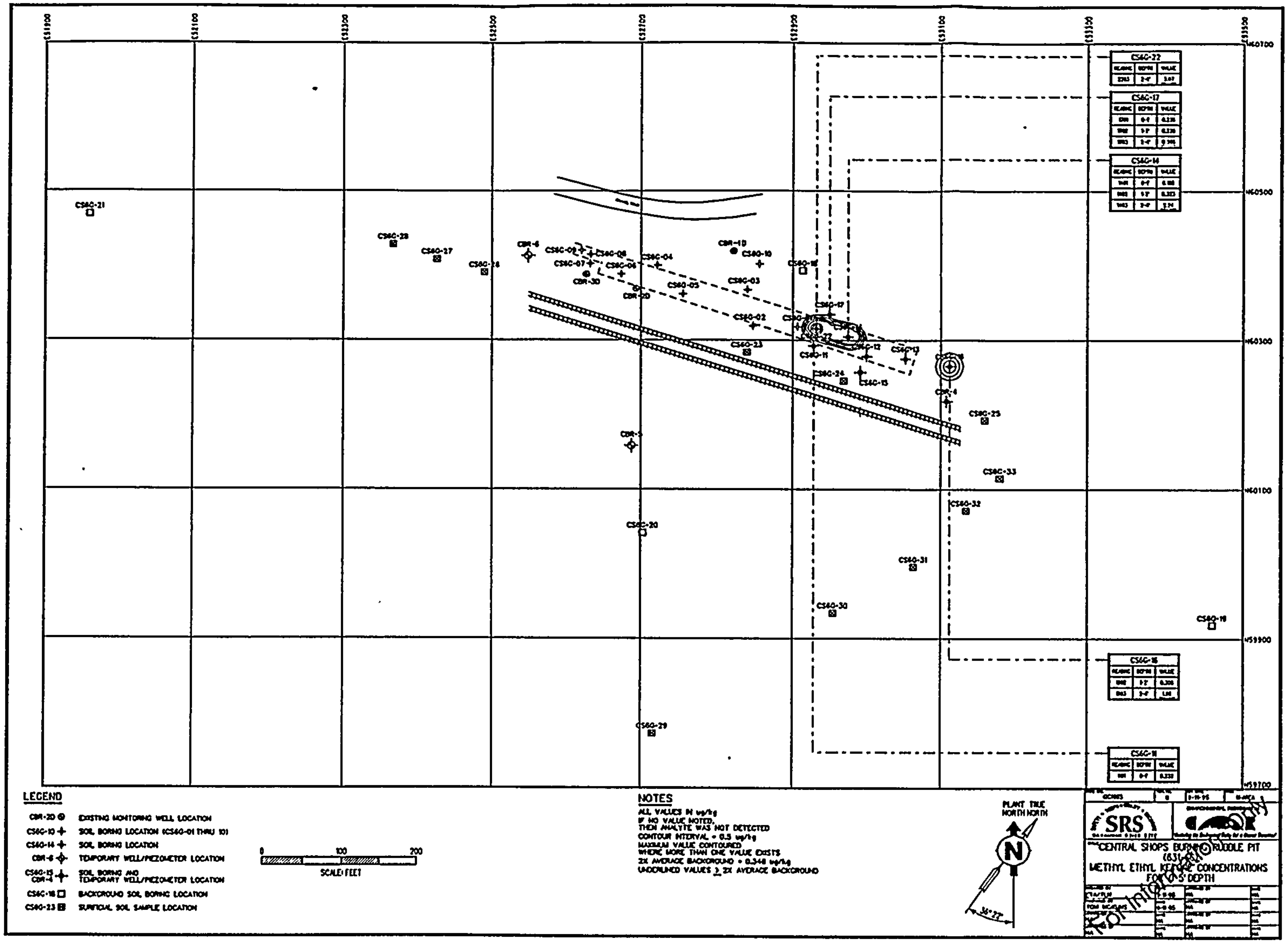

Figure 4-44 Isoconcentration Map of Methyl ethyl ketone Depicting Concentrations From 0-5'

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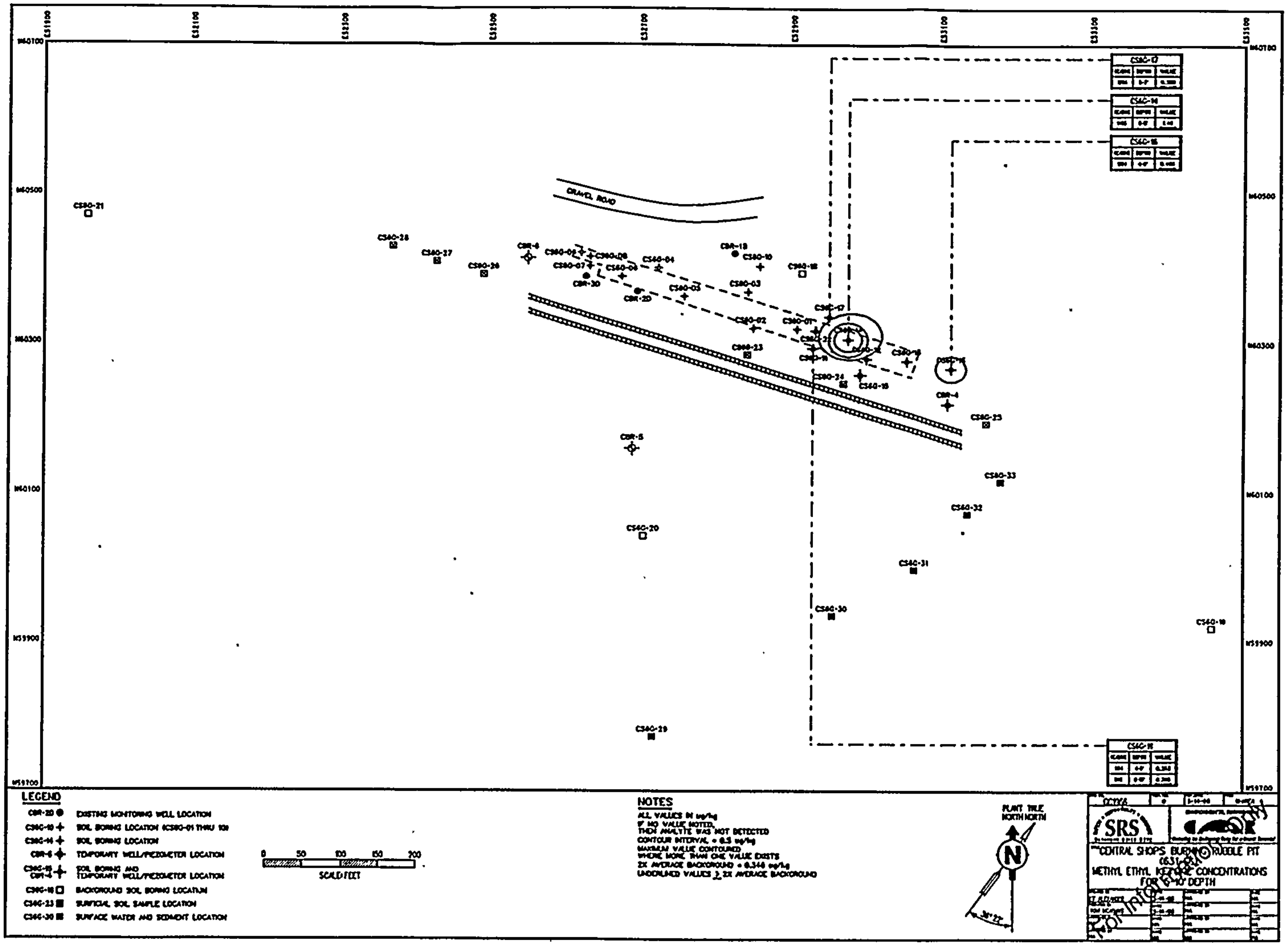

Figure 4-45 Isoconcentration Map of Methyl ethyl ketone Depicting Concentrations From 5- 10'

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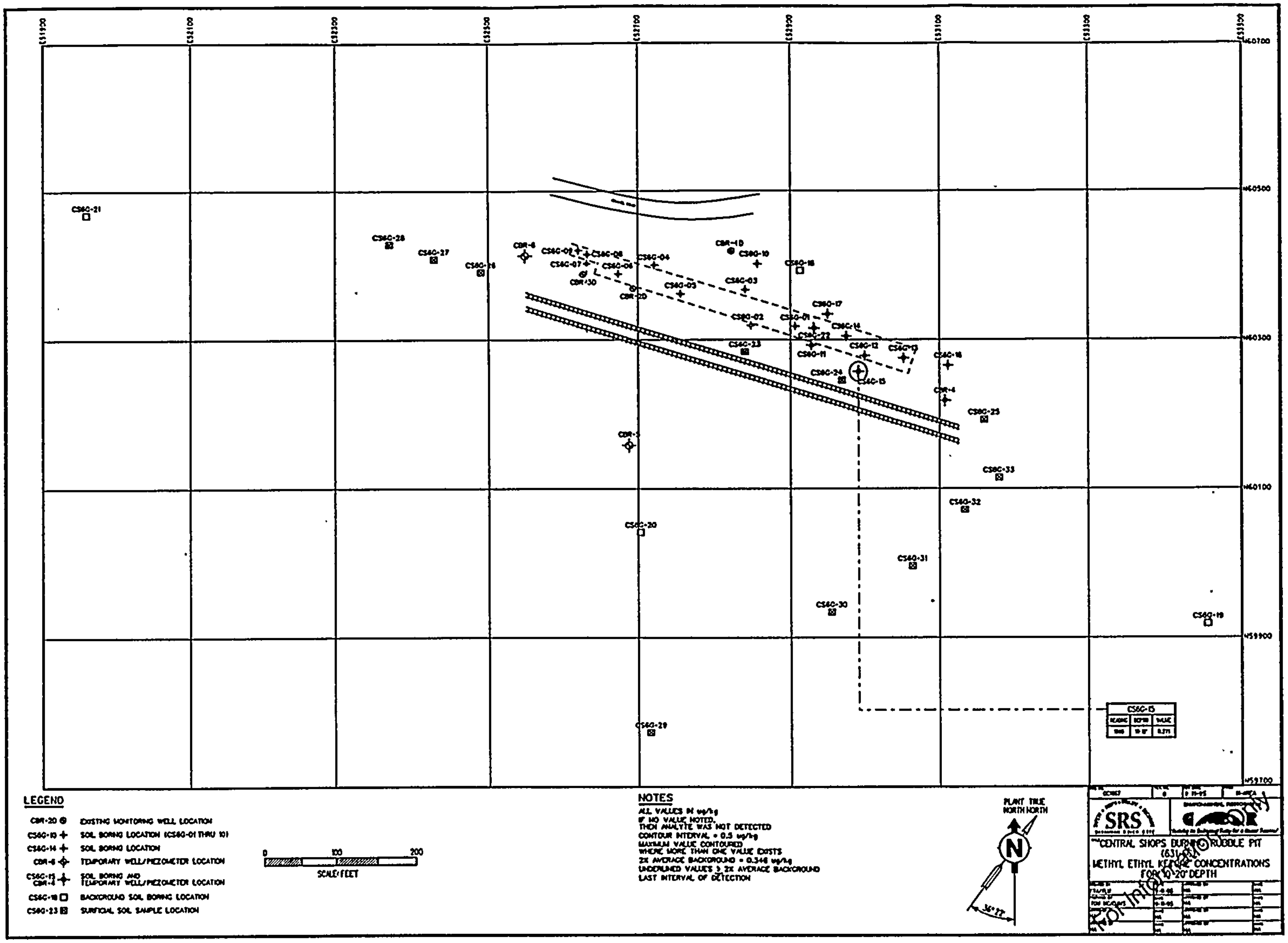

Figure 4-46 Isoconcentration Map of Methyl ethyl ketone Depicting Concentrations From 10-20'

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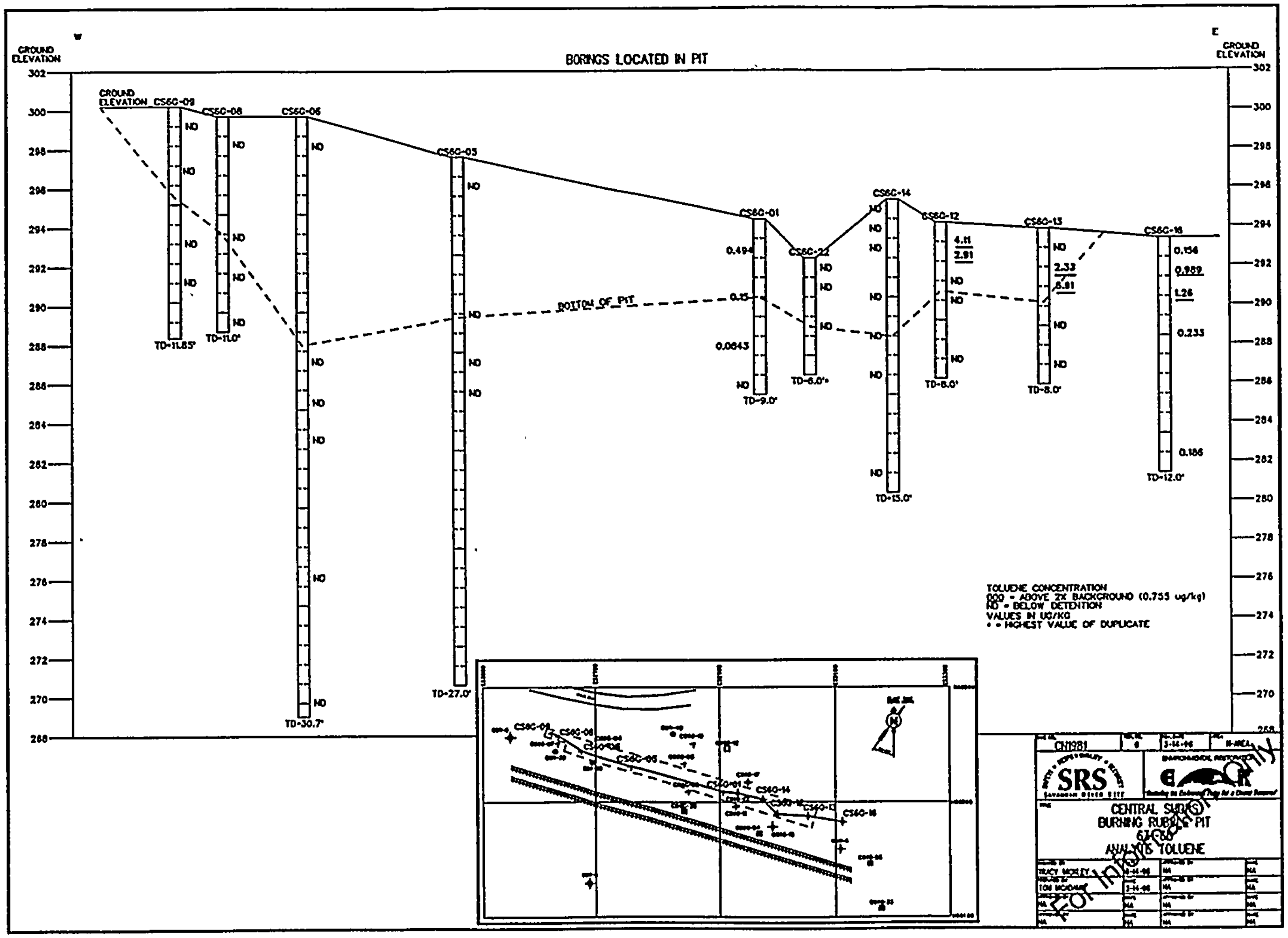

Figure 4-47 West-East Cross-Section Inside Pit Depicting Toluene Concentrations

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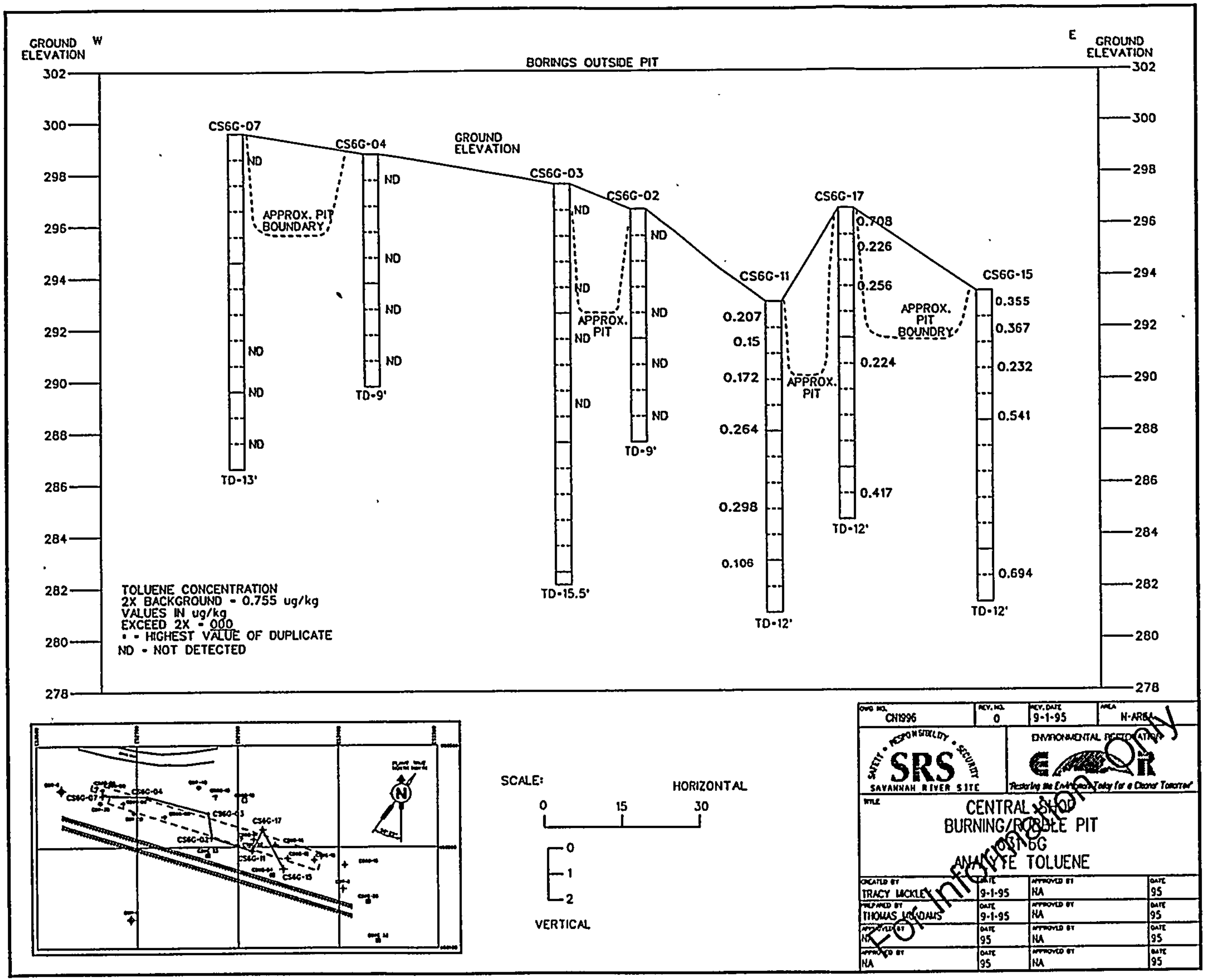

Figure 4-48 West-East Cross-Section Outside Pit Depicting Toluene Concentrations

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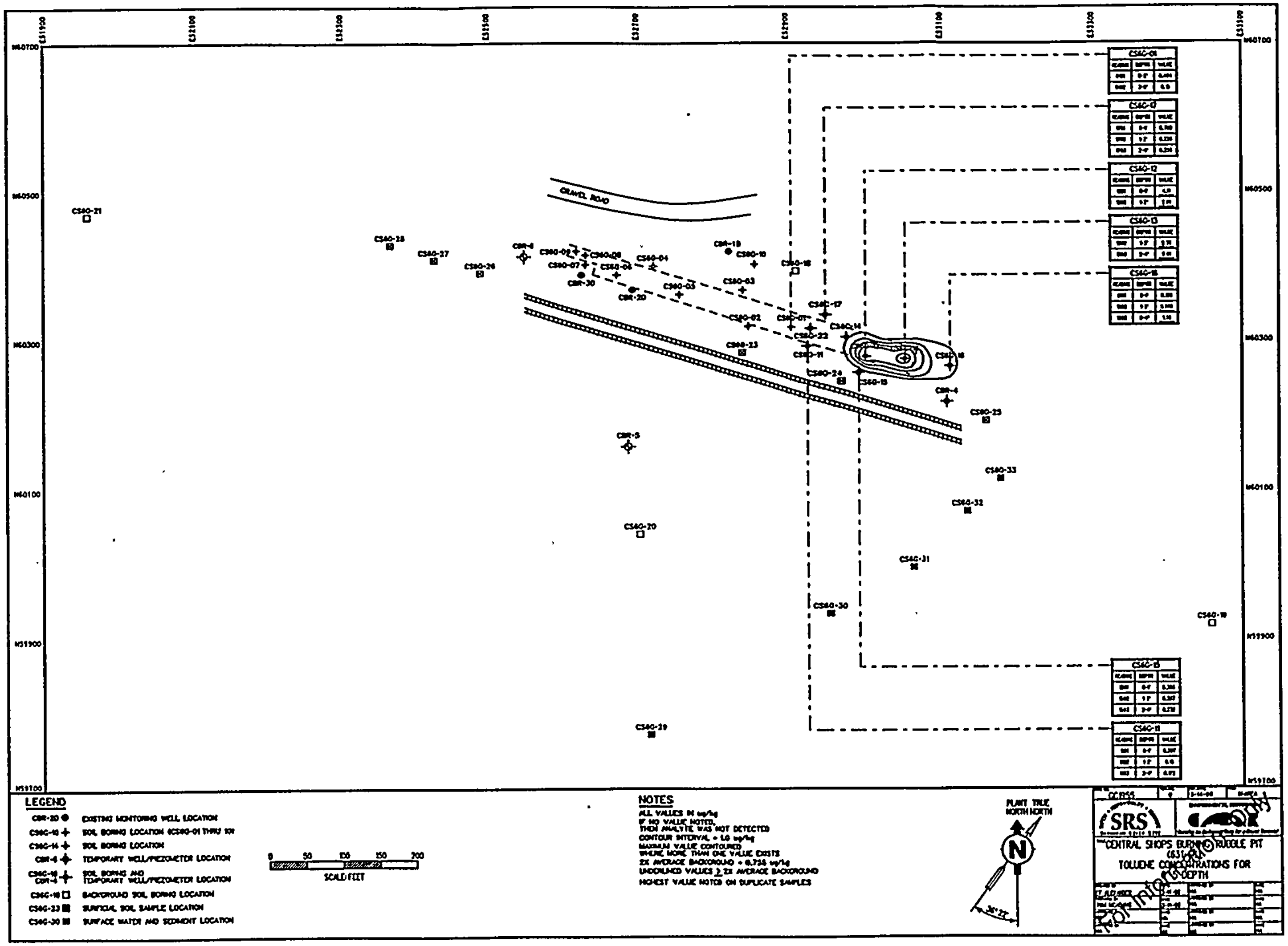

Figure 4-49 Isoconcentration Map of Toluene Depicting Concentrations From 0-5'

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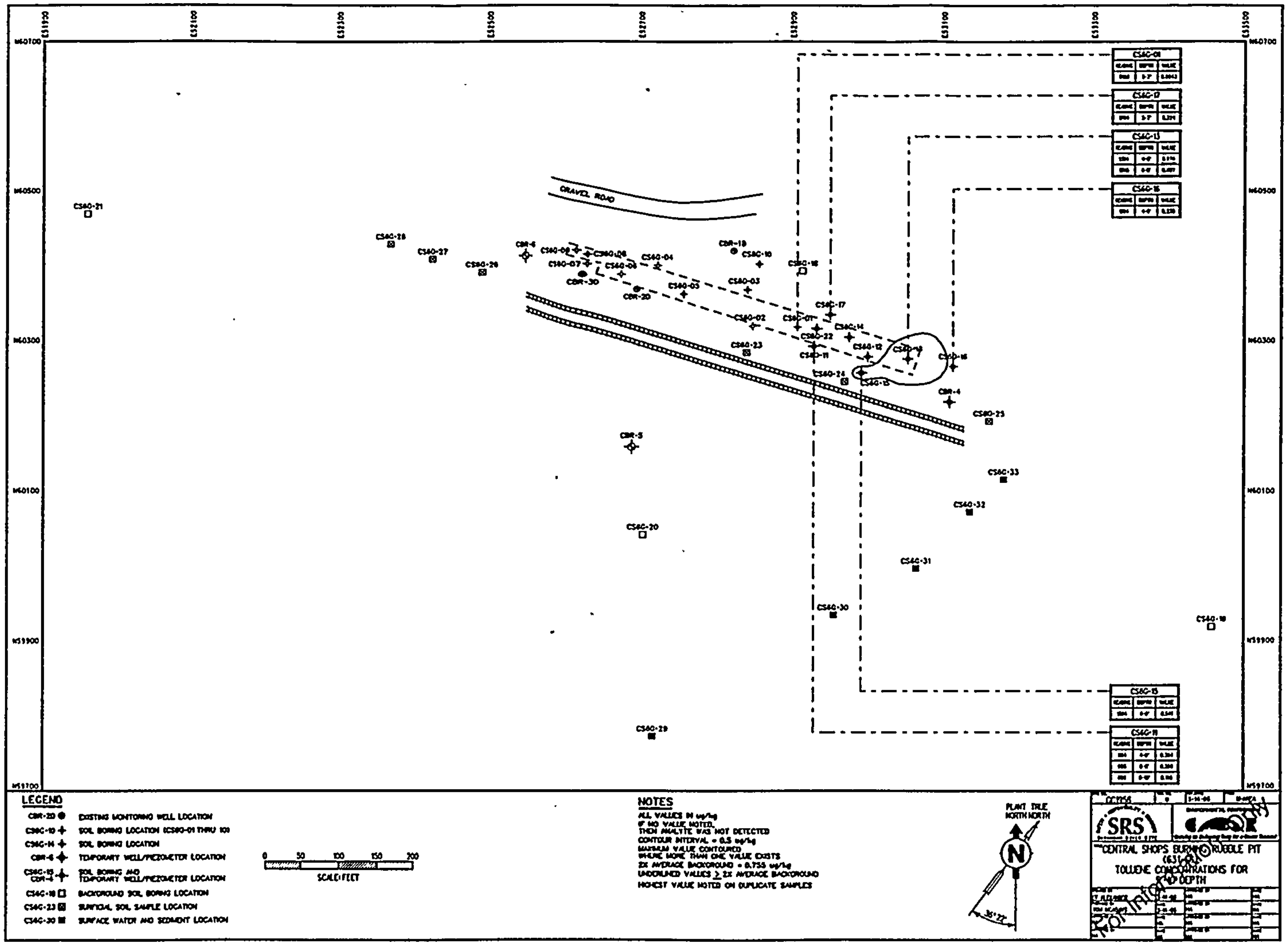

Figure 4-50 Isoconcentration Map of Toluene Depicting Concentrations From 5-10'

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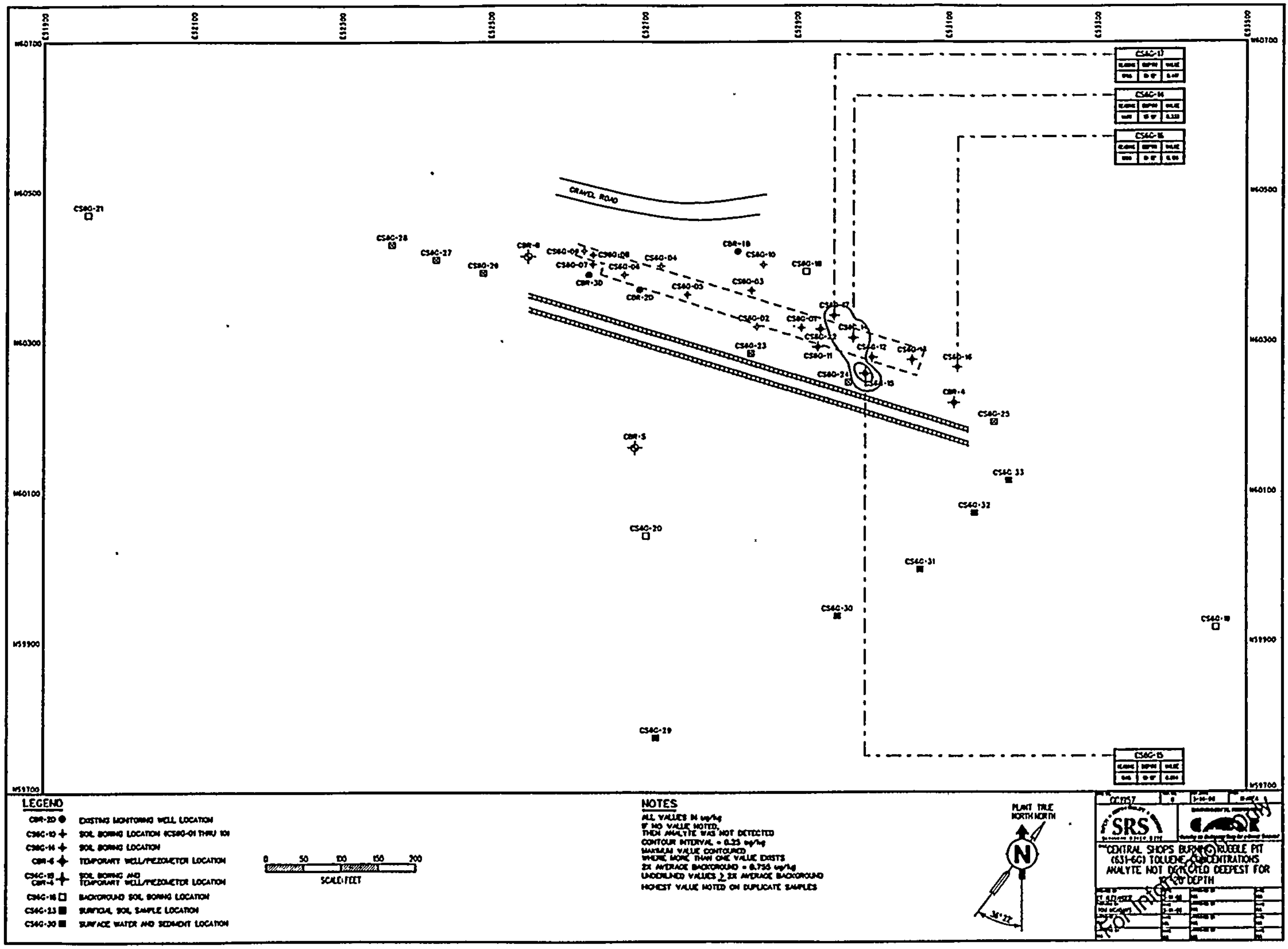

Figure 4-51 Isoconcentration Map of Toluene Depicting Concentrations From 10-20'

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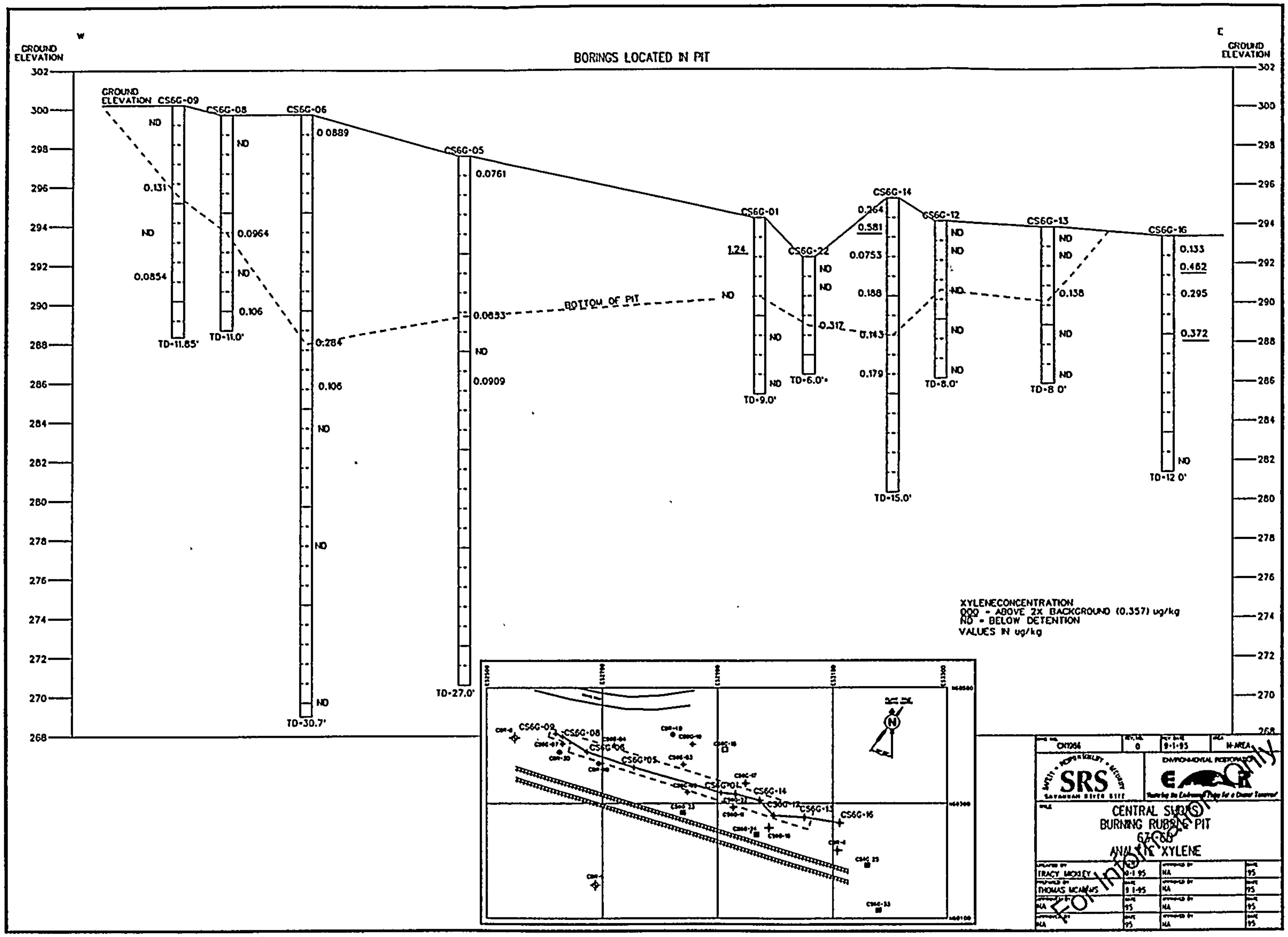

Figure 4-52 West-East Cross-Section Inside Pit Depicting Xylene Concentrations

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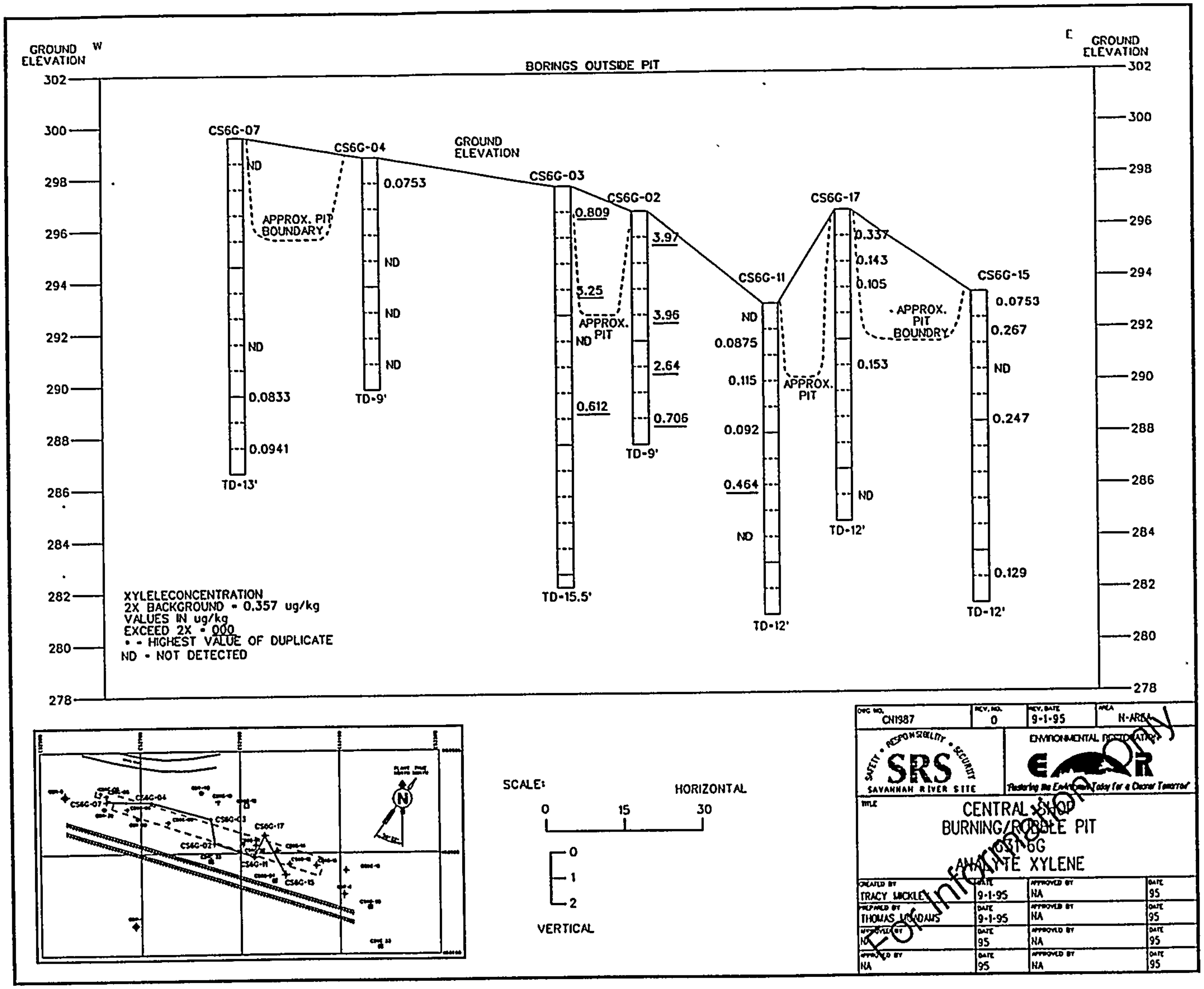

Figure 4-53 West-East Cross-Section Outside Pit Depicting Xylene Concentrations

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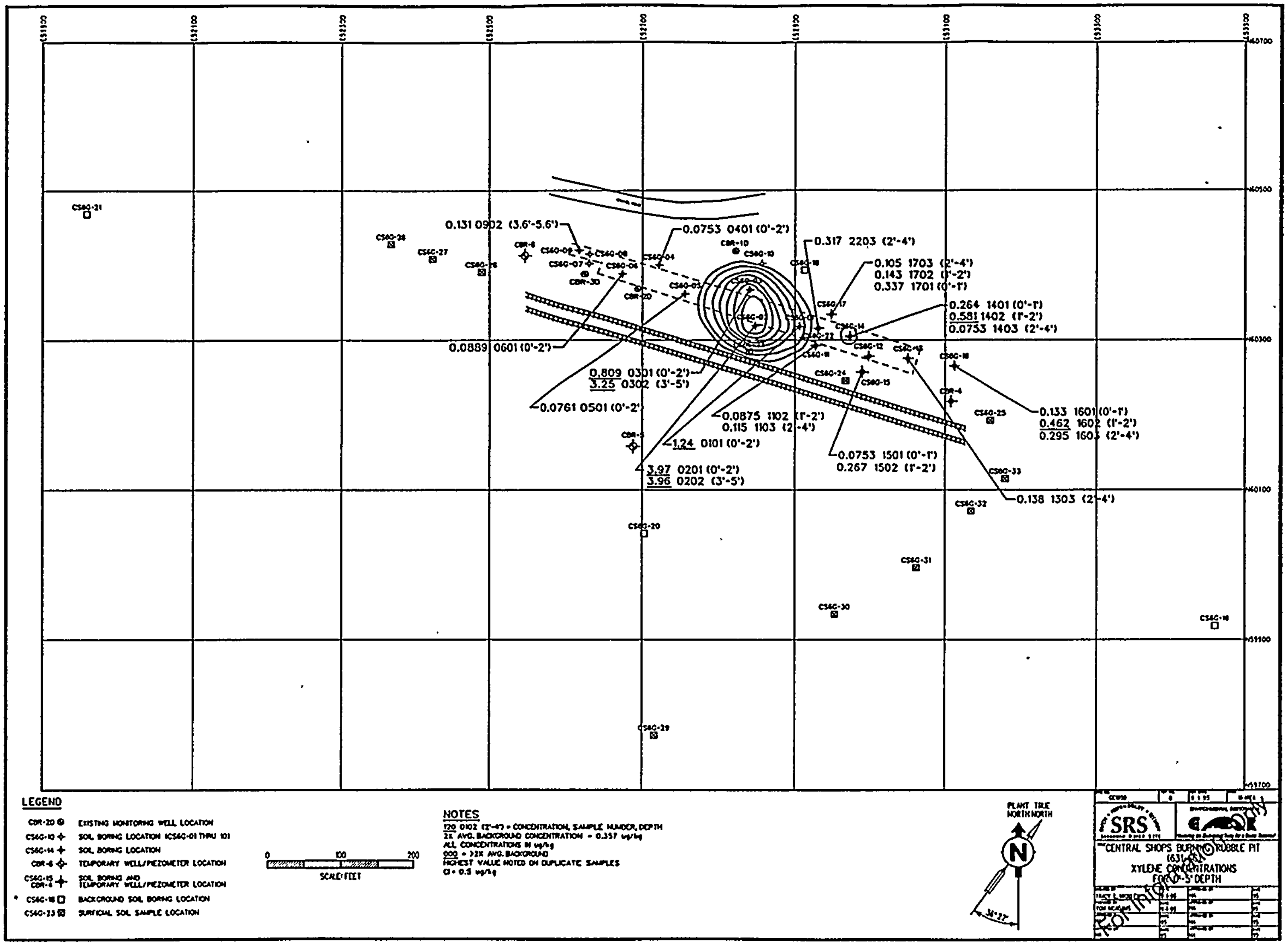

Figure 4-54 Isoconcentration Map of Xylene Depicting Concentrations From 0-5'

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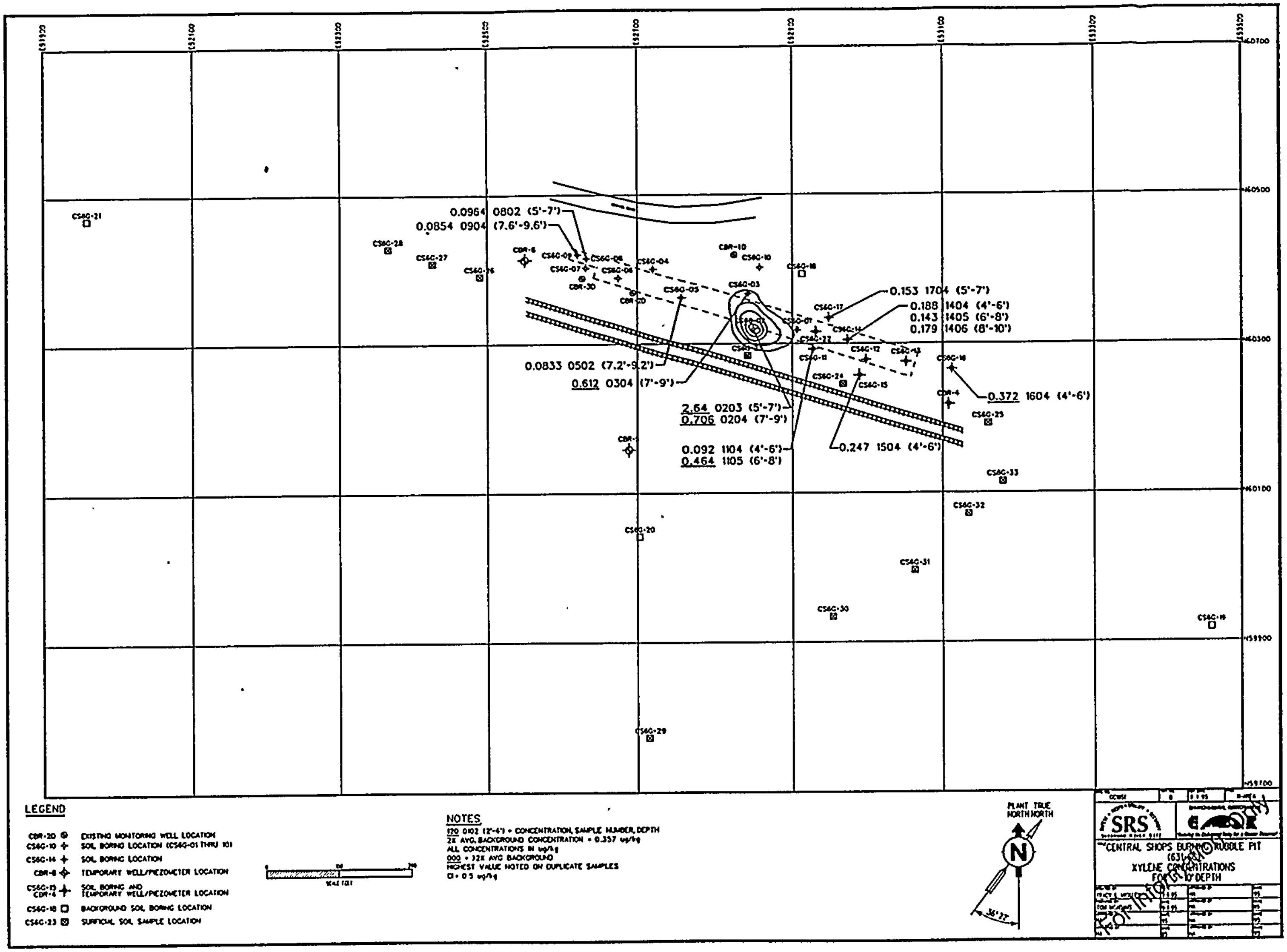

Figure 4-55 Isoconcentration Map of Xylene Depicting Concentrations From 5-10'

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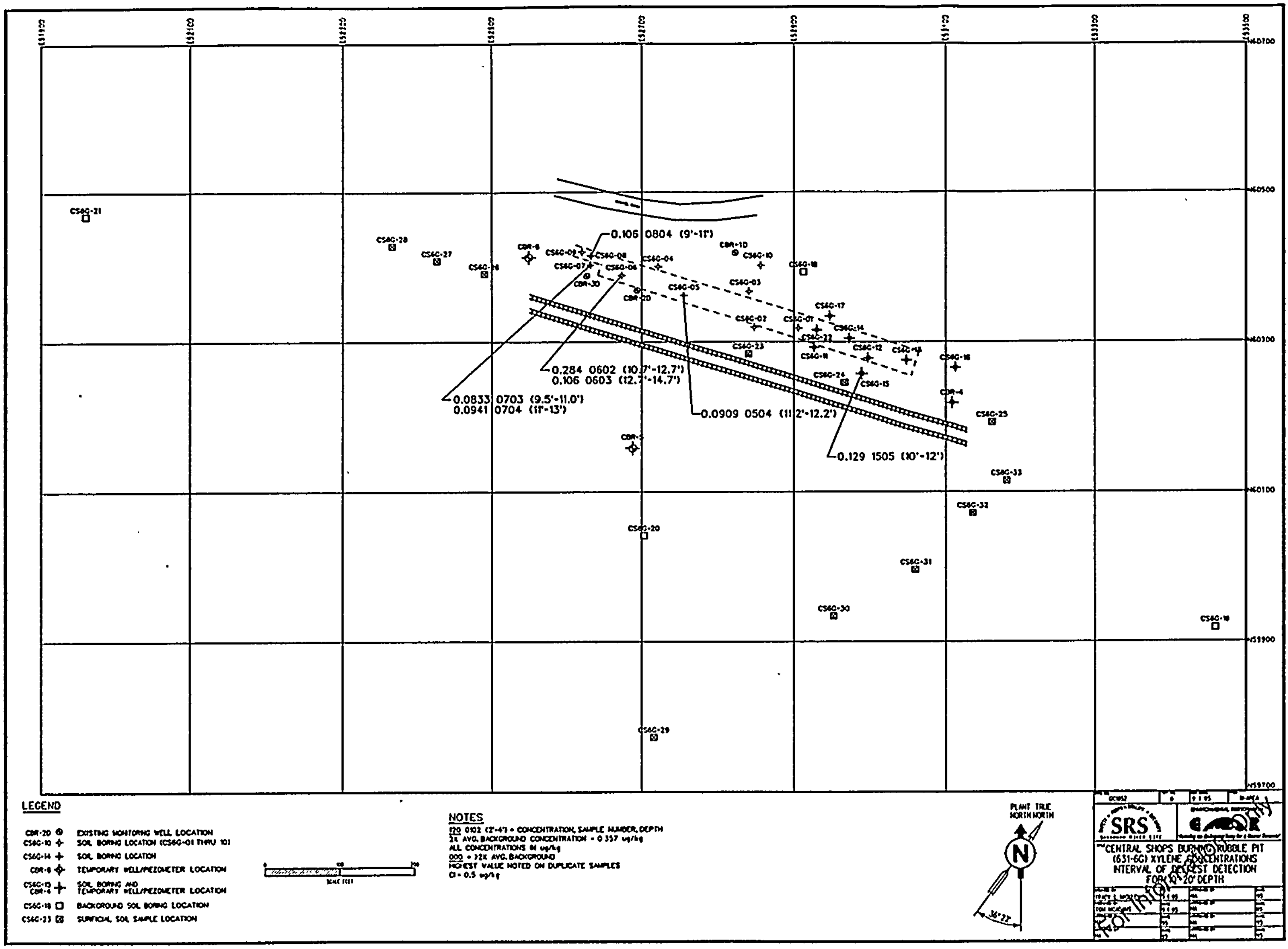

Figure 4-56 Isoconcentration Map of Xylene Depicting Concentrations From 10-20'

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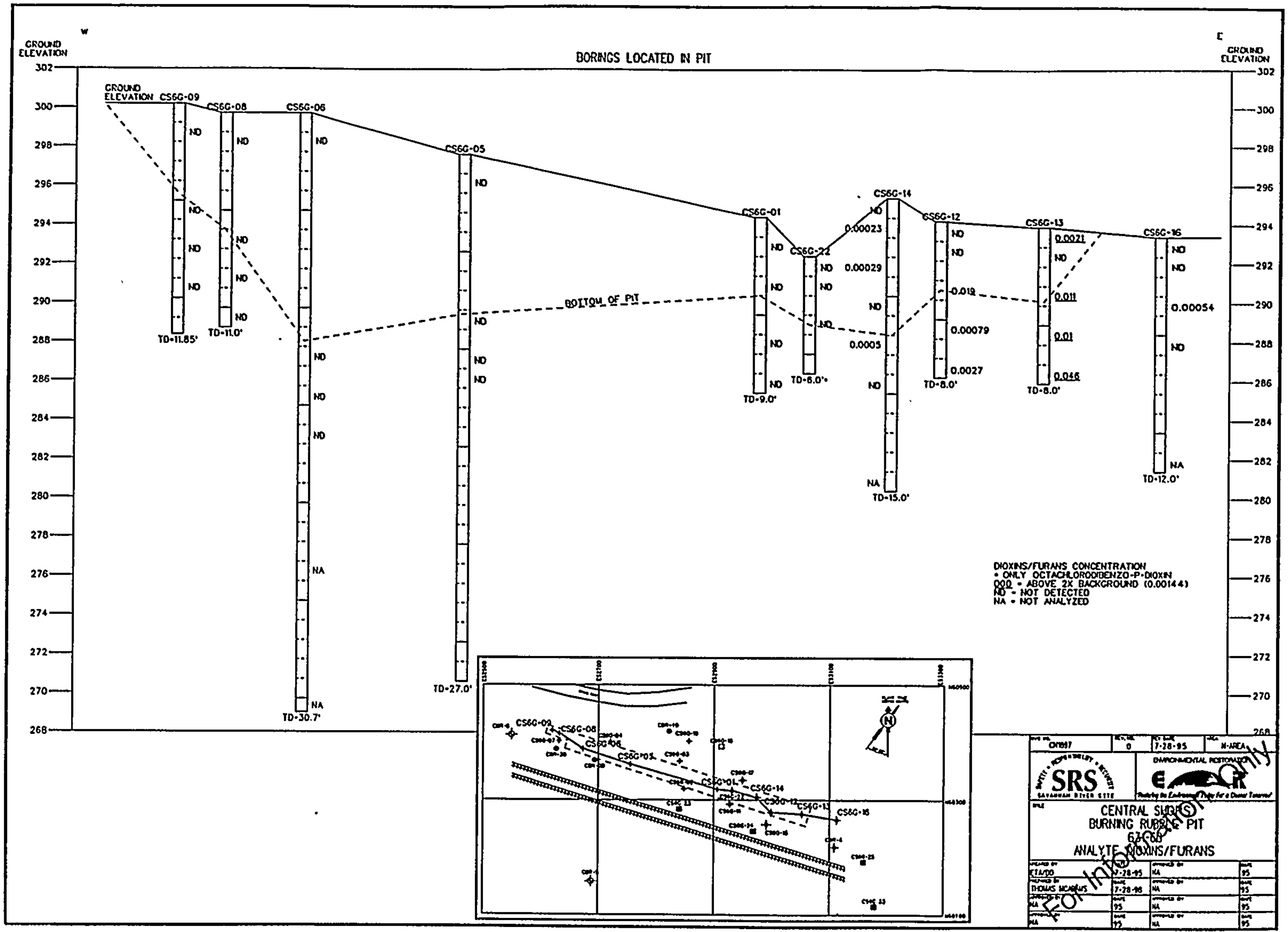

Figure 4-57 West-East Cross-Section Inside Pit Depicting Octachlorodibenzo-p-dioxin Concentrations

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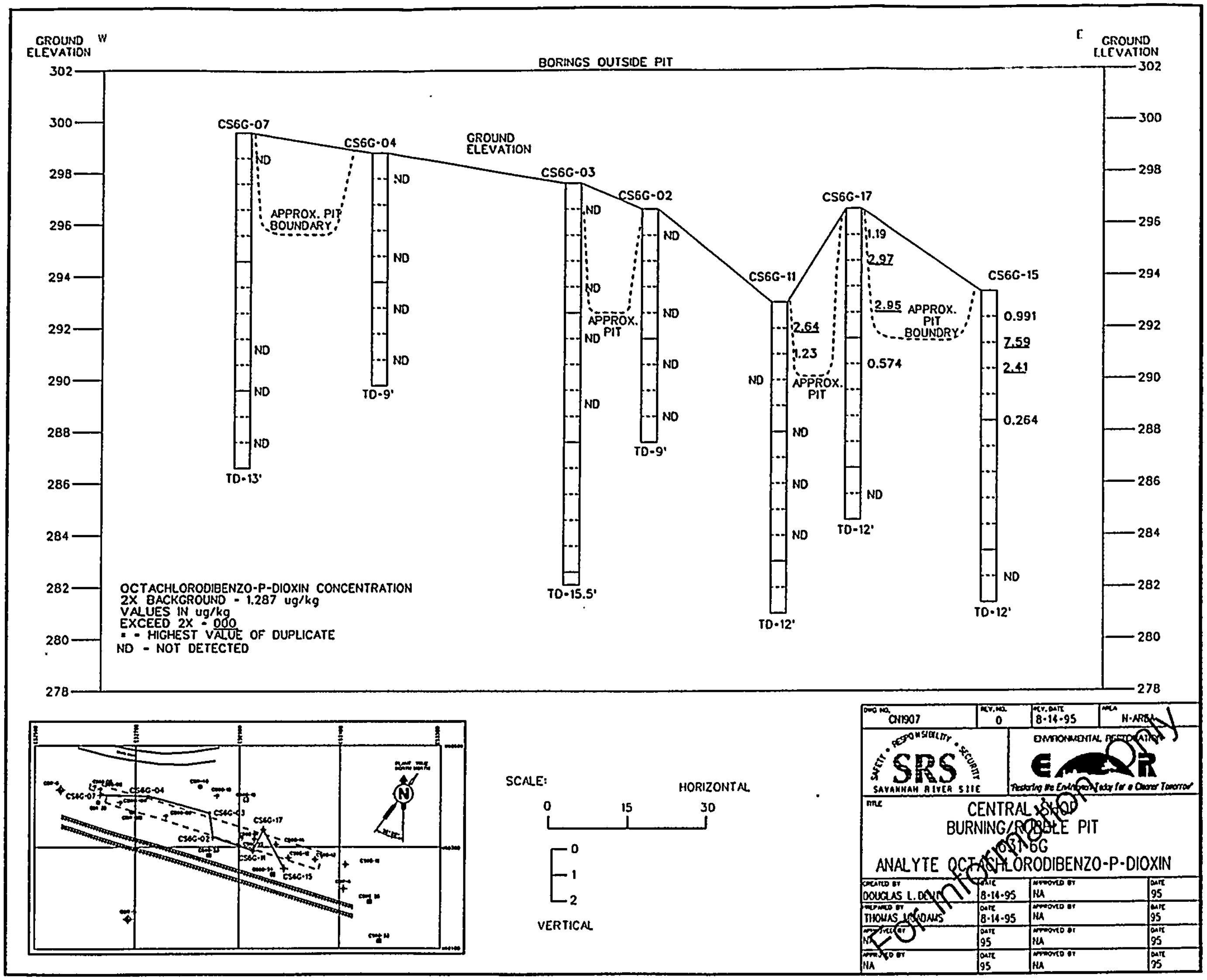

Figure 4-58 West-East Cross-Section Outside Pit Depicting Octachlorodibenzo-p-dioxin Concentrations

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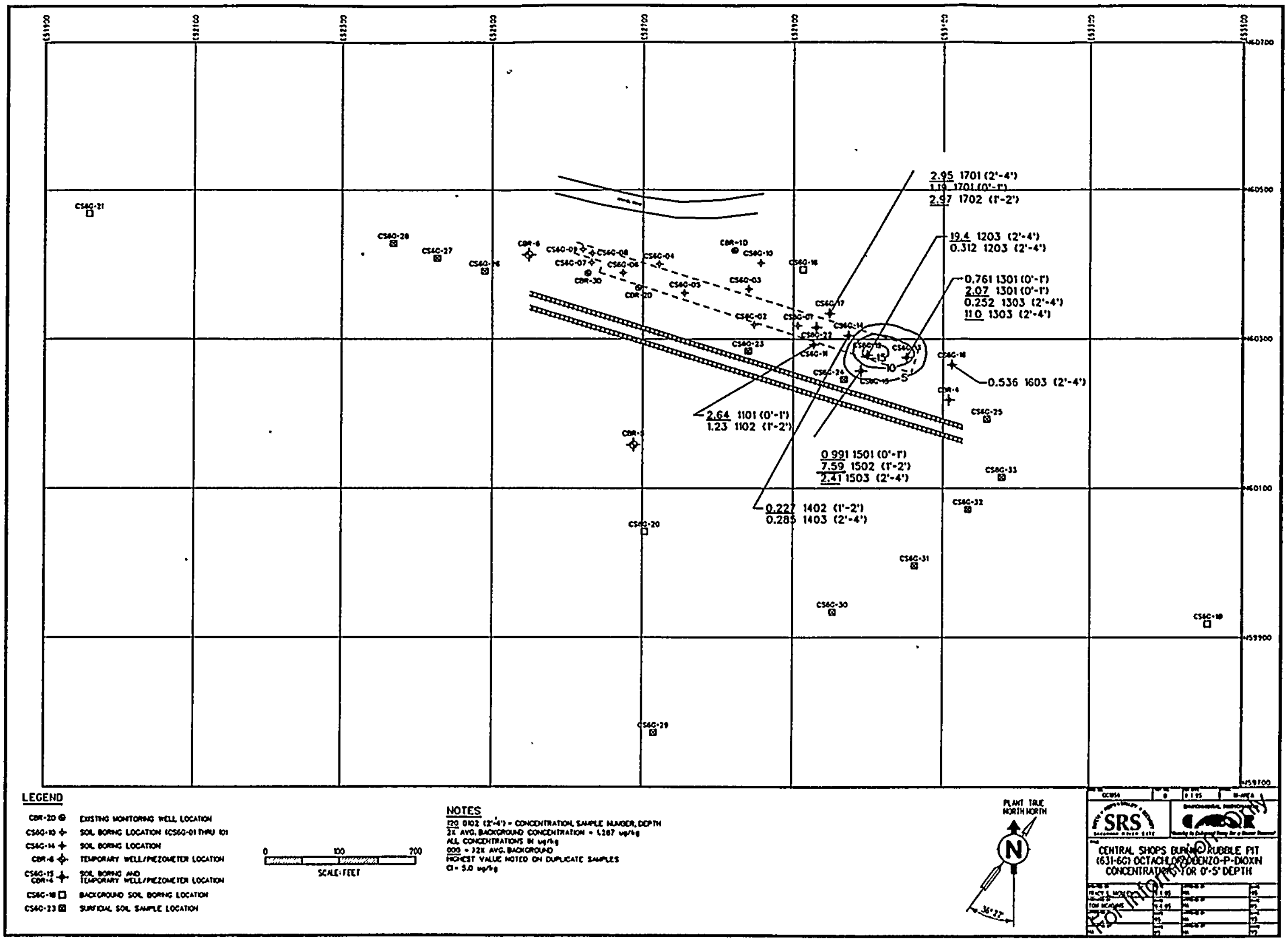

Figure 4-59 Isoconcentration Map of Octachlorodibenzo-p-dioxin Depicting Concentrations From 0-5'

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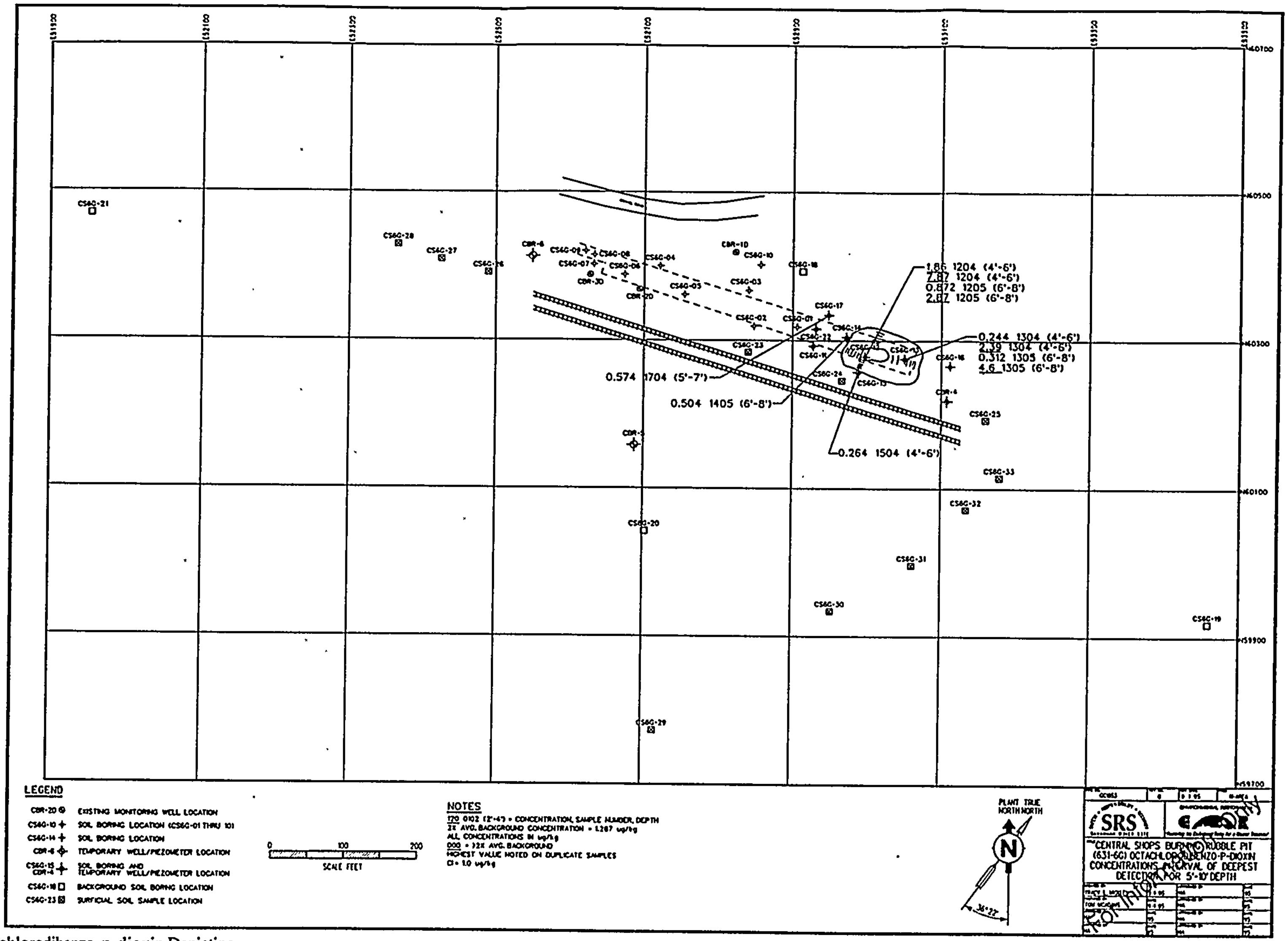

Figure 4-60 Isoconcentration Map of Octachlorodibenzo-p-dioxin Depicting Concentrations From 5-10'

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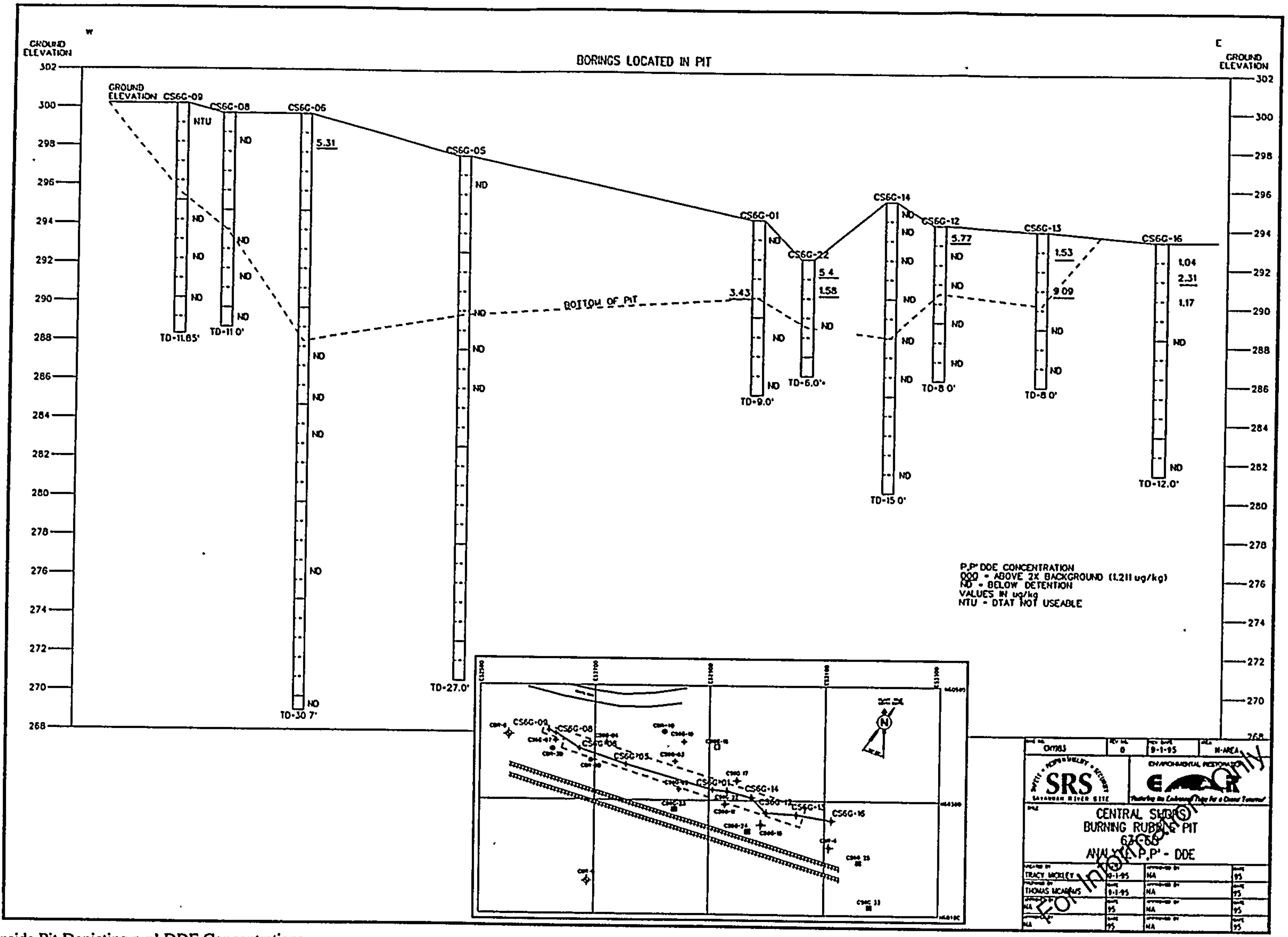

Figure 4-61 West-East Cross-Section Inside Pit Depicting p,p' DDE Concentrations

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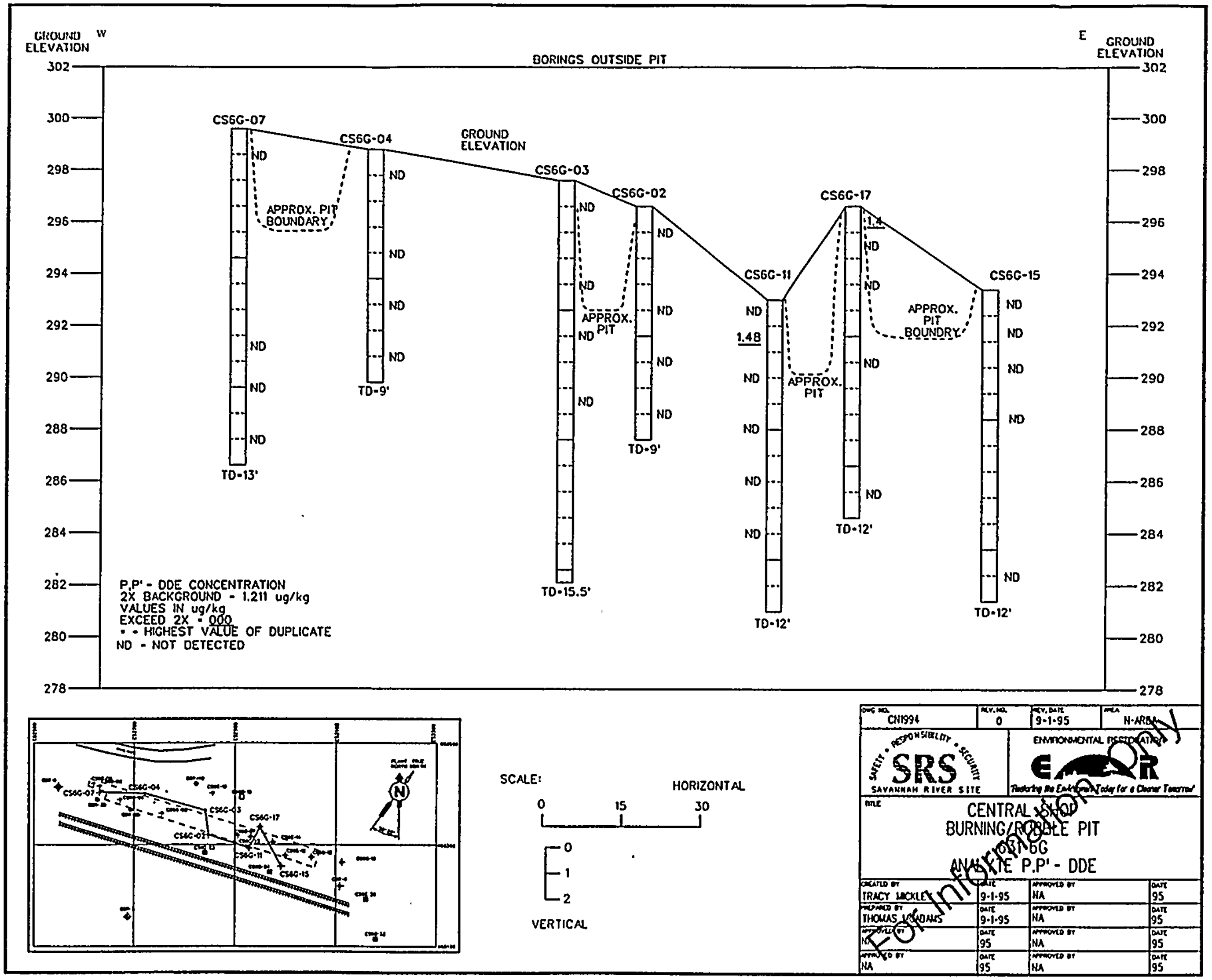

Figure 4-62 West-East Cross-Section Outside Pit Depicting p,p' DDE Concentrations

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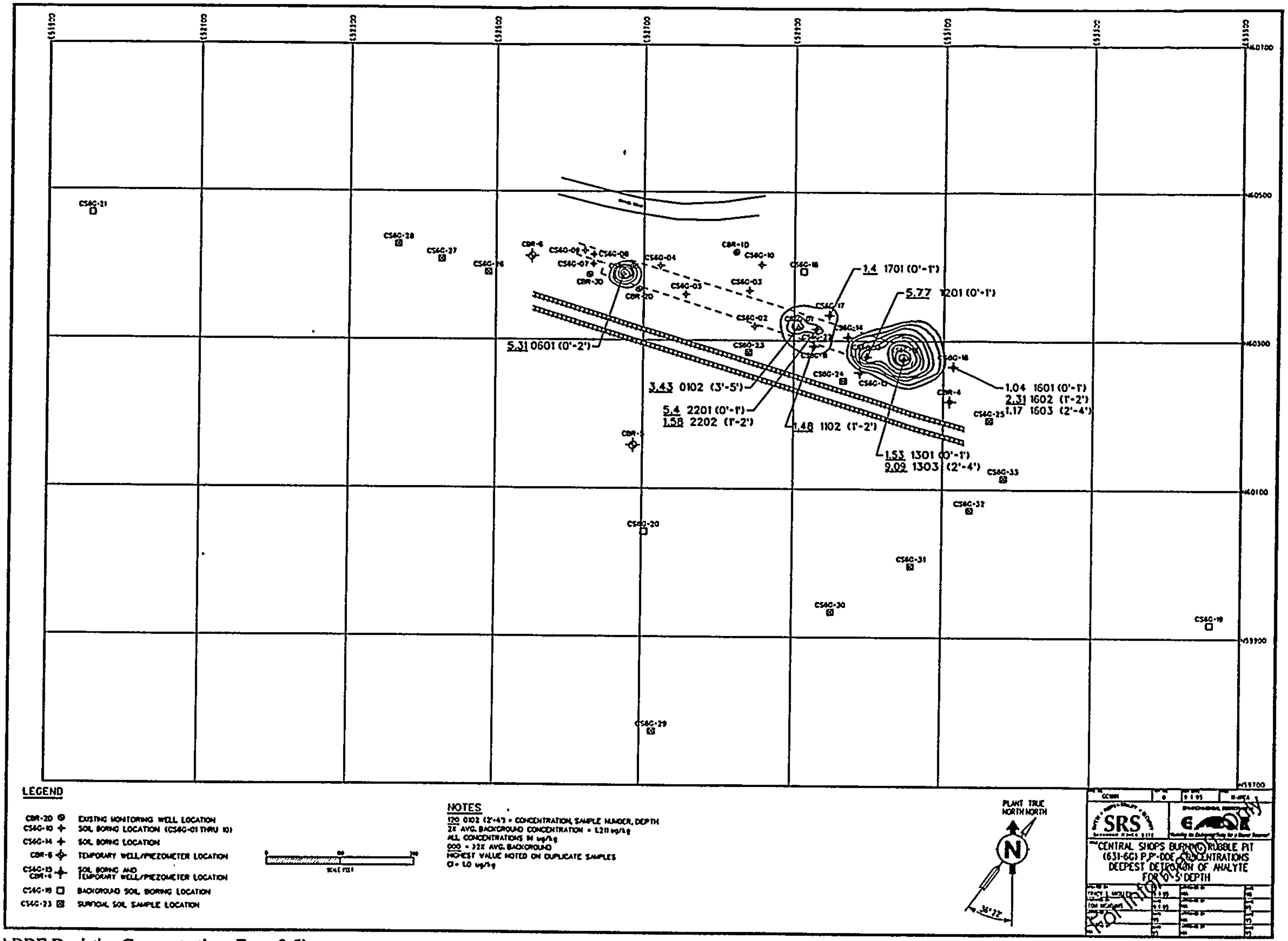

Figure 4-63 Isoconcentration Map of p,p' DDE Depicting Concentrations From 0-5'

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FIGURES

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TABLES

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Table 4.1
Unit Specific Background for Metals in Soils (mg/kg), Showing Range or Concentrations Both Inside and Outside the Pit

Analyte	CS6G-10 (Max) mg/kg	CS6G-18 (Max) mg/kg	CS6G-19 (Max) mg/kg	CS6G-20 (Max) mg/kg	CS6G-21 (Max) mg/kg	Background Range (mg/kg)	Range in Soil Samples (Inside Pit) (mg/kg)	Range in Soil Samples (Outside Pit) (mg/kg)
Arsenic	8.6 (5-7 ft)	5.56 (35-37 ft)	ND	6.27 (10-12 ft)	ND	ND-8.6	2.37-12	2.86-9.22
Barium	ND	71.6 (40-42 ft)	28.1 (1-2 ft)	38.1 (1-2 ft)	105 (35-37 ft)	ND-105	1.78-290	2.35-39.2
Cadmium	ND	ND	ND	0.25 (0-1 ft)	0.54 (5-7 ft)	ND-0.54	0.21-2.87	0.42
Chromium	29.2 (28.7-30.7 ft)	30.3 (30-32 ft)	26.9 (5-7 ft)	23.4 (10-12 ft)	50.1 (15-17 ft)	29.9-50.1	1.91-45.9	3.9-108
Copper	10 (0-2 ft)	787 (0-1 ft)	5.02 (10-12 ft)	4.53 (5-7 ft)	9.36 (2-4 ft)	4.53-787	1.19-1380	1.54-160
Lead	21.7 (28.7-30.7 ft)	31.6 (30-32)	35 (25-27 ft)	17.7 (30-32 ft)	13.5 (35-37 ft)	13.5-35	3.09-301	2.68-54.5
Manganese	34.3 (0-2 ft)	22.5 (1-2)	27.9 (0-1 ft)	92.1 (0-1 ft)	24.2 (1-2 ft)	22.5-92.1	2.16-681	1.1-133
Mercury	ND	140 (40-42 ft)	191 (20-22 ft)	56.4 (1-2 ft)	61.1 (1-2 ft)	ND-191	19.5-130	17.3-76.7
Nickel	1.54 (0-2 ft)	3.82 (1-2 ft)	2.54 (2-4 ft)	3.98 (1-2 ft)	7.27 (2-4 ft)	1.54-7.27	0.51-27.6	0.58-350
Silver	0.33 (5-7 ft)	ND	0.34 (45-47 ft)	ND	3.93 (5-7 ft)	ND-3.93	0.38-3.77	0.54

ND = Non Detect
Depth to maximum concentrations are given in parentheses and are below land surface (bls)

Table 4.2 Unit Specific Background for Semi-Volatile Organic Compounds in Soils (µg/kg), Showing Range of Concentrations Both Inside and Outside the Pit

Analyte	Unit Specific Background Maximum (µg/kg)	Range Detected in Soil Samples (µg/kg) (Inside Pit)	Range Detected in Soil Samples (µg/kg) (Outside Pit)
Acenaphthene	ND	3.6 - 6.8	ND
Acenaphthylene	ND	ND	5.97 - 10.3
Anthracene	ND	12.6 - 17200	14.6
Benzo[a]anthracene	ND	3140 - 74000	ND
Benzo[b]fluoranthene	ND	5.54 - 119000	9.19 - 27.1
Benzo[k]fluoranthene	ND	7.31 - 41500	4.24 - 18.5
Benzoic acid	69.6	17 - 57.9	8.01 - 31.3
Benzo[ghi]perylene	ND	9.34 - 30600	21.9
Benzo[a]pyrene	ND	16.6 - 85800	9.54
Benzyl alcohol	ND	ND	ND
Bis(2-chloroethoxy) methane	ND	ND	ND
Bis(2-chloroethyl)ether	ND	ND	ND
Bis(2-chloroisopropyl)ether	ND	ND	ND
Bis(2-ethylhexyl) phthalate	ND	37.2	78.1
4-Bromophenyl phenyl ether	ND	ND	ND
Butylbenzyl phthalate	ND	ND	ND
4-Chloroaniline	ND	ND	ND
4-Chloro-m-cresol	ND	ND	5.31 - 70.8
2-Chloronaphthalene	ND	ND	ND
2-Chlorophenol	ND	ND	19
4-Chlorophenyl phenyl ether	ND	ND	7.49 - 7.84
Chrysene	ND	3990 - 60200	ND
o-Cresol(2-Methylphenol)	ND	ND	ND
m,p-Cresol	ND	ND	ND
Dibenz[ah]anthracene	ND	1090 - 10400	ND
Dibenzofuran	ND	7.71 - 3750	3.72 - 9.63
Di-n-butyl phthalate	51.4	16 - 37.6	10.5 - 43
1,2-Dichlorobenzene	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND
1,4- Dichlorobenzene	ND	ND	34
3,3'-Dichlorobenzidine	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND
Diethyl phthalate	9.92	4.25 - 78	3.89 - 22.7

Table 4.2 Unit Specific Background for Semi-Volatile Organic Compounds in Soils (µg/kg) Showing Range of Concentrations Both Inside and Outside the Pit(Continued)

Analyte	Unit Specific Background Maximum (µg/kg)	Range Detected in Soil Samples (µg/kg) (Inside Pit)	Range Detected in Soil Samples (µg/kg) (Outside Pit)
2,4-Dimethyl phenol	ND	ND	ND
Dimethyl phthalate	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	28.9
2,6-Dinitrotoluene	ND	ND	ND
Di-n-octyl phthalate	ND	ND	ND
Fluoranthene	6.64	4.4 - 108000	4.7 - 24.7
Fluorene	ND	11 - 8080	4.28
Hexachlorobenzene	ND	ND	10.4 - 12.1
Hexachlorobutadiene	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND
Hexachloroethane	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	ND	11 - 31300	8.84 - 9.98
Isophorone	ND	ND	ND
2-Methyl-4, 6-dinitrophenol	ND	ND	ND
2-Methylnaphthalene	ND	5.74 - 127	9.27
Naphthalene	ND	45.9 - 168	ND
o-Nitroaniline	ND	ND	ND
m-Nitroaniline	ND	ND	ND
p-Nitroaniline	ND	ND	ND
Nitrobenzene	ND	ND	ND
2-Nitrophenol	ND	ND	ND
4-Nitrophenol	ND	ND	ND
N-Nitrosodiphenylamine	ND	ND	4.64 - 5.97
N-Nitrosodipropylamine	ND	ND	ND
Pentachlorophenol	ND	ND	50.6
Phenanthrene	ND	53.3 - 59100	ND
Phenol	ND	ND	ND
Pyrene	23.9	3.86 - 3700	5.09 - 50.2
1,2,4-Trichlorobenzene	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND

Notes: ND = Not Detected

Table 4.3 Unit Specific Background for Volatile Organic Compounds in Soils (µg/kg), Showing Range of Concentrations Both Inside and Outside the Pit

Analyte	Maximum Unit Specific Background (µg/kg)	Range Detected in Soil Samples (µg/kg) (Inside Pit)	Range Detected in Soil Samples (µg/kg) (Outside Pit)
Acetone	46.3	4.5 - 46.4	3.9 - 62.5
Benzene	0.91	.06 - 1.32	0.13 - 2.65
Bromodichloromethane	ND	ND	ND
Bromoform	ND	ND	ND
Bromomethane(Methyl bromide)	ND	ND	ND
Carbon disulfide	5.48	0.2 - 6.89	0.97 - 2.67
Carbon tetrachloride	ND	ND	ND
Chlorobenzene	ND	ND	ND
Chloroethane	ND	ND	ND
Chloroethene (Vinyl chloride)	ND	ND	ND
Chloroform	2.46	0.09 - 2.28	0.51 - 4.61
Chloromethane (Methyl chloride)	ND	ND	ND
Dibromochloromethane	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND
1,1-Dichloroethylene	ND	ND	ND
1,2-Dichloroethylene	ND	ND	ND
Dichloromethane (Methylene chloride)	2.88	0.38 - 2.17	0.41 - 3.68
1,2-Dichloropropane	ND	ND	ND
cis-1,3-Dichloropropene	ND	ND	ND
trans-1,3-Dichloropropene	ND	ND	ND
Ethylbenzene	0.29	.07 - 0.18	0.06 - 0.47
2-Hexanone	ND	0.38	ND
Methyl ethyl ketone	1.61	0.17 - 3.07	0.23 - 1.68
Methyl isobutyl ketone	ND	0.34	ND
Styrene	1.29	ND	ND
1,1,2,2-Tetrachloroethane	ND	0.05	ND
Tetrachloroethylene	0.48	0.08 - 0.15	ND
Toluene	1.48	0.08 - 5.91	0.11 - 1.26
1,1,1-Trichloroethane	0.1	ND	ND
1,1,2-Trichloroethane	ND	ND	ND
Trichloroethylene	0.18	0.2 - 0.26	ND
Vinyl acetate	ND	ND	ND
Xylenes	1.21	0.08 - 1.24	0.08 - 3.97

Note: ND= Not Detected

Table 4.4 Unit Specific Background for Pesticides, PCBs, and Dioxins/Furans in Soils, Showing Range of Concentrations Both Inside and Outside the Pit

Analyte	Maximum Unit Specific Background (µg/kg)	Range in Soil Samples Inside Pit- (µg/kg)	Range in Soil Samples Outside Pit- (µg /kg)
Pesticides (units=µg/kg)			
Aldrin	ND	ND	ND
alpha-Benzene hexachloride	ND	ND	ND
beta-Benzene hexachloride	ND	ND	ND
delta-Benzene hexachloride	ND	ND	ND
alpha-Chlordane	ND	ND	ND
gamma-Chlordane	ND	ND	ND
p,p'-DDD	ND	ND	ND
p,p'-DDE	1.6	1.53-9.09	1.04-2.31
p,p'-DDT	5.72	5.5	3.08
Dieldrin	2.67	1.52-4.8	1.06-2.34
Endosulfan I	0.99	ND	4.69
Endosulfan II	ND	ND	ND
Endosulfan sulfate	ND	ND	ND
Endrin	ND	3.15	ND
Endrin ketone	1.98	ND	ND
Heptachlor	ND	ND	ND
Heptachlor epoxide	ND	ND	ND
Lindane	ND	ND	ND
Methoxychlor	ND	ND	9.24-10
Toxaphene	ND	ND	ND
PCBs (units = µg/kg)			
PCB 1016	ND	ND	ND
PCB 1221	ND	ND	ND
PCB 1232	ND	ND	ND
PCB 1242	ND	ND	ND
PCB 1248	ND	ND	ND
PCB 1254	ND	115	25.9
PCB 1260	ND	ND	31.2
Dioxins and Furans (units = µg/kg)			
1,2,3,4,6,7,8-HPCDD	ND	ND	ND
Heptachlorodibenzo-p-dioxin isomers	ND	ND	ND
1,2,3,4,6,7,8-HPCDF	ND	ND	ND

Table 4.4 Unit Specific Background for Pesticides, PCBs, and Dioxins/Furans in Soils, Showing Range of Concentrations Both Inside and Outside the Pit (Continued)

Analyte	Unit Specific Background (µg/kg)	Range in Soil Samples Inside Pit- (µg/kg)	Range in Soil Samples Outside Pit- (µg/kg)
Dioxins and Furans (units = µg/kg)			
Hexachlorodibenzo-p-furan isomers	ND	ND	ND
1,2,3,4,7,8-HXCDD	ND	ND	ND
Hexachlorodibenzo-p-dioxin isomers	ND	ND	ND
1,2,3,4,7,8-HXCDF	ND	ND	ND
Hexachlorodibenzo-p-furan isomers	ND	ND	ND
Octachlorodibenzo-p-dioxin	6.82	0.23-19.4	0.26-7.59
Octachlorodibenzo-p-furan	ND	ND	ND
1,2,3,7,8-PCDD	ND	ND	ND
Pentachlorodibenzo-p-dioxin isomers	ND	ND	ND
Pentachlorodibenzo-p-furan isomers	ND	ND	ND
1,2,3,7,8-PCDF	ND	ND	ND
2,3,7,8-TCDD	ND	ND	ND
2,3,7,8-TCDF	ND	ND	ND
Tetrachlorodibenzo-p-dioxin isomers	ND	ND	ND
Tetrachlorodibenzo-p-furan isomers	ND	ND	ND

Note: ND = Not Detected

Table 4.5
Background Radionuclide Concentrations for Soil Samples (pCi/g), Showing Range of Concentrations Both Inside and Outside the Pit

Soil Samples / Radionuclide	CS6G-10 (Max) pCi/g	CS6G-18 (Max pCi/g)	CS6G-19 (Max) pCi/g	CS6G-20 (Max) pCi/g	CS6G-21 (Max) pCi/g	Background Range (pCi/g)	Range in Soil Samples (Inside Pit) (pCi/g)	Range in Soil Samples (Outside Pit) (pCi/g)
Gross Alpha	14.5 (11-13 ft)	33.9 (5-7 ft)	25.2 (5-7 ft)	17 (5-7 ft)	28.9 (2-4 ft)	6.21 - 33.9	5.6 - 21.5	4.98 - 29.4
Nonvolatile beta	14.7 (5-7 ft)	13.9 (5-7 ft)	11.5 (10-12 ft)	8.26 (5-7 ft)	9.97 (5-7 ft)	4.5 - 14.7	1.44 - 15	1.61 - 715

ND = Non Detect
Depth to maximum concentrations are given in parentheses and are below land surface (bls)

Table 4.6 Background Well CBR-1D (1st Qtr 93 to 1st Qtr 95)

Analyte	Maximum Concentration	Average Concentration*	2 x Average*
Metals			
Aluminum (total recoverable)	149 µg/L	85.8	171.6
Barium	24.2 µg/L	21.25	42.5
Beryllium	0.165 µg/L	0.158	0.315
Calcium	738 µg/L	613.9	1,228
Copper (total recoverable)	51.8 µg/L	48.7	97.5
Cyanide	0.81 µg/L	0.81	1.62
Iron (total recoverable)	806 µg/L	290.3	581
Lead (total recoverable)	44.8 µg/L	22.0	44.0
Magnesium (total recoverable)	362 µg/L	292.4	584.9
Manganese (total recoverable)	10.5 µg/L	7.983	15.97
Mercury	.05 µg/L	.049	0.097
Nickel	2.98 µg/L	2.98	5.96
Potassium (total recoverable)	1,350 µg/L	373.3	746.7
Sodium (total recoverable)	3,280 µg/L	1,044	2,088
Vanadium	0.568 µg/L	0.568	1.136
Zinc	52.8 µg/L	46.15	92.3
Volatile Organics			
Dichoremethane(methylene chloride)	1.2 µg/L	1.2	2.4
Chloroform	.36 µg/L	0.15	0.30
Toluene	0.18 µg/L	0.125	.25
Semi-Volatile Organics			
Pyrene	0.2 µg/L	0.155	0.31
Radionuclides			
Gross Alpha	0.962 pCi/L	0.744	1.489
Nonvolatile beta	2.41 pCi/L	2.193	4.387
Radium	0.7 pCi/L	0.7	1.4
Tritium	5.13 pCi/ml	4.72	9.43
Miscellaneous			
Chloride	8 mg/L	3.64	7.27
Nitrate as nitrogen	1.08 mg/L	1.08	2.16
Nitrate-nitrite as nitrogen	1,090µg/L	721.7	1,443

Note: * Units in Columns 3 and 4 are same as Column 2.

Table 4.7 Concentrations for Metals in Surface Soils from Borings

CONCENTRATIONS FOR METALS IN SURFACE SOILS IN THE PIT, COMPARED TO TWO TIMES AVERAGE BACKGROUND
(VALUES ABOVE 2X AVERAGE BACKGROUND, BOLDED,AND UNDERLINED)

ANALYTE	2X AVG BKGD	BORINGS IN THE PIT								
		CS6G-01	CS6G-05	CS6G-06	CS6G-08	CS6G-09	CS6G-12	CS6G-13	CS6G-14	CS6G-22
Aluminum	15,984	12,100		8050			5270	14,200	5020	11,600
Antimony	4.96	4.16								
Arsenic	1.664	**7.92**								
Barium	35.64	26.1		11.6			13.3	**53.8**	19.3	14.1
Beryllium	0.2484	0.18		0.11			0.09	0.16	0.17	0.14
Calcium	312.8	**504**		167			174	444	282	**339**
Chromium	22.804	**43**		17.2			9.68	14.8	12.7	18.3
Cobalt	1.2484	**1.32**		0.56			0.51	0.93	0.41	0.86
Copper	323.84	48.6		12.8			**1160**	19.9	129	**400**
Cyanide	114.2	63.3	**184**	**703**	46.2					
Iron	19,688	**20,300**		14,100	7230	**20,000**	11,300	12,300	7890	**22,800**
Lead	18.996	**20.5**		13.2			**32.2**	**45.9**	12	8.1
Magnesium	224.24	183		87.9			79.3	191	142	184
Manganese	82.12	64.8		39.9			40.3	63.4	**84.5**	19
Mercury	20	**24.1**	**37.1**	19.5	**31.6**	**38.8**				
Nickel	3.336	**16.2**		**3.37**			1.98	3.04	1.3	2.68
Potassium	186.48	121		79.6			59.1	121	112	150
Selenium	3.208									
Silver	1									**1.81**
Sodium	12.656			8.67				**15.8**		
Thallium	4.228	3.71						**7.82**	**4.73**	
Vanadium	53.08	39.4		30.1			18.6	31.6	25.4	52.7
Zinc	16.052	**16.2**		11.8			**18.3**	**55**	12.7	13.8

CONCENTRATIONS OFMETALS IN SURFACE SOILS, OUT OF THE PIT, AND COMPARED TO TWO TIMES AVERAGE BACKGROUND
(VALUES ABOVE 2X AVERAGE BACKGROUND BOLDED, AND UNDERLINED)

ANALYTE	2X AVG BKGD	BORINGS OUT OF THE PIT							
		CS6G-02	CS6G-03	CS6G-04	CS6G-07	CS6G-11	CS6G-15	CS6G-16	CS6G-17
Aluminum	15,984	4190	4570			**17,700**	5350	5080	11,200
Antimony	4.96								
Arsenic	1.664								
Barium	35.64	16.8	24.5			21.6	**39.2**	11.6	**37.9**
Beryllium	0.2484	0.1	0.12			0.22	0.18	0.09	0.2
Calcium	312.8	198	230			**481**	**352**	81.6	**369**
Chromium	22.804	**108**	7.01			**46.9**	6.97	7.34	11
Cobalt	1.2484	**2.62**	0.43			**1.69**	0.64	0.21	1.04
Copper	323.84	106	7.85			160	17	48.4	97.9
Cyanide	114.2								
Iron	19,688	8000	4650		15,100	**24,400**	4940	6930	8710
Lead	18.996	**48**	5.24			**54.5**	9.85	6.46	9.75
Magnesium	224.24	74.9	64.8			**309**	101	67.3	**231**
Manganese	82.12	67.5	30.3			71.1	**133**	21.9	24.3
Mercury	20			**74.6**	**47.4**				
Nickel	3.336	**350**	1.89			**19.6**	1.72	0.64	3.17
Potassium	186.48	29.7	55.1			**250**	64.1	42.1	173
Selenium	3.208					**8.36**			
Silver	1								
Sodium	12.656								
Thallium	4.228	**4.4**	3.6						
Vanadium	53.08	12	14			**55.4**	12.4	17.9	23.6
Zinc	16.052	**60.3**	5.18			**28.4**	4.97	4.39	**23.8**

All concentrations are measured in mg/kg except cyanide and mercury, which are in ug/kg.

Table 4.8 Surface Soil Summary for Semi-Volatiles in Surface Soil Greater Than 2 x Background

Sampling Locations / Analyte	2 x Bkgd (ug/kg)	CS6G-02 (ug/kg)	CS6G-03 (ug/kg)	CS6G-04 (ug/kg)	CS6G-07 (ug/kg)	CS6G-11 (ug/kg)	CS6G-15 (ug/kg)	CS6G-16 (ug/kg)	CS6G-17 (ug/kg)
Outside of Pit									
2-Methylnaphthalene	1.566						9.27		
4-Chloro-m-cresol	1.29				5.31				
4-Chlorophenyl phenyl ether	1.148						7.49		
Anthracene	0.436						14.6		
Benzo(b) fluoranthene	1.046						27.1		
Benzo(k) fluoranthene	1.116						18.5		
Bis(2-ethyl hexyl) phthalate	6.208				78.1				
Di-n-butyl phthalate	9.738					17.4	39.2	43.0	24.7
Dibenzo furan	1.47		3.72				9.63		
Diethyl phthalate	1.122	5.49	22.7				8.56		
Fluoranthene	3.1258		4.83			24.7	22.5		
Fluorene	1.396						4.28		
Hexachlorobenzene	.9092						12.1		
Indeno(1,2,3-c,d) pyrene	.9092			8.84					
N-Nitrosodiphenylamine	1.046						4.64		
Pyrene	17.83					30.8	22.5		

Inside the Pit

Sampling Locations / Analyte	2 x Bkgd (ug/kg)	CS6G-06 (ug/kg)	CS6G-09 (ug/kg)	CS6G-12 (ug/kg)	CS6G-13 (ug/kg)	CS6G-14 (ug/kg)	CS6G-22 (ug/kg)
2-Methylnaphthalene	1.566					5.74	
Benzo(b) fluoranthene	1.046		5.78				
Benzoic Acid	31.788						50.9
Di-n-butyl phthalate	9.738	23.2		15.2	17		54.0
Fluoranthene	3.1258		6.17	11.6		28	8.3
Pyrene	17.83					29.1	

Table 4.9 Surface Soil Summary for Volatile Organics Greater Than 2 x Background

Analyte / Sampling Locations	2 x Bkgd (ug/kg)	CS6G-01 (ug/kg)	CS6G-05 (ug/kg)	CS6G-12 (ug/kg)	CS6G-13 (ug/kg)	CS6G-14 (ug/kg)	CS6G-22 (ug/kg)
Inside the Pit							
1,1,2,2-Tetrachloroethane	0.0135		0.05				
2-Hexanone	0.2172		.38				
Benzene	0.0532			0.80	0.08	0.08	
Carbone Disulfide	0.1446			0.35	0.51		
Chloroform	0.0914			0.95		1.87	0.44
Methylene Chloride	0.4882			0.64			1.45
Ethylbenzene	0.0355	0.18				0.07	
Methyl ethyl ketone	0.2532			0.34			
Methyl isobutyl ketone	0.2132		0.34				
Tetrachloroethylene	0.0274						0.15
Toluene	0.5112			4.11			
Trichlorethylene	0.0190						0.26
Xylenes	0.17	1.24				0.26	

Outside of Pit

Analyte / Sampling Locations	2 x Bkgd (ug/kg)	CS6G-02 (ug/kg)	CS6G-03 (ug/kg)	CS6G-11 (ug/kg)	CS6G-15 (ug/kg)	CS6G-16 (ug/kg)	CS6G-17 (ug/kg)
Acetone	28.6			58.5			
Benzene	0.0532				0.32	0.13	1.12
Chloroform	0.0914				0.6	1.34	1.46
Ethylbenzene	0.0355	0.25	0.16				
Toluene	0.5112			0.71			
Xylenes	0.17	3.97	0.81				0.34

☐ = Less Than 2 x Average Background

Table 4.10 Surface Soil Summary for Pesticides/PCBs/Dioxin/Furans in Surface Soil Greater Than 2 x Background

Sampling Locations Analyte	2 x Bkgd (ug/kg)	Inside Pit				Outside Pit			
		CS6G-06 (ug/kg)	CS6G-12 (ug/kg)	CS6G-13 (ug/kg)	CS6G-22 (ug/kg)	CS6G-11 (ug/kg)	CS6G-15 (ug/kg)	CS6G-16 (ug/kg)	CS6G-17 (ug/kg)
Dieldrin	2.551				4.8				
Endosulfan I	0.611						4.69		
p,p'-DDE	1.854	5.31	5.77		5.4				
p,p'-DDT	4.41	5.5							
PCB-1254	22.08		115						
Octachlorodibenzo-p-dioxin	0.232			2.07		2.64	0.99		1.19

☐ = Indicates less than 2 times the average background

Table 4.11 Surface Soil Summary for Radionuclides in Surface Soil Greater Than 2 x Background

Sampling Locations Analyte	2 x Bkgd (pCi/g)	CS6G-05 (pCi/g)	CS6G-06 (pCi/g)	CS6G-08 (pCi/g)	CS6G-09 (pCi/g)	CS6G-12 (pCi/g)	CS6G-13 (pCi/g)	CS6G-14 (pCi/g)	CS6G-22 (pCi/g)
Inside of Pit									
Gross Alpha	19.16	ND							
Nonvolatile Beta	11.48		ND						ND
Outside of Pit									
Sampling Locations Analyte	2 x Bkgd (pCi/g)	CS6G-02 (pCi/g)	CS6G-04 (pCi/g)	CS6G-07 (pCi/g)	CS6G-11 (pCi/g)	CS6G-15 (pCi/g)	CS6G-16 (pCi/g)	CS6G-17 (pCi/g)	
Gross Alpha	19.16	ND			21.9			ND	
Nonvolatile Beta	11.48				15.8		715	ND	

Note: ND = Non Detect

☐ = Indicates less than 2 times the average background

Table 4.12 Summary of Contaminants in Subsurface Soils

CONTAMINANT	2X BACKGROUND CONCENTRATION (in ug/kg except where noted)	FREQUENCY OF DETECTION (above 2x bkgd.) / (num. of detects)	RANGE OF CONCENTRATION (above 2x bkgd.) in ug/kg except where noted	RANGE OF DEPTHS ENCOUNTERED
TARGET ANALYTE LIST				
Aluminum	10,282 mg/kg	18 of 56	12,100-31,900 mg/kg	0 - 7 ft.
Antimony	3.12 mg/kg	13 of 16	3.25 - 5.29 mg/kg	0 - 12.7 ft.
Arsenic	5.436 mg/kg	18 of 31	5.59 - 12 mg/kg	0 - 30.7 ft.
Barium	13.44 mg/kg	33 of 79	14.1 - 290 mg/kg	0 - 12.7 ft.
Beryllium	0.1524 mg/kg	18 of 74	0.157 - 0.366 mg/kg	0 - 8 ft.
Cadmium	0.212 mg/kg	8 of 9	0.244 - 2.87 mg/kg	1.0 - 16.7 ft.
Calcium	138.45 mg/kg	51 of 74	144 - 19,400 mg/kg	0 - 16.7 ft
Chromium	21.67 mg/kg	21 of 79	23.9 - 108 mg/kg	0 - 30.7 ft.
Cobalt	0.5127 mg/kg	30 of 71	0.514 - 6.35 mg/kg	0 - 12.7 ft.
Copper	5.58 mg/kg	45 of 73	6.21 - 1380 mg/kg	0 - 12.7 ft.
Cyanide	99.215	15 of 21	101 - 703	0 - 12.2 ft.
Iron	26,637 mg/kg	13 of 74	27,800 - 69,600 mg/kg	2 - 9.2 ft.
Lead	12.31 mg/kg	22 of 78	12.8 - 477 mg/kg	0 - 30.7 ft.
Magnesium	109 mg/kg	32 of 74	110 - 2430 mg/kg	0 - 12.7 ft.
Manganese	27.15 mg/kg	28 of 74	30.3 - 681 mg/kg	0 - 12.7 ft.
Mercury	19.3	32 of 33	19.5 - 252	0 - 30.7 ft.
Nickel	1.07 mg/kg	42 of 60	1.1 - 350 mg/kg	0 - 12.7 ft.
Potassium	67.85 mg/kg	41 of 69	70.6 - 851 mg/kg	0 - 16.7 ft.
Selenium	4.839 mg/kg	11 of 14	4.99 - 14.3 mg/kg	0.0 -15 ft.
Silver	0.335 mg/kg	13 of 15	0.381 - 3.77 mg/kg	0.0 - 30.7 ft.
Sodium	9.04 mg/kg	15 of 16	9.4 - 294 mg/kg	0.0 - 16.7 ft.
Thallium	3.70 mg/kg	6 of 9	3.71 - 18.1 mg/kg	0 - 9.2 ft.
Vanadium	68.475 mg/kg	15 of 74	69.1 - 161 mg/kg	2 - 9 ft.
Zinc	2.736 mg/kg	50 of 73	2.74 - 678 mg/kg	0 - 16.7 ft.
SEMI-VOLATILES				
1,4-Dichlorobenzene	5.852	1 of 1	34	2 - 4 ft.
2,4-Dinitrotoluene	0.639	1 of 1	28.9	9.5 - 11.0 ft.
2-Chlorophenol	2.8	1 of 1	19	9.5 - 11.0 ft.
4-Chloro-m-cresol	1.331	2 of 2	5.31 - 70.8	0 - 11.0 ft.
4-Chlorophenyl phenyl ether	1.197	2 of 2	7.49 - 7.84	0 - 6 ft.
2-Methylnaphthalene	1.608	8 of 8	5.74 - 1210	0 - 14.7 ft.
Acenaphthene	1.691	3 of 3	22 - 6830	3.6 - 8 ft.
Acenaphthylene	0.904	2 of 2	5.97 - 10.3	0 - 6 ft.
Anthracene	0.452	5 of 5	12.6 - 17,200	0 - 9.2 ft.
Benzo(a)anthracene	1.356	2 of 2	3140 - 74,000	3.6 - 6.0 ft.
Benzo(a)pyrene	1.138	5 of 5	9.54 - 85,800	0 - 9.6 ft.
Benzo(b)fluoranthene	1.076	8 of 8	5.54 - 119,000	0 - 10 ft.
Benzo(g,h,i)perylene	0.452	6 of 6	9.34 - 30,600	0 - 9.6 ft.
Benzo(k)fluoranthene	1.138	6 of 6	4.24 - 41,500	0 - 9.6 ft.
Benzoic Acid	13.174	10 of 11	17 - 57.9	0 - 6 ft.
Bis(2-ethylhexyl) phthalate	4.624	2 of 2	37.2 - 78.1	0 - 7.6 ft.
Chrysene	0.825	2 of 2	3990 - 60,200	3.6 - 6 ft.
Dibenz(a,h)anthracene	0.584	2 of 2	1090 - 10400	3.6 - 6 ft.
Dibenzofuran	1.522	7 of 7	3.72 - 3750	0 - 8 ft.
Diethyl phthalate	8.109	7 of 18	8.18 - 78	0 - 12.7 ft.
Dimethyl phthalate	0.583	2 of 2	8.56 - 8.58	0 - 6 ft.
Fluoranthene	1.125	22 of 22	4.27 - 108,000	0 - 14.7 ft.
Fluorene	1.453	5 of 5	4.28 - 8080	0 - 14.7 ft.
Hexachlorobenzene	0.94	2 of 2	10.4 - 12.1	0 - 6 ft.
Ideno(1,2,3-c,d)pyrene	0.94	6 of 6	8.84 - 31,300	0 - 9.6 ft.
N-nitrodiphenylamine	1.076	2 of 2	4.64 - 5.97	0 - 6 ft.
Napthalene	1.608	3 of 3	45.9 - 168	6 - 12.7 ft.
Pentachlorophenol	13.019	1 of 1	50.6	9.5 - 11 ft.
Phenanthrene	0.639	5 of 5	24.3 - 59,100	3.6 - 14.7 ft.
Phenanthrenecarboxylic acid	600	1 of 6	1100	0 - 1 ft.
Pyrene	7.55	21 of 30	7.71 - 83,700	0 - 14.7 ft.
VOLATILE ORGANICS				
Acetone	28.869	10 of 63	29.7 - 788	0 - 10 ft.
Carbon disulfide	1.049	3 of 17	1.06 - 6.89	5 - 9 ft.
Chloroform	0.856	20 of 38	0.945 - 4.61	0 - 15 ft.
Dichloromethane (Methylene chloride)	1.678	6 of 28	1.79 - 3.68	1 - 12 ft.

Table 4.12 Summary of Contaminants in Subsurface Soils (contd)

	Ethylbenzene	0.069		15 of 17	0.0698 - 0.47		0 - 9 ft.
	Methyl ethyl ketone	0.346		8 of 16	0.356 - 3.07		0 - 12.7 ft.
	Methyl isobutyl ketone	0.236		1 of 1	0.337		0 - 2 ft.
	Tetrachloroethylene	0.059		2 of 2	0.0824 - 0.148		0 - 2 ft.
	Toluene	0.755		6 of 28	0.989 - 5.91		0 - 15 ft.
	Trichloroethylene	0.052		2 of 2	0.2 - 0.261		0 - 2 ft.
	Xylenes	0.357		12 of 45	0.372 - 3.97		0 - 9 ft.
PESTICIDES / PCB'S / &							
DIOXINS / FURANS							
	Dieldrin	1.301		3 of 5	1.52 - 4.8		0 - 4 ft.
	Endosulfan I	0.987		1 of 1	4.69		0 - 1 ft.
	Endrin	0.945		1 of 1	3.15		1 - 2 ft.
	Methoxychlor	9.49		1 of 2	10		2 - 4 ft.
	Octachlorodibenzo-p-dioxin	1.287		13 of 28	1.86 - 19.4		0 - 8 ft.
	p,p'-DDE	1.211		10 of 12	1.4 - 9.09		0 - 5 ft.
	p,p'-DDT	2.759		2 of 2	3.08 - 5.5		0 - 2 ft.
	PCB 1254	22.73		2 of 2	25.9 - 115		0 - 2 ft.
	PCB 1260	22.73		1 of 1	31.2		1 - 2 ft.
RADIONUCLIDES							
	NON-VOLATILE BETA	17.874 pCi/g		1 of 63	715 pCi/g		0 - 11 ft.
UNKNOWN							
	Unknown Alcohol	582.85		3 of 25	710 - 1600		0 - 6 ft.
	Unknown Alkane	320		1 of 5	370		1 - 2 ft.
	Unknown Alkene	340		1 of 1	350		0 - 1 ft.
	Unknown Silane	360		1 of 1	440		0 - 1 ft.

Table 4.13 Summary Of Soil Sediment Data Greater Than 2 x Background

Sampling Locations / Analyte	2 x Bkgd	CS6G-23	CS6G-24	CS6G-25	CS6G-29	CS6G-30	CS6G-31	CS6G-32	CS6G-33
Metals (mg/kg)									
Barium	7.547	7.62	15.4						10.3
Cadmium	0.394			0.422					
Calcium	295.3		313						
Chromium	30.07			201					
Cobalt	1.146		1.28	1.54					
Copper	7.286	12.5	23.3	1050	62	588	92.2	56.5	76.5
Lead	11.954			13.5					
Magnesium	142		255						
Manganese	19.11			70.7	22.3				20.2
Nickel	2.694	3.01	5.06	104			4.89		
Potassium	162.1		199						
Silver	1.316	1.33	1.64						
Zinc	7.12		9.9	10.2					
Volatile Organics (µg/kg)									
Chloroform	0.062	0.12	0.073		0.338		0.167		
Methylene Chloride	2.01						2.12		2.37
Tetrachloroethylene	0.03				0.275				
Trichloroethylene	0.02				0.088				

Table 4.13 Summary Of Soil Sediment Data Greater Than 2 x Background (Continued)

Sampling Locations / Analyte	2 x Bkgd	CS6G-23	CS6G-24	CS6G-25	CS6G-29	CS6G-30	CS6G-31	CS6G-32	CS6G-33
Semi-Volatile Organics (µg/kg)									
Benzo(a) pyrene	1.177	7.11	20.9						248
Benzo(b) fluoranthene	293.04								388
Benzo(g,h,i) perylene	88.29								105
Benzoic Acid	75.63		75.7						
Bis(2-ethylhexyl)phthalate	4.776				53.7	38.2	26.8	82.2	
Chrysene	200.3								275
Dibenzofuran	1.574		4.73						
Diethyl phthalate	7.53				7.9	9.55	7.53		8.35
Fluoranthene	208.9		314						444
Fluorene	1.504		9.46						
Indeno(1,2,3-c,d) pyrene	84.59								108
Phenanthrene	0.662		168						95.5
Radionuclides (pCi/g)									
Gross Alpha	7.566		11				8.15	7.9	
Nonvoltile Beta	7.486								
Dioxins/Furans (µg/kg)									
Octachlorodibenzo-p-dioxin	0.343		0.512						

☐ = Equal to or less than 2 x Average Background

Table 4.14 Summary of Groundwater Data (Maximum Concentration Unless Noted Otherwise)

Analyte / Monitoring Wells	Background CBR-1D (Max Conc.)	Background CBR-1D (2 x Average)	CBR-2D	CBR-3D	CBR-4	CBR-5	CBR-6
Metals (μg/L)							
Aluminum	149	171.6	317*	55.6*	41,400*	3,530*	1,160*
Antimony	ND	ND	5.0	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	5.1	ND	ND
Barium	24.2	42.5	43.4	39.3	40	27.7	53.1
Beryillium	0.165	0.315	0.26	0.227	0.409	0.213	0.191
Cadmium	ND	ND	4.07	ND	ND	ND	ND
Calcium	738	1,228	395	363	4,090	3,280	2,980
Chromium	2.6	3.62	ND	4.4	67	ND	ND
Cobalt	2.05	2.8	1.53	1.99	1.8	1.19	1.05
Copper	51.8	97.5	1.16	3.5	26.3	1.6	3.9
Cyanide	0.81	1.62	ND	0.81	1.26	1.26	1.26
Iron	806	581	186	74.3	94,900*	3,060*	15,800*
Lead	44.8	44.0	6.19	6.4	89.1*	5.15	3.24
Magnesium	362	584.9	951	932	771	1,280	851
Manganese	10.5	15.97	2.60	3.9	297*	28.6	62.6*
Mercury	0.05	0.097	ND	ND	ND	0.181	ND
Nickel	2.98	5.96	ND	3.06	2.64	ND	2.22
Potassium	1,350	746.7	540	1,190	661	952	1,040
Sodium	3,280	2,088	3,150	2,660	9,740	6,610	2,300
Vanadium	0.568	1.136	0.402	0.323	224*	8.63	6.81
Zinc	52.8	92.3	5.9	19.1	51.2	26.3	31.3

Table 4.14 Summary of Groundwater Data (Continued)

Analyte / Monitoring Wells	Background CBR-1D (Max Conc.)	Background CBR-1D (2 x Average)	CBR-2D	CBR-3D	CBR-4	CBR-5	CBR-6
Volatile Organics (µg/L)							
2-Methyl-4,6-dinitrophenol	ND	ND	1.34	ND	ND	ND	ND
Acetone	ND	ND	4.05	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	0.07	ND	ND
Bromodichloromethane	ND	ND	ND	ND	0.3	0.2	ND
Carbon Disulfide	ND	ND	ND	ND	2.8	3.93	11.8**
Chloroform	0.36	0.30	0.46	0.34	1.15	0.60	ND
Dibromochloromethane	ND	ND	ND	ND	0.18	0.16	ND
Ethylbenzene	ND	ND	ND	0.082	ND	ND	ND
Methyl Chloride	ND	ND	0.41	5.31	ND	ND	ND
Methylene Chloride	1.2	2.4	ND	0.36	ND	0.39	0.36
Toluene	0.18	0.25	0.17	0.16	0.2	0.12	0.12
Trichloroethylene	ND	ND	ND	ND	ND	0.06	ND
Semi-Volatile Organics (µg/L)							
1,2,4-Trichlorobenzene	ND	ND	ND	ND	0.12	ND	ND
Bis(2-ethylhexyl) phthalate	ND	ND	0.58	ND	6.11***	ND	3.87
Butylbenzyl phthalate	ND	ND	0.33	ND	ND	ND	ND
Di-n-butyl phthalate	ND	ND	ND	ND	ND	0.891	0.598
Diethyl phthalate	ND	ND	ND	ND	ND	0.228	0.176
Fluorene	ND	ND	0.91	ND	ND	ND	ND
Pyrene	0.2	0.31	0.29	ND	0.16	ND	0.167

Table 4.14 Summary of Groundwater Data (Continued)

Analyte / Monitoring Wells	Background CBR-1D (Max Conc.)	Background CBR-1D (2 x Average)	CBR-2D	CBR-3D	CBR-4	CBR-5	CBR-6
Radionuclides (pCi/L)							
Gross Alpha	0.962	1.489	1.00	0.892	ND	ND	ND
Nonvolatile beta	2.41	4.387	2.60	1.83	ND	ND	ND
Radium (Total alpha emitting)	0.7	1.4	1.3	1.1	ND	ND	ND
Tritium	5,130	9,430	6,900	7,630	8,190	12,100	1,150
Radium-226	ND	ND	0.23	ND	ND	ND	ND
Radium-228	ND	ND	4.7	ND	ND	ND	ND

Table Notes:

☐ = Non Detect

* = Exceeds MCL for US EPA Secondary Drinking Water Standards (SDWS)
** = Exceeds MCL established by EPA Method 8240
*** = Exceeds MCL for Primary Drinking Water Standard (PDWS)

5.0 CONTAMINANT FATE AND TRANSPORT

This chapter discusses the fate of the contaminants of potential concern (COPCs) as identified by the BRA (Chapter 6) and the site specific contaminants (SSCs) as identified by the characterization of the nature and extent of contamination (Chapter 4). The framework for the discussion is the conceptual site model (CSM) as presented in the previous chapters (see Figure 5-1). The COPCs identified by the BRA are contaminants found in the soil from 0 to 5 feet in depth and contaminants in the groundwater. The COPCs are arsenic and octochlorodibenzo-p-dioxin in surface soils and chloroform, chloromethane (methyl chloride), and bis (2-ethylhexyl) phthalate in groundwater. The SSCs are contaminants found in the vadose zone from 0 feet to the water table. Contaminants were identified as SSCs based upon their frequency of detection above two times the average background (see Table 5.1) and their health risks and/or mobility. The SSCs include metals (antimony, arsenic, cyanide, and mercury), semi-volatiles (fluoranthene and pyrene), volatiles (chloroform, ethylbenzene, methyl ethyl ketone, toluene, and xylenes), and pesticides/dioxins (p,p'-DDE and octochlorodibenzo-p-dioxin). Contaminants whose average soil concentration was higher than the EPA soil screening level or were identified as a COPC in the soil were compared to site specific soil screening levels (see Table 5.2).

The extent to which contaminants migrate and their fate depends on three principal factors: (1) the physical and chemical properties of the contaminants, (2) transport processes, and (3) the properties of the media through which the contaminants migrate. These factors control dominant transport pathways and contaminant migration rates through different media of concern. For example, the mobility of contaminants will be affected by the physical adsorption of a chemical onto soil particles. In addition, the rate of transport will be affected by the permeability of soils through which the contaminants migrate. The physical and chemical properties of the contaminants were obtained from various ATSDR publications, see Chapter 8.

5.1 Potential Routes of Migration

The primary sources of contamination at the pit are the actual material in the pits (i.e., burnt material, paint cans, etc.), and the soils in the pit. The release mechanisms which may potentially transport contaminants away from the unit have been identified in the CSM and include: infiltration and leaching, fugitive dust, volatilization, and drainage water runoff. The migration routes from the soils and the material in the pits are the same.

Infiltration and leaching, are the primary release mechanisms for contaminants to enter the groundwater. Through infiltration and leaching the contaminants can be transported from the area in and around the pits, through the vadose zone, into the soils and the groundwater below. Other release mechanisms for the contamination at the BRP6G are wind-borne dust, and/or volatile emissions. These release mechanism contaminate the air which is then transported away from the Unit. Approximately seventy (70)% of the Unit is covered with vegetation, which will reduce airborne migration of contaminants in the form of dust. Surface drainage of stormwater runoff is a potential release mechanism which may carry contaminants or contaminated soil off the Unit. Finally, bioaccumulation of contaminants in vegetation and the food chain, may present a route for migration off the Unit. The burning/rubble pit is believed to have been covered with at least two feet of fill material to close the pit. The applicability of these potential routes of migration is discussed in Chapter 6 (i.e., the Baseline Risk Assessment) as they pertain to specific human and ecological receptors.

5.2 Physical and Chemical Properties of the Contaminants

As depicted in Table 5.1, the SSCs are present in the subsurface soils which in turn may act as a secondary release mechanism. The primary contaminants detected at this Unit are metals, semi-volatiles, and volatiles, (see Table 5.2). Lower levels of pesticides and dioxins were also identified as SSCs. Physical and chemical properties of these contaminants are discussed below.

Physical and chemical properties of a contaminant provide information on the behavior of that contaminant in different media. An understanding of these properties helps predict how the contaminant will move (or partition) from one medium into another (i.e., soil to air or water to air). This understanding will also define the release mechanism which will eventually result in exposure to humans or the environment. The extent to which a contaminant moves or is transported through the environment is often referred to as mobility. A contaminant that is easily released from a waste source or soils into groundwater or air, is considered highly mobile. On the other hand, a contaminant that remains strongly adsorbed onto soil particles is considered to have low mobility. The mobility of a contaminant is based on many types of chemical and physical interactions between the contaminant and the media it contacts. In addition, chemicals undergo different degrees of degradation. Examples of the types of interactions or processes that influence the transport of a contaminant are hydrolysis, volatilization, adsorption, and photolysis. Physical and chemical properties of the contaminant affecting these interactions include, but are not limited to, water solubility, partition coefficients, and chemical structure, (see Table 5.3).

The water solubility of a chemical is defined as the maximum concentration of that chemical that will dissolve in pure water at a specific temperature and pH. The water solubilities of most common organic chemicals fall between 1 and 100,000 mg/L. Highly soluble chemicals can be rapidly leached from wastes or contaminated soils and are generally easily transported in water.

Vapor pressure and Henry's Law constant are two measures of chemical volatility. Vapor pressure is a measure of the volatility of a chemical in its pure state at a specific temperature. The vapor pressure of liquids typically ranges from 0.001 to 760 mm Hg. A higher vapor pressure indicates a greater tendency for movement of a chemical from water or soil into air. A vapor pressure greater than 1 mm Hg is usually characteristic of chemicals having high volatility, whereas a vapor pressure less than 0.01 is characteristic of chemicals with low or very limited volatility.

The Henry's Law constant considers the interaction between water solubility and vapor pressure and is an important predictor of a chemical's volatilization from water to air. A large Henry's Law constant (i.e., greater than 1×10^{-3} atm-m^3/mole) indicates a tendency for a chemical to readily move from water into air.

The octanol/water partition coefficient (Kow) represents the distribution of a chemical between octanol and water phases under equilibrium conditions. Octanol/water partition coefficients are usually reported in logarithmic form and represent the tendency of a chemical to move between organic material, such as soil or fish tissue, or organic phases such as nonaqueous phase liquids, and water. Chemicals with a low log Kow value (i.e., less than 1) tend to remain dissolved in water rather than adsorb onto an organic material and are classified as hydrophilic compounds. Chemicals with a high log Kow value (i.e., greater than 4) are more likely to remain adsorbed to organic material rather than migrate to water. These chemicals are considered hydrophobic.

The organic carbon partition coefficient (Koc) indicates the tendency of an organic chemical to be adsorbed to organic material in soils or sediments. The Koc is largely independent of soil properties. The capacity for a chemical to be adsorbed is a function of the Koc and is directly dependent on the percentage of organic carbon in the soil. A low value indicates that a chemical can easily be leached (desorbed) from soil/sediment to water. A high Koc value indicates that a chemical has a strong affinity to bind to organic material in soil. A chemical with a high Koc value may be of great concern if it is detected in water, as it usually indicates a tendency to bioaccumulate. The typical range of Koc values for organic chemicals is from 1 to 1×10^7. Values of Koc greater than 1,000 generally indicate chemicals with greater adsorption potential. A Koc value between 100 and 1,000 is considered intermediate, while a Koc value less than 100 indicates a low adsorption capability.

Density, mass per unit volume, is a physical parameter that controls the rate of contaminant movement in the subsurface. In natural waters, density and specific gravity are approximately equivalent. If the density of the contaminant is greater than that of water (i.e., greater than 1 g/cm^3), the contaminant will tend to displace groundwater and sink until a less permeable barrier is encountered. It will move laterally along the barrier in the direction of maximum slope. A density less than that of water (i.e., less than 1 g/cm^3), will tend to cause the contaminant to float on the groundwater surface and move downgradient along the water surface.

The following sections describe how these properties help characterize the tendency of the contaminants detected at the BRP6G to be transported through or be retained in specific media in the unit study area.

5.2.1 Volatile Organics

In general, volatile organics are nonmethane organic compounds characterized by high vapor pressures and Henry's Law constants, moderate to low Kow's, and low Koc's. As a result, these chemicals tend to be very mobile in the environment. Volatile organics were detected in the groundwater at the BRP6G. Volatile organics were also detected in the soil and sediment samples.

5.2.1.1 Chlorinated Aliphatics

Chlorinated aliphatics is a term that describes branched or straight-chained alkanes, alkenes, and alkynes that are chlorinated. Chlorinated aliphatic contaminants at this Unit include bromodichloromethane, chloroform, dibromochloromethane, dichloromethane (methylene chloride), methyl chloride, tetrochloroethane, 1,1,2,2- tetrochloroethane, tetrachloroethylene (PCE), and trichloroethylene (TCE).

If released to soils, these chemicals have more of a tendency to leach rapidly to groundwater than to adsorb to soil particles because of low Koc's and high water solubilities. Volatilization from soils, particularly surface or shallow soils, also occurs rapidly because of high vapor pressures and can be a primary removal mechanism from this medium.

Once in groundwater or surface water, chlorinated aliphatics are very mobile because of low Koc's and Kow's.. A major mechanism for removal of these chemicals from groundwater and even more so from surface waters is volatilization to the atmosphere, as indicated by high Henry's Law constants. Adsorption to sediments does not readily occur. Upon release to the atmosphere, chlorinated aliphatics preferentially exist in a vapor phase, and wet deposition of these chemicals is likely due to large water solubility values.

Chlorinated aliphatics do not readily degrade in the atmosphere. Degradation products formed from PCE include TCE, dichlorinated alkenes, chloroethane, vinyl chloride, and carbon tetrachloride. Trichloroethylene will degrade slowly in soil and water, though this is not considered a significant removal mechanism. The predominant chemicals formed during the degradation of TCE are 1,2-DCE (cis and trans isomers). In general, the dechlorinated aliphatics are relatively resistant to degradation processes.

In addition, chlorinated aliphatics are denser than water. If these chemicals are released to aqueous systems in concentrated form, they may migrate vertically through a saturated medium as a separate phase. In this form, these chemicals are referred to as DNAPLs (dense non aqueous phase liquids).

5.2.1.2 Aromatic Volatiles

At the BRP6G, aromatic volatiles were detected in the soils, sediment samples, and the groundwater. This group of chemicals includes benzene, 2,2bis(4-chlorophenol), ethylbenzene, toluene, and xylene. Collectively, aromatic volatiles possess similar physical and chemical properties, which influence their fate and transport throughout natural environments.

In soils, aromatic volatiles have a stronger tendency to leach into groundwater or surface water because of relatively high water solubilities. Volatilization from dry or wet soils is a major removal mechanism, especially from shallow soils. This occurs because of high vapor pressures and Henry's Law constants. A combination of high Kow's and moderate Koc's causes aromatic volatiles to readsorb to soils and sediments while dissolved in water. When in contact with soils, aromatic volatiles may adsorb to the soil surface. The degree of adsorption is primarily dependent on the amount of organic matter present in the soils. Since aromatic volatiles have low Koc's, higher organic matter content provides more favorable conditions under which aromatic volatiles will adsorb to the soils.

In subsurface soils and water, degradation is an important removal process. The rates of degradation in the atmosphere and water and soil systems depend on many variables including microbial populations, temperature, moisture, and oxygen conditions. Aromatic volatiles are relatively resistant to hydrolysis.

Aromatic volatiles are less dense than water. As saturation is reached between these chemical and aqueous systems, or if released in concentrated solutions, these chemicals are lighter than water and will tend to float on top of the water column. When groundwater comes into contact with the concentrated solutions, dissolution and leaching of the aromatic volatile components occur until saturation in groundwater is reached or exceeded.

Chloroform and chloromethane were detected in the groundwater from wells at the BRP6G, and are COPCs as determined by the BRA. Chloroform, ethylbenzene, methyl ethyl ketone, toluene and xylenes were identified as SSC in the soils.

5.2.1.2.1 Chloroform

CAS No.: 67-66-3
Major Synonym(s): Methyl Chloride, Methane Trichloride, Methyl Trichloride, Trichloromethane

Chloroform was identified as a SSC at concentrations above two times average background in soil samples collected from the BRP6G. Chloroform was detected in the groundwater from wells at the BRP6G, and is a COPC as determined by the BRA. Chloroform concentrations at the BRP6G decreased in lateral extent as the sampling progressed from 0-5 feet down to the deepest level detected, 10-20 feet. The 10 to 20 foot level, had only five detections, four out of five were above the two times average background number of 0.856 ug/kg. No detections occurred below the twenty foot level. (See Figures 4-35 through 4-37 in Chapter 4)

Chloroform, or trichloromethane, is both a naturally occurring and man-made compound. It is used primarily in the production of fluorocarbon-22; however, past uses included its application as a dry cleaning spot remover, as an extraction solvent, in fire extinguishers, as an anesthetic, and in the manufacture of dyes and pesticides.

Chloroform is a colorless liquid with a pleasant, ethereal odor. It has a molecular weight of 119.38, a melting point of -63.2°C, and a boiling point of 61.3°C. Chloroform is highly soluble in water and is miscible with principal organic solvents.

Fate and Transport of Chloroform

Release of chloroform to the atmosphere may occur during the manufacture and handling of product and from its use in the production of other chemicals. Volatilization from contaminated or chlorinated water sources and contaminated soil are major sources of chloroform vapors in the air. Interaction of chloroform with photochemically produced hydroxyl radicals degrades airborne chloroform, which may otherwise travel vast distances. Large amounts of chloroform may be transported from air to soil and water through wet deposition. There is evidence that some biodegradation of chloroform may occur in soil and water; however, this does not appear to be a primary mechanism for removal from sediment or water. Most chloroform is removed from these media through volatilization.

5.2.1.2.2 Chloromethane

CAS No(s).: 74-87-3
Major Synonym(s): Methyl chloride

Chloromethane was detected in groundwater samples collected from the BRP6G. Chloromethane concentrations at the BRP6G ranged from 0.39, to 0.41, to 5.31 ug/L in wells CBR-5, CBR-2D, and CBR-3D respectively. No detection was made in the background well, CBR-1D, nor in the soils. The regulatory guideline is 10 ug/L.

Chloromethane, also known as methyl chloride, was once widely used as a refrigerant and is used in the manufacture of products such as polystyrene foam. It can be rapidly absorbed into the blood stream through oral and inhalation routes of exposure, and is widely distributed to most body compartments. Chloromethane is a possible laboratory artifact.

5.2.1.2.3 Ethylbenzene

CAS No(s).: 100-41-4
Major Synonym(s): Ethylbenzol, Phenylethane

Ethylbenzene was identified as a SSC at concentrations above two times average background in soil samples collected from the BRP6G. Ethyl benzene concentrations at the BRP6G decreased in lateral extent and value as the sampling progressed from 0-5 foot down to the level below, 5-12 feet. At the 5 to 12 foot level below the ground surface, which was the deepest level where detected, there were much fewer detections. All further samples below the 12 foot level were below the detection limit. (See Figures 4-40 and 4-41 in Chapter 4).

Ethylbenzene is an aromatic hydrocarbon produced anthropogenically for use in styrene production, as a solvent, as a component of asphalt and naphtha, and in the manufacture of other compounds such as cellulose acetate, propylene oxide, and alpha-methyl benzyl alcohol. Ethylbenzene is a natural component of fossil fuels. Ethylbenzene is a colorless liquid with an odor similar to gasoline. It has a molecular weight of 106.6, a melting point of -95°C, and a boiling point of 136.25°C. Ethylbenzene is less dense than water, with a density of .866. It is slightly soluble in water, miscible with many organic solvents, and soluble in alcohol and ether.

Fate and Transport of Ethylbenzene

Ethylbenzene has been detected in all environmental media, however it is most prevalent in the atmosphere. Releases into the air occur during manufacturing, fuel combustion, solvent use, as well as pesticide and other consumer product use. Reactions with atmospheric hydroxyl radicals appears to be an important pathway of ethylbenzene degradation. Reactions of gaseous ethylbenzene with ozone and toluene-like compounds has been observed, and at least one product of these reactions, peroxyacetyl nitrate (PAN) is a toxic component of smog.

Surface water contamination with ethylbenzene can occur through industrial discharges and gasoline spills, whereas groundwater discharges arise from leaking underground storage tanks, landfill leachate, and improper waste disposal. Biodegradation, photooxidation, and volatilization are the processes responsible for removal of ethylbenzene from surface waters.

Ethylbenzene releases to soil may result from fuel spills, disposal of solvents and certain household products such as paint, cleaners and degreasers, varnishes, pesticides, and leaking underground storage tanks. Ethylbenzene does not readily adhere to soil, and therefore will either volatilize or migrate through soil until it reaches the groundwater. The solvent properties of ethylbenzene may release other organic compounds which would normally be tightly adsorbed to soil and thus increase their mobility. Biodegradation of ethylbenzene is significant in aerobic sediments, however migration of ethylbenzene to deeper, anaerobic soils is so rapid that the amount of aerobic transformation is limited.

5.2.1.2.4 Toluene

CAS No(s).: 108-88-3
Major Synonym(s): Tolulol, Methylbenzene, Phenylmethane

Toluene was identified as a SSC at concentrations above two times average background in soil samples collected from the BRP6G. Toluene concentrations at the BRP6G generally decreased in lateral extent and value as the sampling progressed from 0-5 feet, through 5-10 feet, and down to the deepest level encountered, 15 feet. Toluene was detected in four borings at the deepest level, but only one of the samples deeper than ten feet level was above the two times average background level of 0.755 ug/kg. (See Figures 4-49 through 4-51 in Chapter 4).

Toluene is primarily used as a gasoline additive to improve octane ratings but also finds usage in the production of benzene, as a solvent in many household products, in the production of polymers, pharmaceuticals, cosmetics, and trinitrotoluene (TNT). Toluene is a natural component of crude oil. Toluene is a colorless liquid with a sweet, pungent benzene-like odor. It is miscible in water, alcohol, chloroform, ether, acetone, glacial acetic acid, and carbon disulfide. Toluene has a boiling point of 232°F and a vapor pressure of 22 mm Hg at 20°C.

Fate and Transport of Toluene

The potential for exposure of the general population to toluene is high due to the large quantities released to the environment each year. The most frequent releases of toluene occur as a result of the production, transport, and use of gasoline.

Most toluene enters the environment via direct release to the air, and that which is released in liquid form to soil or surface water quickly volatilizes. In the atmosphere, toluene is degraded through reaction with hydroxyl radicals to yield simple hydrocarbons as a final product. The half-life of toluene based on the rate constant for this process is estimated at approximately 13 hours. Toluene may also react with nitrogen dioxide, oxygen, and ozone to a lesser degree.

Toluene released to the soil can be biodegraded by bacteria, in both aerobic and anaerobic conditions. The half-life of toluene in the soil can range from 1-7 days .

Degradation of toluene in surface and shallow ground water occurs primarily through microbial biodegradation. The half-life of toluene in water can be less than one day if temperature and other environmental parameters are favorable.

5.2.1.2.5 Xylene

CAS No(s).: 1330-20-7, 108-30-3, 95-47-6, 106-42-3
Major Synonym(s): Methyl toluene, m-xylene, o-xylene, p-xylene

Xylene was identified as a SSC at concentrations above two times average background in soil samples collected from the BRP6G. Xylene concentrations at the BRP6G generally decreased in lateral extent and value as the sampling progressed from 0-5 feet, through 5-10 feet, and down to the deepest level encountered, which was 14.7 feet. While detected in five borings at the deepest level, none of the samples deeper than ten feet level were above the two times average background level of 0.357 ug/kg. (See Figures 4-54 through 4-56 in Chapter 4).

Most xylenes are produced anthropogenically as solvents for paints and coatings, as a blending agent in gasoline, or as an intermediate in the chemical production of ethyl benzene or other compounds. There are 3 isomers of xylene: meta-xylene (m-isomer), ortho-xylene (o-isomer), and para-xylene (p-isomer). These are produced together and collectively are called mixed xylene. The ratio of the isomers in mixed xylene varies, depending on the method of synthesis.

Xylene, or mixed xylene, and each of the isomers have a molecular weight of 106.16. The chemical make-up of each isomer is the same; however, structurally, placement of the methyl group varies in its position on the ring. All of the isomers have a boiling point around 138° C, but melting points range from -45° C to -13° C. They are all colorless liquids with a sweet odor. All are completely or nearly insoluble in water, but soluble in organic solvents.

Fate and Transport of Xylene

Xylenes occur in many types of media and have been detected in air, rain, soil, surface water, ground water, aquatic biota, human blood, urine, and expired air. Most releases of xylene occur from industrial uses, as a component of fuel, and during production and handling of product. Natural emissions, only a minor source of emissions, can occur in smoke from forest fires or through seepage of petroleum from underground formations into the oceans.

Xylenes are highly volatile and most emissions eventually partition into the atmosphere. Photo-oxidation is the primary pathway for transformation of xylenes, and the estimated half-life for the photo-oxidation of xylene is 24.1 hrs. Reactions with hydroxyl radicals also occur and ultimately lead to the formation of 2 products: carbon dioxide and water.

Xylene spilled on land is mobile and will either leach into the ground or evaporate. Retention time may be increased in organic or hydric soils. Photo-oxidation may transform xylene on the soil surface at a rate similar to photo-oxidation in the atmosphere; however, the importance of this degradation pathway is unclear, based on the rate of mobility of xylene in soils. In sub-surface soils, biodegradation is a slow, but significant, process. Apparently, specific bacteria are capable of biodegrading specific isomeric forms of xylene. These degradation processes occur under both aerobic and anaerobic conditions.

Water-borne xylene is subject to evaporation from surface waters and to microbial biodegradation. Oxidation and hydrolysis are not likely degradation pathways.

5.2.2 Semivolatile Organics

High Koc's and Kow's coupled with low vapor pressures and Henry's Law constants indicate the tendency of semivolatile organics to be relatively immobile and very persistent in the environment. For the most part, when released to water or soil systems, the major fate of these chemicals is governed by adsorption to soil and sediment, particularly those high in organic materials. At the BRP6G, semivolatile organics were found in soil, sediment, and groundwater samples.

5.2.2.1 PAHs

Members of this group consist of PAHs with 2- to 6-ring structures and include acenaphthene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[ghi]perylene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenzo[ah]anthracene, dibenzofuran, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, napthalene, 2-methylnapthalene, phenanthrene, and pyrene. PAHs identified as SSCs in vadose zone soils are fluoranthene and pyrene.

CAS No(s).:	82-32-9, 208-96-8, 120-12-7, 56-55-3, 50-32-8, 205-99-2, 207-08-9, 191-24-2, 218-01-9, 53-70-3, 206-44-0, 86-73-7, 193-39-5, 85-01-8, 129-00-0
Major Synonym(s):	Acenaphthene, Acenapthylene, Anthracene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i) Perylene, Benzo(k)fluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Fluorene, indeno(1,2,3-cd)pyrene, Phenanthrene, Pyrene

Polycyclic aromatic hydrocarbons (PAHs) are a group of chemicals produced from combustion from automobiles and other gas-burning engines, wood-burning stoves and furnaces, tobacco smoke, industrial smoke, and charbroiled foods. PAHs occur in nature in crude oil and shale oil and are released during forest fires and volcanic eruptions. Anthracene, acenaphthene, fluorene, phenanthrene, and fluoranthene are produced commercially for industrial use.

As a group of similar chemical compounds, PAHs typically exist as colorless, white, or pale yellow-green solids. They tend to occur as mixtures of two or more PAHs. Molecular weights range from 158.2 - 278.35. Most are insoluble in water, yet soluble in organics.

Fate and transport of PAHs

In contrast to volatile organics, PAHs strongly adsorb to soils, sediments, and organic materials because of large Koc's and are not easily leached to water systems. Because the smaller-ring PAHs (i.e., napthalene) have moderate Koc's, they are slightly soluble in water and may volatilize from water to air to a limited extent. The extent to which napthalenes adsorb to soils largely depends upon the organic content of the soils. In general, PAHs do not reside in the water column, as they quickly adsorb to soils, sediment, or organic particles. In general, as the number of aromatic rings in the chemical structure of PAHs increases, the affinity for adsorbing to soils and organic materials increases, and solubility and volatilization processes decrease. This is related to increasing Koc and Kow values coupled with decreasing vapor pressures and Henry's Law constants and lower solubility in aqueous systems.

Biodegradation of larger-ring PAHs in water and soil, although slow, is the major mechanism for the removal of PAHs. Degradation of PAHs in water by photolysis and chemical oxidation are important removal processes.

PAHs are further classified according to molecular weight and the members within a group behave similarly in the environment. They are grouped as follows:

- Low molecular weight PAHs (153-178 g/mol): acenaphthene, acenapthylene, anthracene, fluorene, and phenanthrene

- Medium molecular weight PAHs (202 g/mol): fluoranthene and pyrene

- High molecular weight PAHs (228-278 g/mol): Benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i) perylene, benzo(a)pyrene, chrysene, dibenzo(a,h) anthracene, and indeno(1,2,3-cd)pyrene

The bulk of PAH released to the environment is to the air, where they occur as vapor or as solids adsorbed to particulate matter. PAHs sorbed to particulate matter are transported and deposited according to the size of the particles. PAHs may be photo-oxidized in the air or may interact with other atmospheric pollutants. Some of the products of these reactions are also toxic.

PAH contamination of surface waters arises primarily from atmospheric deposition, however, industrial effluents and runoff, municipal and urban runoff, and oil spills also contribute. A certain amount of PAH will volatilize from water to the atmosphere, particularly low molecular weight compounds. Microbes will biodegrade low molecular weight compounds, whereas medium and high molecular weight compounds may sorb to particles in the water column and remain suspended or settle to the bottom.

PAHs are also present in soil, where they may be found adsorbed to soil and sediment. Their occurrence in soil may result from atmospheric deposition, automotive exhaust, use of compost and fertilizer, and sludge from sewage treatment plants. Most degradation of PAH in soil occurs through microbial degradation.

5.2.2.2 Bis (2-ethylhexyl) phthalate

CAS No(s).: 117-81-7

Synonym(s) DEHP, BEHP

Bis (2-ethylhexyl) phthalate was found in surface and subsurface soils as well as in groundwater samples at the BRP6G. The range in concentrations in the groundwater samples was from 0.58 (CBR-2D), to 3.87 (CBR-6), to 6.11 (CBR-4) ug/L. No concentrations were detected in the background well. Three soil samples noted occurrences of this contaminant. The concentrations ranged from 37.2 (CS6G-0903, 5.6 to 7.6 feet), to 65.1 (CS6G 2203D, 2 to 4 feet), to 78.1 (CS6G 0701, 0 to 2 feet), ug/kg. All three of these samples were above the two times average background concentration of 4.62 ug/kg for subsurface soils. Bis (2-ethylhexyl) phthalate is a common laboratory artifact

Bis (2-ethylhexyl) phthalate is produced commercially for use as a plasticizer in polyvinyl chloride (PVC) and vinyl copolymer resins (EPA 1981). Other reported uses include bis (2-ethylhexyl) phthalate as an inert component of pesticides, a solvent for erasable ink, as a component of dielectric fluids, as a replacement for PCBs, and others (EPA 1981, HSDB 1987).

Bis (2-ethylhexyl) phthalate is a colorless liquid having a molecular weight of 391. It has a melting point of 50° C and a boiling point of 384° C. It has minimal solubility in water (0.4 mg/L) (EHRAV 1995), but is miscible with oil, hexane, and organic solvents (ATSDR 1988).

Fate and Transport of Bis (2-ethylhexyl) phthalate

Bis (2-ethylhexyl) phthalate may be volatilized into the atmosphere during its manufacture and from commercial plastics use. Bis (2-ethylhexyl) phthalate adsorbs to particulate matter, therefore wet deposition would assist in transport of bis (2-ethylhexyl) phthalate from air to other media (ATSDR 1988). The most likely mechanism for degradation of bis (2-ethylhexyl) phthalate in the atmosphere is through its reaction with hydroxyl radicals.

Bis (2-ethylhexyl) phthalate does not readily volatilize from surface waters to air. Its removal from water is principally through adsorption to suspended particulate matter and sediments and uptake and transformation by biotic organisms (ATSDR 1988).

In soils, bis (2-ethylhexyl) phthalate binds particles, particularly organic matter. There is little mobility of bis (2-ethylhexyl) phthalate in soils and biodegradation in soils occurs faster in aerobic versus anaerobic conditions.

5.2.3 Dioxins/Furans

Octachlorodibenzo-p-dioxin was identified as a SSC at concentrations above two times average background in soil samples collected from the BRP6G. The BRA (Chapter 6) also identified this dioxin as a possible COPC.

5.2.3.1 Octachlorodibenzo-p-dioxin

CAS No(s).: 1746-01-6 (2,3,7,8-TCDD)
Major Synonym(s): Dioxin

Octachlorodibenzo-p-dioxin was identified as a SSC at concentrations above two times average background in soil samples collected from the BRP6G. Octachlorodibenzo-p-dioxin concentrations at the BRP6Ggenerally decreased in lateral extent and value as the sampling progressed from 0-5 feet, down to the deepest level encountered, 8 feet. While detected in five borings at the deepest level (8 ft), none of the samples deeper than eight feet had concentrations above the detection level of 1.287 ug/kg. (See Figures 4-59 through 4-60).

For the purpose of this report, 2,3,7,8-TCDD will be used as a surrogate compound for those chemicals listed above which exhibit dioxin (TCDD)-like effects both biologically and toxicologically. Collectively, these agents are known as dioxin.

Dioxin is produced as a by-product (and contaminant) of hexachlorophene, a germicide previously used to bathe babies, Agent Orange, an herbicide used extensively in the Vietnam War, and pentachlorophenol, a treatment for wood.

Chemically, dioxins are chlorinated phenolic compounds which are water insoluble. They are very persistent in the environment, as they are not readily biodegraded by most organisms.

Fate and Transport of Dioxin

Although dioxin has an extremely low vapor pressure, it has been shown to volatilize and to occur in the atmosphere in both the gaseous and aerosol states. Airborne dioxin has been shown to be subject to long-distance transportation prior to its removal from the atmosphere. Dioxins react with hydroxyl radicals in the atmosphere with an estimated half-life of 8.3 days. Although insoluble in water, dioxins may be removed from air through wet as well as dry deposition.

Dioxin contaminants in water adsorb to sediments or suspended particulate matter which may slow down the rates of photolysis and evaporation, which occur at the water's surface. A half-life of 21 hours (in summer) to 118 hours (in winter) has been estimated for photolysis of dioxin at the water surface. A volatilization half-life of 46 days has been estimated for dioxin, however, when adsorbance and sedimentation are accounted for, the total half-life is increased to 50 years, indicating that aquatic sediments represent a significant sink for dioxins.

Soil-bound dioxin shows little vertical mobility and most is contained in the upper 8 cm. Dioxin is very stable to metabolism, and biodegradation is considered rare. Photolysis, however, may be significant, but confined to the upper 1 cm.

5.2.4 Pesticides

The pesticide p,p'-DDE was identified as a SSC at concentrations above two times average background in soil samples collected from the BRP6G. Concentrations of p,p'-DDE were found only in the upper five feet from the soil samples in the borings. Ten of the twelve detections were above two times average background concentration of 1.211 ug/kg. (See Figure 4-63).

CAS No(s).:	50-29-3 (DDT), 72-55-9 (DDE), 72-54-8 (DDD)
Major Synonym(s):	Dichlorodiphenyltrichloroethane (DDT), dihydrochloride (DDE)

DDT was first synthesized in 1874; however, its insecticidal properties were not discovered until 1939. From that time until its use was banned by the EPA in 1972, DDT was one of the most widely used insecticides in the United States. DDT was very effective in the control of insect vectors of malaria and typhus. It was extensively used on cotton, peanuts, and soybean crops, and at one time was registered for use on 334 agricultural commodities.

Structurally, DDT, DDE, and DDD are very similar, differing only in the number of chlorine and hydrogen atoms. DDT has a molecular weight of 354.49, a melting point of 108-109° C, and a boiling point of 260° C. DDE has a molecular weight of 318.03 and a melting point of 88.4-90° C. DDD has a molecular weight of 320.05, a melting point of 109-110° C, and a boiling point of 193° C. All are colorless crystals or white powder, insoluble in water, and soluble in organic solvents and/or lipids.

Fate and Transport of DDE

Prior to its ban in the United States, DDT was released to the atmosphere during application as an insecticide. Because it is currently used in other countries, DDT may still enter the atmosphere during pesticide application and may be transported to the United States by wind currents. Volatilization from soil and water also may contribute to atmospheric contamination by DDT. DDE and DDD occur in air and other environmental media as products of DDT degradation. DDT and its metabolites in are subject to decomposition by photo-oxidation and reaction with hydroxyl radicals. Precipitation is thought to remove DDT from the air at a faster rate than other pathways and leads to deposition in surface waters and sediments.

DDT in the water quickly adsorb to particulate matter, causing sedimentation. It may be transformed through photodegradation and biodegradation or DDT may be transported back to the atmosphere by evaporation.

DDT is persistent in soils where it binds to soil particles. It may slowly volatilize to the atmosphere with an estimated half-life of 100 days. DDT in soils is also subject to water runoff, photo-oxidation, and biodegradation in aerobic and anaerobic conditions. Nonetheless, DDT may take up to 15 years to degrade in soil.

5.2.5 Metals

Antimony, arsenic, cyanide, and mercury were identified as SSCs at the BRP-6G. Arsenic was also listed as a COPC in the BRA. Assessing the mobility and persistence of metals in environmental media is complicated and often difficult because of the many inorganic and organic complexes and salts they form. In addition, metals undergo a variety of processes in soils and water, which include hydrolysis, reduction, oxidation, and ion exchange. These reactions, are highly dependent on factors such as pH, salinity, ionic strength, particle-surface reactions, and the presence of anions and natural organic acids (humics and fulvics).

Many metals are relatively insoluble either in metallic form or as inorganic complexes and salts; yet become soluble in the presence of organic acids and oxidizing conditions. An exception is mercury, which is not very soluble in water but will readily volatilize from water to air. Cation exchange of metals by soils and sediments is the dominant fate mechanism in natural systems.

5.2.5.1 Antimony

CAS No(s): 7440-36-0
Major Synonym(s): Antimony Black, Stibium

Antimony was identified as a SSC at concentrations above two times average background in soil samples collected from the BRP6G. Antimony concentrations increased progressing from the 0-5 foot level, and to the 5-10 foot level. However, the concentrations decreased in lateral extent and value at the deeper level from 10 to 20 feet. At the deepest level of 20 feet, only two samples noted concentrations above detection. Only one sample was detected above the two times average background concentration of 3.12 mg/kg, (see Figures 4-3 through 4-5).

Antimony and its compounds occur naturally in the earth's crust. It occurs in association with minerals, particularly the sulfides, and is often combined with lead, copper, and silver. Antimony is used in alloys with other metals to increase their hardness, strength, corrosion resistance, and electrochemical stability. Antimony is a silvery-white solid with a molecular weight of 121.75. It is insoluble in water. It volatilizes during combustion.

Fate and Transport of Antimony

Antimony is released to the environment by natural sources such as windblown dust, sea spray, forest fires, and biogenic sources. Most anthropogenic releases occur during smelting and refining processes, refuse incineration, and coal burning. Antimony may enter the air in a vapor phase upon burning, but attaches to suspended particles upon condensation. Large particles are subject to gravitational settling whereas smaller particles are deposited on the earth's surface through precipitation. Antimony released or deposited in water is often bound to suspended particulate matter, which may settle out and rest on bottom sediments.

In soils, antimony may bind to organic and inorganic matter, depending on the particular antimony compound. Antimony in minerals does not adsorb to soil. Most studies have revealed that antimony is not mobile in soils and tends to concentrate in the upper layers; however, several studies have presented conflicting data.

5.2.5.2 Arsenic

CAS No(s):	7440-38-2
Major Synonym(s):	None

Arsenic was identified as a SSC at concentrations above two times average background in soil samples collected from the BRP6G. Arsenic concentrations generally decreased in lateral extent and value as the sampling progressed from 0-5 feet, through 5-10 feet, and down to the deepest level encountered, 30.7 feet. Although only found in one boring at the deepest level, the sample deeper than twenty feet is above the two times average background level of 5.436 mg/kg, (see Figures 4-8 through 4-11).

Arsenic exists in low concentrations in all environmental media as a natural component of the earth's crust. Typical arsenic concentrations are less than ten parts per billion in water and less than 40 parts per million in soil. It is a silver-gray, brittle, crystalline substance that is soluble in nitric acid but insoluble in water and in caustic and non-oxidizing acids. It has a molecular weight of 74.92 g/mole, sublimes at 613° C, melts at 817° C (at 28 atmospheres), has a vapor pressure of 1 mm Hg at 372° C, and has a density of 5.73 at 14° C. Arsenic will vaporize when heated to 100° C, with rapid vaporization at 450° C.

Fate and Transport of Arsenic

Arsenic is found primarily in soil or rock and is mainly transported adsorbed onto particulate material. In water, soluble forms of arsenic can be carried long distances, but may be adsorbed onto sediments or soils due to chemical or biological reactions that change arsenic speciation. In soil, arsenic is subject to a number of transformation processes, such as oxidation-reduction reactions, ligand exchange, biotransformation, precipitation, and adsorption. It is rarely encountered as a free element in natural waters, where it is also subject to processes such as oxidation-reduction reactions, ligand exchange, biotransformation, precipitation, and adsorption. Arsenic accumulates to varying degrees in some organisms such as algae and shellfish, but does not biomagnify in the food chain. Some arsenic is absorbed via inhalation and oral routes, but dermal absorption is considered to be minor.

5.2.5.3 Cyanide

CAS No(s).: 57-12-5
Major Synonym(s): NA

Cyanide was identified as a SSC at concentrations above two time average background in soil samples collected from the BRP6G. Cyanide concentrations generally decreased in lateral extent and value as the sampling progressed from 0-5 feet, through 5-10 feet, down to the deepest level encountered, 16.7 feet. While detected in three borings at the deepest level, three of the samples deeper than ten feet are above the two times average background level of 99.215 ug/kg, (See Figures 4-14 through 4-16).

The cyanides are a group of compounds based on the chemical combination of carbon and nitrogen. These compounds occur naturally in very small quantities in fruits, roots, and leaves of certain plants and are produced by some bacteria, fungi, and algae. Cyanide is also a constituent of vitamin B12(cyanocobalamin), an important dietary requirement for the human body. Nonetheless, cyanide is very toxic and the majority of cyanide in the environment is produced anthropogenically. Cyanide compounds are utilized by the pharmaceutical industry, the textile industry in making nylon, agriculturally, as a fumigant, in electroplating and metal treatment, as an anticaking agent in roads, in photograph development, and in gold and silver extraction from ores.

Sodium cyanide is a white solid with a molecular weight of 49.02. It is soluble in water and ethanol. Hydrogen cyanide is a gas having a molecular weight of 27.03. It is less dense than air, with a density of 0.6884. It is miscible with water and soluble in ethanol. Hydrogen cyanide and several other cyanide compounds have an odor similar to bitter almond.

Fate and Transport of Cyanide

According to the United States Department of Health and Human Services (ATSDR 1991), a conservative estimate of cyanide emissions to the air is estimated at 44 million pounds per year. More than 90% of these emissions can be attributed to automobile exhaust. Once emitted to the atmosphere, cyanide compounds have an extended residence time, estimated at 1.4-4.3 years. Since most of the cyanide emitted into the air is in gaseous form, gravitational settling is not a major transport mechanism, except in instances where metal cyanide particles are present. Removal from the air by precipitation also appears to be a negligible deposition pathway. Degradation of atmospheric cyanide occurs primarily through interaction with hydroxyl radicals, and the rate of these reactions appear to be altitude dependent, with reactions proceeding at a faster rate in the lower altitudes.

Hydrogen cyanide, which is a gas at standard conditions, is the prominent form of cyanide in water. When cyanide salts, such as sodium cyanide or potassium cyanide, enter the water they readily dissociate and the released cyanide ion reacts with hydrogen to form hydrogen cyanide. These reactions are dependent on pH and a number of other parameters, and proceed at a faster rate in lower pH conditions. At pH 7.0, 99% of cyanide in the water is in the form of hydrogen cyanide, which can volatilize to the atmosphere. Bacteria can also degrade many of the cyanide compounds to ammonia and ultimately nitrogen, under aerobic conditions, or to nitrogen directly by denitrification of cyanide under anaerobic conditions. The estimated half life of cyanide when converted by these biodegradation processes is 10-24 days.

Cyanide does not adsorb strongly to particles in soil, but nonetheless is not often found in groundwater. It may complex with metals present in soil, thereby reducing its mobility or it may be degraded by soil microorganisms. The EPA has found groundwater leaching in conditions where the concentration of cyanide is lethal to microrganisms, such as at solid waste sites. Hydrogen cyanide can also volatilize to the atmosphere from soil at a pH less than 9.2.

5.2.5.4 Mercury

CAS No(s):	7439-97-6
Major Synonym(s):	Hydragyrum, Liquid Silver, Quick Silver

Mercury was identified as a SSC at concentrations above two times average background in soil samples collected from the BRP6G. Mercury concentrations generally decreased in lateral extent and value as the sampling progressed from 0-5 feet, through 5-10 feet, and down to the deepest level encountered, 30.7 feet. Although only found in one boring at the deepest level, both of the samples deeper than twenty feet map level are above the two times average background level of 19.3 ug/kg. (See Figures 4-19 through 4-22).

Metallic mercury is a bright, silvery, dense liquid that freezes at -38.9°C and boils at 357° C. It has a molecular weight of 201. Mercury has a water solubility of 0.03 and a vapor pressure of 0.002 mm Hg. Mercury is naturally occurring element which is distributed throughout the environment. Mercury occurs in three valence states and is found in the environment in the metallic form as well as various inorganic and organic complexes. Mercury is found in small amounts in all classes of geologic formations. The major sources of mercury in the atmosphere is degassing from mineral mercury in the lithosphere. Anthropogenic sources of mercury include mining, various industrial and manufacturing processes, fertilizers, insecticides, solid waste disposal, and land application of animal and human waste.

Fate and Transport of Mercury

The cycling of mercury in the environment includes degassing from soils and surface waters, followed by atmospheric transport and deposition, and subsequent sorption to soils or sediments. Particulate bound mercury can be converted to inorganic mercury sulfide or into more volatile or soluble forms that can escape back to the atmosphere or enter the aquatic or terrestrial food chains.

Metallic mercury is the most reduced valence state, Hg^0, which exists as a liquid at room temperature. The free metallic form of mercury, Hg^0, readily vaporizes. Residence time in the atmosphere has been estimated from 6 days to 2 years. Wet and dry deposition are thought to be equally important as removal mechanisms from the atmosphere. The propensity for atmospheric transport explains mercury concentrations encountered in remote lakes unimpacted by other sources.

In surface water, mercury usually exists in the mercuric, Hg^{2+} or mercurous Hg^{1+}, state. The fate and transport depend on the form of the compound. Volatile forms will be lost to the atmosphere while solid forms will partition to sediments and particulates. Although volatilization from surface has been measured, the controlling factor in mercury distribution in surface waters is sorption, deposition, and resuspension of sediments.

Similar to sediment, mercury in soil is sorbed to the humic and seseuioxides substances contained in the soil organic fraction. Inorganic forms of mercury sorbed to particulate matter are not readily desorbed. Thus, sediments are important sinks for inorganic complexes of mercury and leaching of inorganic mercury complexes is a relatively insignificant process in soils. Thus, sorbed forms of mercury are primarily transported through surface runoff.

Mobilization of sorbed forms can occur through chemical or biological reduction to elemental mercury or through bioconversion to volatile organic forms. Mercury has been shown to volatilize from soil and this loss may be controlled by temperature with greater emissions being greater in warmer weather when microbial action reduction of Hg^{2+} to the more volatile Hg^0 is greatest. Free metallic mercury may move through dry soil a few inches, but it is unlikely further penetration would occur. Small amounts of mercury in groundwater have shown to move to surface water impoundments, but the concentrations were very low compared to amount deposited to the soil. Because of the limited leaching , mercury contamination of groundwater is generally not a problem.

Methylmercury is the most common organic form of mercury. This compound is soluble, mobile and is readily bioaccumulated and biomagnified in the aquatic food chain. The large potential to bioaccumulate makes fish consumption the most important nonoccupational exposure route for the general population. Terrestrial food chain bioaccumulation is possible, but is thought to be relatively small. Inorganic mercury can be methylated by microorganisms in soil and water under aerobic and anaerobic conditions. The amount of methylation in surface water depends on many factors such as pH and dissolved organic content. In soils methylmercury formation is also controlled by pH, salt content, and composition of the soil solution. Since methylmercury is soluble, once inorganic mercury is transformed in soil, it can readily move through environmental media and eventually migrate back to surface water systems.

5.3 Contaminant Migration

Precipitation that infiltrates unit soils will move downward to the groundwater. This precipitation may pick up contaminants as it infiltrates through the soil. The transport of contaminants through the soil to the water table causes groundwater contamination. The infiltration of water through the vadose zone is controlled by soil properties and characteristics. The presence of groundwater contaminants at levels above 2 times background indicates that the groundwater beneath the BRP6G has been impacted. The Unit has only one upgradient groundwater monitoring well, and this will lead to an overly conservative estimate of SSCs (because more upgradient monitoring wells would tend to exhibit natural variation and thus yield a greater range of analyte concentrations and probably higher background values).

Toxicity characteristic leaching procedure, TCLP, is a test for characteristically toxic hazardous wastes developed using a subsurface fate and transport model. It is generally a measure of the ability of a substance to be leached from its current mode and become mobile. The TCLP analysis was performed on soil samples at the BRP6G. The analytes which for which the TCLP analysis were performed are presented in Table 5.4. The analytes having values which exceeded the TCLP limit, being therefore more mobile are mercury, benzene and methyl ethyl ketone, (depicted in bold type in Table 5.4).

The BRP6G was constructed in 1951 and was operated until 1955. After disposal activities ceased, the area was covered with soil. Considering the presence of groundwater contaminants and the age of the unit, any contaminants which are mobile would be expected to have already leached from the soil to the groundwater. Immobile contaminants are likely bound to soils. Groundwater from the water table aquifer beneath the BRP6G must travel approximately 7000 feet before outcropping to a stream. While traveling through the aquifer, contaminants may be sorbed to soil particles. Recent EPA soil screening guidance is discussed in Section 5.4 to determine future transport potential.

5.4 Leachability of Contaminants to Groundwater

One of the concerns regarding the SSCs that have been identified in the vadose zone is whether the potential exists for these contaminants to migrate to the water table in a sufficient quantity over time such that future groundwater concentrations could create a risk (i.e. exceed MCLs or other risk based criteria). Modeling is recommended in order to attempt to answer this concern. There are models that have the required sophistication to produce an answer to this complex problem, although no single model has been generally accepted as superior to others. In addition, modeling requires a large number of assumptions regarding current and future subsurface conditions and chemical behaviors, such that any model will produce a range of responses (projections) from conservative to nonconservative, depending upon the input values. Thus, in general, whether a model will identify a future risk is dependent upon the input values chosen. The appropriateness (correctness) of the input values is generally open to debate, and often results in ambiguous or inconclusive modeling results. In an attempt to provide a more standardized approach, that is somewhat less subjective, WSRC has opted to utilize recent EPA guidance that provides a model (and calculated values for a number of analytes) for this complex problem.

The EPA Soil Screening Guidance (EPA/540/R-94/101, December 1994) provides the framework for the development of Soil Screening Levels (SSLs). In general, soils with contaminant levels below SSLs would not warrant further study or action under CERCLA. The EPA guidance provides for three approaches, (1) simple site-specific, (2) detailed site-specific, and (3) generic. According to the guidance the generic approach is usually the most conservative and is the approach chosen for this report. The generic approach essentially involves a comparison of the contaminants levels in the soils to the levels presented in the guidance. Contaminant levels below the SSL generally warrant no further study or action. Contaminant levels above the SSL do not automatically trigger a response action, however, additional evaluation of the potential risks posed by the site contaminants is appropriate.

In addition, the EPA Soil Screening Guidance provides for three pathways of exposure, (1) ingestion of soil, (2) inhalation of volatiles and fugitive dusts, and (3) ingestion of contaminated groundwater caused by migration of chemicals through soil to an underlying potable aquifer (residential land use scenario). The BRA (Chapter 6) addresses the surface soils and current groundwater contaminant levels. The purpose of this modeling is to determine the potential for SSCs identified in the vadose zone (from 0 feet to the water table) to have a future impact on the groundwater quality. That is, could the SSCs identified in the vadose zone migrate to the water table and create a risk (i.e., exceed MCLs or other risk based criteria) in the groundwater at some time in the future.

SSLs as calculated based upon the EPA guidance (and the generic SSLs provided in the guidance) represent conservative estimates of the amount of contaminants in soil which could adversely impact future groundwater resources. The default SSLs provided in the EPA guidance are conservative based upon the following assumptions used in the calculations:

1. The source of contamination is defined as an evenly contaminated 30-acre site. Source size has significant implications for the dilution/attenuation factors (DAFs). Large sources generally result in low DAFs (more conservative), while smaller sources generally justify higher DAFs.

2. The soil contamination extends from the surface to the top of the aquifer. This is a reasonable assumption for sites where the water table is fairly shallow (e.g., 5 to 10 feet below surface). However, at sites with deeper water tables this is a conservative assumption.

3. No attenuation is considered in the unsaturated zone. This assumption affects the DAF because a thick, uncontaminated, unsaturated zone would probably justify a higher DAF.

4. The point of compliance is at the edge of the site, which is assumed to be uniformly contaminated. This conservative assumption also has implications for the calculation of the DAF.

5. The simple generic DAF assumes that an unconfined, unconsolidated aquifer with homogeneous and isotropic hydrologic properties underlies the site.

6. The calculations assume a resident scenario as the future land use.

Table 5.2 notes the contaminant name, maximum soil detected concentration, average soil concentration, the EPA SSL, and the site specific SSL concentration, which is based upon site input parameters. The calculations for these site specific SSL values, as well as the calculations for the DAF, etc., are in Appendix L The EPA guidance provides for two generic comparisons, (1) DAF 10, and (2) DAF 1. The DAF is part of the conservative nature of the generic model as discussed above. A DAF of 1 would indicate very little dilution and/or attenuation. A DAF of 1 would be most appropriate to use in instances where there are high water tables, karst topography, fractured bedrock, or a source size greater than 30 acres. A DAF of 10 is less conservative, however, it is still a conservative figure based upon the assumptions used in the calculations (as discussed above). For the purposes of this report, a DAF of 1 was used in the EPA SSL comparison. That is because the SSL calculation using site specific parameters computed a site specific DAF of 1.57. The choice of the DAF (either 1 or 10) for the EPA SSL should be chosen with the site specific DAF taken into consideration.

In the framework for soil screening, the following steps were followed:

develop/alter the conceptual model of the site based on the site information available;

collect a representative sample set for each exposure area. This data will support the calculation of an exposure area arithmetic average concentration of contaminants to be used as the exposure point concentration;

compare the site-measured data with the SSLs.

In the case of BRP6G, the primary source is the waste deposited/burned in the pit. For the soils at BRP6G, the primary release mechanism is through infiltration/leaching of the contaminant to the groundwater, see Figure 5.1 for the Conceptual Release Model. At BRP6G the distribution of the contaminants is heterogeneous in their physical location and distribution. In the case of the PAHs, specifically benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene the highest concentrations were detected in two borings being CS6G 1404 (4-6'), and CS6G 0902 (3.6-5.6'). The depths of these samples corresponds to the base of the pit where the material was burned. Samples taken from the next interval below these depths in the same borings, exhibited concentrations which were orders of magnitude lower than these samples. For benzo(a)anthracene and chrysene, these two samples were the only detections. Borings adjacent to the above-captioned borings had either very low detections or were non-detect in the same sampled intervals. The data set which would therefore be representative of the exposure area would be the set of samples which are from ground surface down to approximately ten feet in the area of the pit. Also included would be any detected value which was from a boring outside the pit, and the samples from that boring down to ten feet. Some of the parameters in which this unit differs from the default model for the generic SSLs are its relative source size, the non-uniform distribution of contaminants from ground surface to the top of the water table, hydraulic gradient, infiltration rate, mixing zone depth, and aquifer hydraulic conductivity.

In comparing the site measured data with the SSLs, the first step is to compare the maximum soil detected concentration with the EPA generic SSL. If the maximum concentration is less than the EPA SSL concentration for a DAF of 1, then the contaminant requires no further action. In Table 5.2, an "N/A" is listed in the Soil Average Concentration Column for that situation. If the soil maximum concentration is greater than the EPA SSL concentration, a soil average concentration is calculated over the exposure area, using half of the detection limit for those samples where the contaminant is not detected. A site specific SSL is calculated if any of the soil average concentrations are above the EPA SSL concentration. The calculated average is then compared to the EPA SSL concentration, and if greater than the EPA SSL, it is compared to the site specific SSL concentration. If the soil average concentration is greater than both the EPA and site specific SSL, then a "Fail" is noted in the last column of Table 5.2. For those constituents whose average concentration is greater than the generic and site specific SSLs, more complex fate and transport modeling software or a spreadsheet analysis used to calculate transport in the vadose zone to determine the groundwater concentrations is employed. After the groundwater concentrations are determined, exposure risks and hazard indices are calculated for the industrial worker and future resident.

Specifically for BRP6G, five constituents failed the comparison with site specific SSL concentrations. They are barium, benzo(a)pyrene, benzo(b)fluoranthene, chromium, and dieldrin. Analysis of leachability to groundwater of these soil contaminants was performed in a spreadsheet model, utilizing site specific input parameters and calculations of the estimated groundwater concentrations when the contaminants reach the groundwater with estimates of time required to reach the water table, (Appendix L). This calculation method allows for attenuation of the contaminants in the vadose zone and is used in combination with a dilution factor. That is, the metals concentrations are reduced because adsorption is considered in the vadose zone. Organic concentrations are reduced due to adsorption and biological decay.

With this method, all of the organic compounds, benzo(a)pyrene, benzo(b)fluoranthene, and dieldrin, are predicted to enter the water table at negligible concentrations. Concentrations of barium and chromium were reduced because of adsorption, but they are projected to migrate to groundwater at measurable levels. Hazard indices were therefore calculated for these metals. Barium poses no undue risk to either the future resident or the industrial worker. Chromium +3, the dominant oxidation state for this environment, poses a minimal risk with a hazard index of 0.04 for the future resident from ingestion of groundwater also at a time in excess of five hundred and seventy years in the future. Although not considered to be present, chromium in the +6 oxidation state would pose a risk with a hazard index of 2 for the future resident from ingestion of groundwater. The time of peak groundwater concentration is in excess of five hundred and seventy years in the future. A more detailed discussion of the risks associated with the metals and appropriate tables are located in Appendix L.

Chromium in the +3 oxidation state was considered as the dominant ion for this analysis, based on the SRS soil chemistry and its relationship to the ionic state of chromium. The oxidation state of chromium is considered to be +3 rather than +6 because reducing conditions are evident by the observed methane from the soil gas survey and the pH is approximately five. For the above-mentioned conditions, chromium is most likely found in the form of Cr_2O_3, which is a poorly soluble precipitated solid. The subsurface system would need to become extremely oxic (positive Eh) at a pH of five or less for a mobile form of chromium +6 to be formed. A more detailed discussion of chromium and its ions is included in the report on the leachability analyses of chromium and the other four constituents, located in Appendix L.

5.5 Contaminant Fate and Transport Conclusions

Of the SSCs and COPCs, only barium, benzo(a)pyrene, benzo(b)fluoranthene, chromium, and dieldrin have average concentrations which exceed site specific SSLs. Spreadsheet analyses to determine the leachability of these contaminants to groundwater were performed and estimated groundwater concentrations were used to ascertain any future risk or hazard based on these concentrations. Barium, benzo(a)pyrene, benzo(b)fluoranthene, and dieldrin are projected to have negligible concentrations in the groundwater in the future years, and pose no hazard or risk to either a future resident or future industrial worker. Estimated groundwater concentrations of chromium in the +3 oxidation state yielded a Hazard Index of 0.043 for the combined exposure of adult/child resident for ingestion and inhalation. Estimated groundwater concentrations of chromium in the +6 oxidation state yielded a Hazard Index of 2.0 for ingestion of groundwater in the scenario for a future resident in the distant future, i.e., in excess of five hundred and seventy years, although this oxidation state for chromium is not present due to reducing and anoxic conditions in the subsurface soils. These calculations were made in order to depict all conditions for the analytes evaluated. Based on the previous discussions regarding the behavior of the BRP6G contaminants in the environment and the results of the spreadsheet calculations estimating their groundwater concentrations, the contaminants present in the soils at the BRP6G have limited mobility and those contaminants which are mobile have no unacceptable impact on future groundwater quality.

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FIGURES

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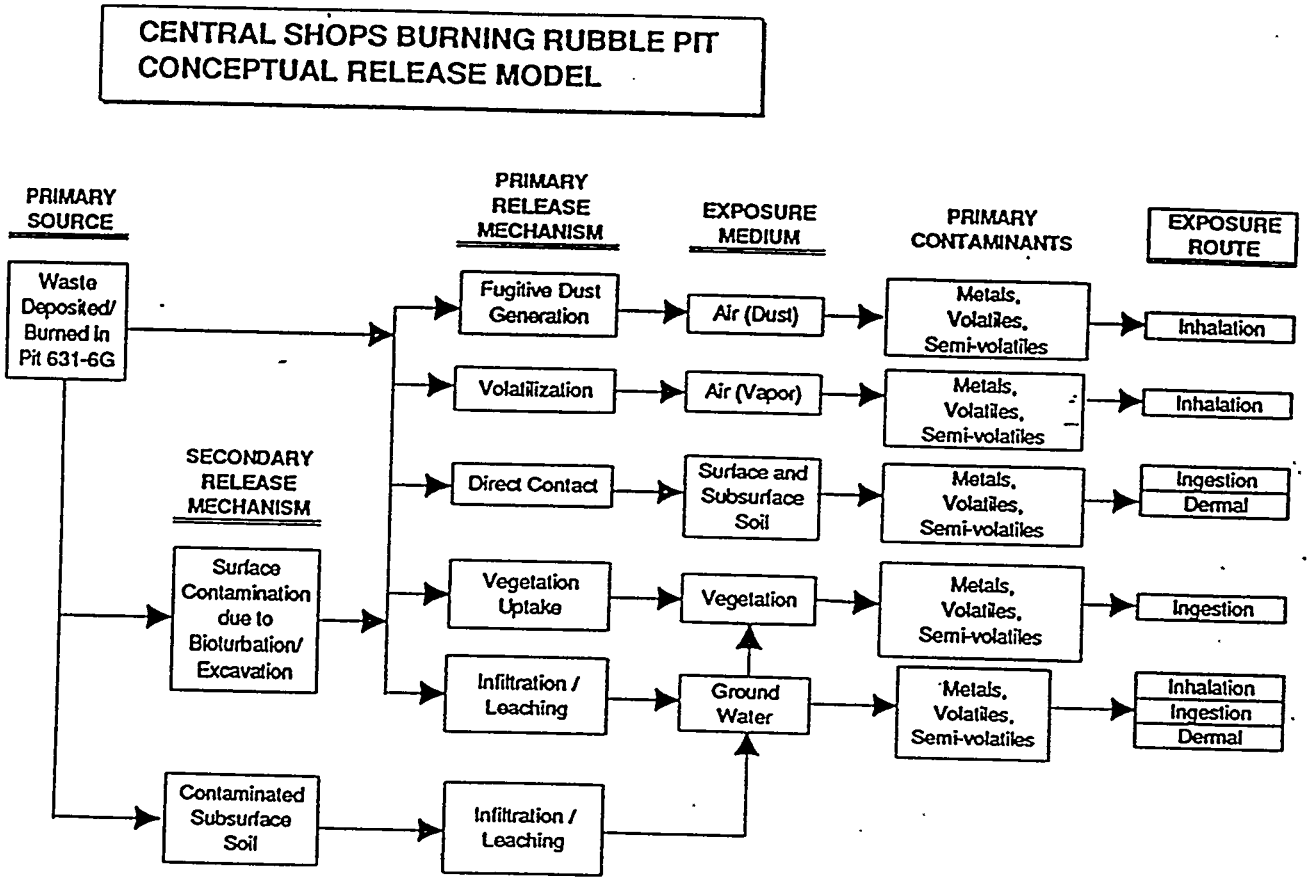

Figure 5-1 Central Shops Burning/Rubble Pit Conceptual Release Model

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TABLES

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Table 5.1 Summary of Site Specific Contaminants in Soil

Inside BRP6G Boundary- Surface and Below	
Metals	Antimony • Arsenic • Cyanide • Mercury
Semi-Volatiles	Fluoranthene • Pyrene
Volatiles	Chloroform • Toluene • Methyl ethyl ketone • Xylene • Ethylbenzene
Pesticides, PCBs, Dioxins and Furans	Octachlorodibenzo-p-dioxin • p, p'-DDE
Outside BRP6G Boundary- Surface and Below	
Metals	Antimony • Arsenic • Mercury
Semi-Volatiles	Fluoranthene • Pyrene
Volatiles	Chloroform • Methyl ethyl ketone • Xylene • Ethylbenzene
Pesticides, PCBs, Dioxins and Furans	p, p'-DDE

Table 5.2

AVERAGE SOIL CONCENTRATIONS OF SSCs AND COPCs COMPARED TO SOIL SCREENING LEVELS

NAME	Soil Maximum Detection, (mg/kg)	Soil Average Concentration (mg/kg)#	MCL or RBC (mg/L)	Koc (L/kg)	Kd (L/kg)	Henry's Law Constant *	EPA SSL (mg/kg) DAF = 1	Site Specific SSL (mg/kg) DAF = 1.57	SSL TEST
antimony							none available		
arsenic	12	0.98	0.05000000	NA	2.90E+01	0.00E+00	1.50	2.2863	Pass
barium	290	23.56	2.00000000	NA	1.40E+00	0.00E+00	3.20	4.7885	Fail
benzo(a)anthracene	74	1.575	0.00009200	1,380,000	13800	4.50E-08	0.07	1.9933	Pass
benzo(a)pyrene	85.8	1.859	0.00000920	5,500,000	55000	3.72E-06	0.40	0.7944	Fail
benzo(b)fluoranthene	119	2.575	0.00009200	550,000	5500	1.18E-05	0.40	0.7944	Fail
benzo(g,h,i)perylene							none available		
benzo(k)fluoranthene	41.5	0.905	0.00092000	550,000	5500	3.94E-05	0.40	7.9444	Pass
chromium	108	19.08	0.10000000	NA	1.90E+01	0.00E+00	1.90	3.0026	Fail
chloroform	0.0046	N/A					0.03	0.0000	Pass
chrysene	60.2	1.310	0.00920000	200,000	2000	9.60E-07	0.10	28.8898	Pass
cyanide							none available		
p,p' DDE	0.009	0.0008					0.0500	0.0000	Pass
dichloromethane	0.003	N/A	0.00500000	9	0.088	2.60E-03	0.01	0.0018	Pass
(methylene chloride)									
dieldrin	0.0048	0.00065	0.00000420	1,700	17	1.10E-05	0.0001	0.0001	Fail
ethyl benzene	0.00047	N/A					0.05		Pass
fluoranthene	108	1.3980					9.80		Pass
methyl ethyl ketone							none available		
mercury	0.252	N/A	0.00200000	NA	145	1.10E-02	0.30	0.4559	Pass
nickel	350	7.0	100.00000000	NA	21	0.00E+00	2.10	3,316.6250	Pass
octochloro dibenzo-							none available		
p-dioxin									
phenanthrene							none available		
pyrene	83.7	1.08					14		Pass
toluene	0.006	N/A					0.05		Pass
xylene	0.004	N/A					0.70		Pass
*= (atm-m^3/mol)									

= N/A in this column means that an average concentration was not calculated since the maximum concentration was below the EPA SSL concentration

Note: Values bolded in column C where average is above EPA SSL concentration.

Table 5.3 Physical and Chemical Properties for Site Specific Contaminants (SSCs)

Analyte	CAS Number	Molecular Weight	Diffus-ivity (cm^2/s)	Boiling Point (C°)	Melting Point (C°)	Water Solubility	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-M^3/mol)	Koc	LogKow
4,4'-DDE	72-55-9	318	0.05336	NA	89	0.04	0.0000065	0.000068	29700	5.69
Antimony	7440-36-0	121.75	NA	1635	630.5	NA	1	NA	NA	NA
Arsenic	7440-38-2	75	NA	615	NA	NA	0	NA	NA	NA
bis(2-ethylhexyl) phthalate	117-81-7	391	0.03542	384	-50	0.4	0.0000002	0.00000044	87400	5.11
Chloroform	67-66-3	119.38	0.08868	61	-64	7220	151	0.0038	44	1.97
Chloromethane	74-87-3	50.49	0.1398	-24	-97.1	6500	760	0.0099	5	0.95
Cyanide	57-12-5	26	0.1853	25.6	-13.3	NA	620	NA	0.575	-0.25
Ethyl Benzene	100-41-4	106.17	0.06667	136.2	-95	153	7	0.00843	220	3.15
Fluoranthene	206-44-0	202.08	0.04941	375	111	0.26	0.0000092	0.00000941	38000	5.2
m-Xylene	108-38-3	106.17	0.07164	138.8	-47.9	198	8.36	0.0069	238	3.2
Mercury	7439-97-6	201	NA	357	-38.9	0.03	0.002	0.011	NA	NA
Methyl ethyl ketone	78-93-3	72.12	0.08944	79.6	-86.3	268000	77.5	0.0000514	4.51	0.26
o-Xylene	95-47-6	106.17	0.07164	144	-25.2	202	6.69	0.0049	236	2.77
p-Xylene	106-42-3	106.17	0.07164	138.3	13.3	198	8.82	0.00704	238	3.15
Pyrene	129-00-0	202.08	0.05039	404	156	0.135	0.0000045	0.00000886	38000	5.18
Toluene	108-88-3	92.15	0.07828	110.6	-95	1550	28.44	0.0066	120	2.69

Notes: NA = Not Available

1. Octachlorodibenzo-p-dioxin isomers have numerous physical and chemical properties because of differences in the structure of their molecules which are to numerous to list in this table.

Table 5.4 TCLP Data for Central Shops Burning/Rubble Pit (631-6G)

TCLP data for Central Shops Burning/Rubble Pit (631-6G)								
TCLP Data (soil borings)								
Central Shops Burning/Rubble Pit								TCLP
	BORING							Limit
++ ND = below detection limit++	0302	0402	0502	0602	0702	0802	0902	(MGL)
Metals (MGL)								
Arsenic	ND	ND	ND	ND	ND	ND	ND	5
Barium	0.693	0.182	0.765	0.987	0.0978	0.681	0.505	100
Cadmium	ND	ND	ND	0.00244	ND	0.00258	0.003	1
Chromium	0.234	0.00974	0.146	0.0104	ND	ND	ND	5
Lead	0.0333	ND	0.0994	0.325	ND	0.195	0.878	5
Mercury	ND	**0.73**	**0.31**	**0.46**	**0.55**	**0.61**	**0.58**	0.2
Selenium	ND	ND	ND	ND	ND	ND	ND	1
Silver	ND	ND	ND	ND	ND	ND	ND	5
Semi-volatiles (MGL)								
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	400
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	2
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	0.13
cresol, m- and p- combined	ND	ND	ND	ND	ND	ND	ND	200
Hexachlorobenzene	ND	ND	0.0018	ND	ND	ND	ND	0.13
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND	3
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	2
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	100
Pyradine	ND	ND	ND	ND	ND	ND	ND	5
0-Cresol (2-Methylphenol)	ND	ND	ND	ND	ND	ND	ND	200
Volatile Organics (MGL)								
1,1-Dichloroethylene	ND	ND	ND	ND	ND	ND	ND	0.7
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	0.5
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	0.0075
Benzene	ND	**0.0007**	0.001	ND	ND	ND	ND	0.0005
Carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND	0.0005
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	0.1
Chloroethane (Vinyl chloride)	ND	ND	ND	ND	ND	ND	ND	0.0002
Chloroform	ND	ND	ND	0.0017	0.0005	ND	ND	0.006
Methyl ethyl ketone	0.045	ND	0.0141	0.0042	0.0268	0.0079	**0.309**	0.2
Tetrachloroethylene	ND	ND	ND	ND	0.0005	ND	ND	0.0007
Toluene	0.0079	ND	0.0084	0.0043	0.013	0.0077	0.0341	
Trichloroethylene	ND	ND	ND	ND	ND	ND	ND	0.0005
Pesticides/PCBs & Dioxins/Furans								
2,4,5-TP (Silvex)	ND	ND	ND	ND	ND	ND	ND	1
2,4-Dichlorophenoxyacetic acid	ND	ND	ND	ND	ND	ND	ND	10
Chlordane	ND	ND	ND	ND	ND	ND	ND	0.03
Endrin	ND	ND	ND	ND	ND	ND	ND	0.02
Heptachlor	ND	ND	ND	ND	ND	ND	ND	0.008
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	0.008
Lindane	ND	ND	ND	ND	ND	ND	ND	0.4
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	10
Toxaphene	ND	ND	ND	ND	ND	ND	ND	0.5
++ND = below detection limit++								
0.309 = above TCLP Limit								

6.0 BASELINE RISK ASSESSMENT

The purpose of the Baseline Risk Assessment (BRA) is to help determine whether additional response action is necessary at the Central Shops Burning/Rubble Pit 631-6G (BRP6G). It is divided into two parts: (1) the human health risk assessment, and (2) the environmental risk assessment.

The purpose of the human health risk assessment is to determine the exposure pathways exceeding risk threshold levels and the contaminants causing that risk for human receptors under both current use and hypothetical future use conditions.

The purpose of the ecological risk assessment is to determine whether (1) there is little or no risk of adverse effects, and therefore, little or no need for remediation (i.e., no further action) based on ecological concerns, or (2) there is unacceptable risk present and there is need for remediation. The determination will depict the likelihood of present and future adverse ecological effects.

The BRA also provides a basis for determining residual chemical levels that are protective of human health and the environment in support of decision making regarding various remedial alternatives.

This BRA has been developed consistent with the latest available Environmental Protection Agency (EPA) guidance (EPA, 1989a, 1989b, 1989c, 1991a, 1992a, 1992b, 1992c, 1994a, 1994b, 1995).

6.1 Data Results/Identification of Chemicals of Potential Concern

6.1.1 General Site-specific Data Collection Considerations

Soil

Soil borings were performed within the suspected pit areas for characterization of the primary source area. Soil borings were also performed in proximity to the suspected pit areas and located based on preliminary soil gas analysis, to characterize soils potentially impacted by waste unit operations. Several soil borings produced samples containing burnt black materials indicating that the soil was impacted by pit operations. Borings containing burnt black materials are CS6G-01, CS6G-05, CS6G-06, CS6G-08, CS6G-09, CS6G-12, CS6G-13, CS6G-14, and CS6G-22.

Initial examination of the soil sampling results show that borings in close proximity to the pit contain potentially elevated contaminant levels. Based on the uncertainty of the pit boundaries and initial examination of the data, borings CS6G-02, CS6G-03, CS6G-04, CS6G-07, CS6G-11, CS6G-15, CS6G-16, and CS6G-17 have been included in the area of concern along with those samples containing burnt material. Samples from these locations are used to calculate intakes for the BRA (refer to Figure 2-4 for sampling locations).

Unit specific background boring samples (5) for the pit characterization were taken upgradient (CS6G-10, -18) and downgradient, across the railroad tracks (CS6G-19, -20, -21). The selection of the background borings is based on their location relative to the pit and initial examination of sampling results indicating that the background soil borings do not appear to have been impacted by pit operations.

The soils have been divided into two exposure groups so exposure point concentrations can be calculated for specific exposure routes and pathways. The "surface soil" exposure group contains soil samples taken at depths between 0 and 2 feet. The "excavation/burrowing animal soil" exposure group contains soil samples taken at depths between 0 and 5 feet.

Sampling of soils at the BRP6G occurred in two phases. Surface soil samples were collected from a depth of 0 to 2 feet during the first phase and 0 to 1 feet during the second phase. The "surface soil" exposure group was expanded from the recommended depth of 1 foot to a depth of 2 feet to include data from the first sampling event. Both phases of sampling were conducted per approved work plans.

Groundwater

Groundwater contamination was evaluated using monitoring well data collected from waste unit wells CBR-1D, -2D, -3D, -4, -5, and -6. Data from the four most recent quarterly sampling events (i.e., 2nd quarter 1994 to 1st quarter 1995) were used in for the BRA. Wells CBR-4, -5, and -6 were only sampled twice because they are temporary wells and are not part of the SRS quarterly monitoring program. Well CBR-1D (upgradient) is used as unit specific background for groundwater. Wells CBR-2D, -3D, -4, -5, and -6 are used to determine concentrations of contaminants in groundwater impacted by pit operation.

The reader should note that in Chapter 4 more data was used in determining groundwater maximum concentration and estimates of average concentration (i.e., Chapter 4 uses up to 8 quarters of groundwater sampling data and Chapter 6 uses the 4 most recent groundwater sampling events). Older data was not used so that the current risk is presented in the BRA. If there is a trend, contaminant levels rising or falling, the older data may skew the results. The four most recent sampling events best represent the current risk.

Drainage water and sediment

The BRP6G is located topographically and hydrologically down-gradient and immediately adjacent to an active excess materials lay-down yard and downgradient of the Ford Building Waste Site and the Ford Building Seepage Basin. The Ford Building Seepage Basin received wastewater from equipment repair which contained low levels of radioactivity and trace quantities of non-radioactive organic and inorganic compounds. The Ford Building Waste Site history of disposal is unknown, but it is suspected that work on radioactive equipment may have occurred. The FFA field start for the Ford Building Waste Site RFI/RI and for the Ford Seepage Basin RFI/RI is scheduled for 6/30/97 and 10/20/97 respectively. The lay-down yard routinely accepts industrial materials for storage. Sheet flow from the lay down yard and drainage from the Ford Building's CS-008 permitted outfall migrates to a drainage ditch which has produced depositional erosion across the BRP6G. A drainage conduit has been added at the site to control and eliminate further erosion across the site. This conduit accepts run-off form the drainage conduit under the dirt road to the north of the unit and discharges to a drainage ditch along the railroad track embankment. This drainage ditch converges and flows to the railroad track embankment and ultimately discharges to an unnamed tributary of Pen Branch to the southeast of the BRP6G. The unnamed tributary is approximately 7000 feet in length and generally flows only after rainfall events.

This drainage feature could serve as a potential migration/transport route but is a minor contributor to the overall flow from the drainage basin. The overall setting, within the vicinity of an active industrial area and other inactive waste sites, increases the complexity of both the background reference and contaminant source definition for samples collected from the drainage ditch. The drainage ditch may contain potential contaminants from a large area not attributable to the BRP6G.

Drainage from the Pen Branch water shed area which includes the BRP6G eventually flows to Pen Branch (see Figure 6-6). The Pen Branch water shed area which includes the BRP6G is approximately 15 square miles (9,600 acres). The BRP6G covers 0.75 acres or 0.008 percent of the water shed. Assuming runoff from BRP6G is proportional to its surface area the drainage runoff from the unit is approximately 0.008 percent of the total and diluted by a factor of 12,800.

If all contamination in the drainage ditch were from BRP6G, then contaminant levels in the drainage ditch should be lower than at the unit because the contaminants were transported from the unit and diluted to some degree. If this is the case then neglecting the risk due to drainage sediments should introduce little error in the risk assessment. However, the drainage ditch may contain potential contaminants from a large area not attributable to the BRP6G. Drainage water and sediment samples were collected from the drainage ditch (locations CS6G-23 through -33) to determine the nature and extent of contamination associated with the BRP6G, but are not evaluated in the human health or ecological risk assessment.

The exposure groups used in the BRA are summarized in Table 6.1. The reader should note that data in Chapter 4 is grouped differently than in Chapter 6. In general, the soil samples are grouped at different depths. The reader should also note that in Chapter 4 more data was used in determining groundwater maximum concentration and estimates of average concentration (i.e., Chapter 4 uses up to 8 quarters of groundwater sampling data and Chapter 6 uses the 4 most recent groundwater sampling events). The different groupings result in differences in average background concentrations and consequently differences between SSCs identified in Chapter 4 and COPCs identified in this chapter. Also contributing to the disparity between the SSCs and COPCs are differences in screening criteria (e.g., Chapter 4 uses MCLs as a screening criteria whereas Chapter 6 does not use MCLs as a screening criteria). Screening criteria used in this BRA is discussed in Section 6.1.2.

6.1.2 General Site-specific Data Evaluation Considerations

The objective of the sampling and analysis performed for environmental media at the BRP6G focused on the collection of data which would be valid for the purposes of site characterization and risk assessment. Samples were collected and analyses were performed so that Level 3 Data Quality could be obtained and used for risk assessment. Quality assurance/oversight and documentation were performed during sampling. Sample collection logbooks and field reports are presented in Appendices D, E, F, H, and I. Quality assurance/quality control activities used to validate the BRA data are documented in the "Quality Control Summary Report for the RFI/RI Assessment Sampling at the Central Shops Burning/Rubble Pit Waste Unit" (WSRC, 1995a). The QA/QC methods used to validate the data are discussed in quality control report.

The data analyses were conducted in accordance with U.S. EPA-approved data acceptance criteria and quality control requirements. Further data evaluation and COPC screening was accomplished as follows:

Step 1. Divide the data into exposure groups.

Data from each specific medium is grouped for data evaluation into media-specific exposure groups as shown in Table 6.1.

Step 2. Eliminate constituents which have no detects in any media or exposure group. In order to be eliminated, all results for a specific analyte within a medium or exposure group, must be associated with a "U" result qualifier. Analyte data sets, for each exposure group shall have "proxy" values assigned to "U" qualified data if at least one data point within the data set contains an unqualified, detected analyte concentration. The proxy value assigned to "U" qualified data shall represent 1/2 the Detection Limit for that analyte. The range of assigned proxy values for each analyte should be stored for evaluation.

Step 3. Eliminate all Quality Control (QC) sample results from the data sets, including blanks, standards, duplicates, splits, rinsates, etc., which shall not be used in the calculation of exposure assessment information.

Step 4. Identify and be prepared to list all Tentatively Identified Compounds (TIC) data, i.e., "N" qualified data contained in the data set. Store the "N" qualified data (i.e., the complete listing of available information for the TIC) where it may be evaluated later for re-inclusion into the data set. Eliminate "N" qualified data from the data set after storing the data as described above.

Step 5. Evaluate the analytical data with respect to blanks. Eliminate all constituents which are qualified with a "V" result qualifier or "V" analysis qualifier coupled with a "U" result qualifier, indicative of blank contamination. The “V” result qualifier or “V” analysis qualifier coupled with a “U” result qualifier is used to identify the following:

a) All analytes - The constituent concentration is less than 5 times the maximum concentration detected in the associated blank.
b) Common lab contaminants - The constituent concentration is less than 10 times the maximum detected in the associated blank.

Note: Rev.0 of this document misinterpreted the “V” qualifier and the data set changed based on the correct use of the “V” qualifier as defined above.

Step 6. Address data with qualifiers.

Analytical data with an "R" (rejected) result qualifier will not be used in the data evaluation. Eliminate all data with a Rejected (R) result qualifier from the data set. Data which indicates that the analyte is present but which has an uncertain concentration is used as reported.

Step 7. Determine parameters.

Determine for each sample group, the following parameters:

a) Population distribution - normal, log-normal, or neither. - The Shapiro-Wilk W test is used to determine the statistical distribution of the data (see Appendix C1). If data for an individual analyte are shown to be normally distributed by the Shapiro-Wilk W test, then the untransformed data is used to calculate the mean. If data for an individual analyte are shown to be log-normally distributed by the Shapiro-Wilk W test, then the log-transformed data is used to calculate the mean (EPA, 1992a).

b) Mean or estimated mean concentration. - Using the transformed or untransformed data as appropriate per the data distribution, determine the mean concentration. Analytical results reported as below the quantitation limit are included at half the reported quantitation limit as a proxy concentration for use with positively detected concentrations.

c) Standard deviation.

d) Maximum detected concentration.

e) Upper confidence level 95 concentration. - If the analyte passed the Shapiro-Wilk Statistical test (W-test) for normality, the untransformed data are used to calculate the 95 percent upper confidence limit (UL 95) on the arithmetic mean concentration. If the analyte passed the W-test for log normality, the log transformed data are used to calculate the UL 95 concentration. If the analytes passed neither test, the measured results are assumed to be log normally distributed (EPA, 1992a).

f) Frequency of detection. - Number of detects/total number of analyses (not including duplicates).

g) Concentration term value. - For both normally and log normally distributed data, the smaller of the UL 95 concentration or the maximum concentration detected, is used to calculate risk (EPA, 1992a).

Sample calculations for the population distribution, mean for both normal and lognormal population distributions, and upper confidence level 95 concentration for both normal and lognormal population distributions (i.e., parameters a, b, and e above) are presented in Appendices C1, C2, and C3.

Step 8. Perform comparison of the maximum detected concentrations to two times the average unit-specific background concentrations. Non-radioactive inorganic analytes and naturally occurring radionuclides in soil, groundwater, and sediment are eliminated as COPCs if the maximum concentration is less than twice the mean background concentration.

Step 9. Evaluate whether infrequently detected constituents should be retained or dropped. Infrequently detected constituents should not be eliminated on low detection frequency alone. Other evidence suggesting the data may be spurious must be used to eliminate a COPC (e.g., lab qualifiers indicate sampling or analytical problems, or the COPC is not detected in any other sampled media).

Step 10. For each medium and exposure group, determine if any COPCs remain. If not, drop the medium and exposure group from consideration in the BRA.

Step 11. Statistical comparisons - No statistical comparisons to background are used in this BRA.

Step 12. Re-inclusion analysis - Consider whether any previously eliminated constituent, medium, or exposure group should be re-included.

Step 13. Use the remaining COPCs as the starting point for comparison to ecotoxicological benchmarks: no observed adverse effect level (NOAEL), lowest observed adverse effect level (LOAEL), etc.

Step 14. Additional human health screening criteria - Compare remaining COPCs to the following human health screening criteria:

a) Screening for Risk Based Concentrations (RBC). Compare the maximum detected concentrations to RBC values (EPA, 1995a). If the maximum detected concentration is less than the RBC, then eliminate the constituent as a human health COPC.

b) Screening levels for essential nutrients. Compute the expected chronic daily intake and compare to the recommended daily allowance (RDA), the safe and adequate daily intake level (SADI), and the Reference Dose (RfD) for each of the following:

- Chloride
- Magnesium
- Phosphorus
- Sodium
- Calcium
- Iodine
- Manganese
- Potassium
- Zinc
- Iron

If the expected chronic daily intake is below safe levels, then eliminate the constituent as a human health COPC.

6.1.3 Summary of Chemical of Potential Concern

Tentatively Identified Compounds (TICs) made up less than one percent of the total data set. After review all TICs were removed from the data set. Table 6.2 contains all inorganic compounds which were eliminated because the maximum detected concentration was less than 2 times unit specific background.

Table 6.3 contains constituents that were eliminated based on low frequency of detection in conjunction with other evidence indicating that the detection is spurious (e.g., frequency of detection is low and contaminant detected in only one media such as groundwater). Chloromethane and 2-Methyl-4,6-dinitrophenol in the groundwater are believed to be artifacts and therefore were eliminated as COPCs. There are no chloromethane hits in the soil and only an isolated incident of chloromethane in one well (CBR-3D). The two chloromethane hits in well CBR-3D are believed to have been contaminated in the field during sampling. There are no hits for 2-Methyl-4,6-dinitrophenol in soil and only 1 hit in groundwater (well CBR-2D).

Table 6.4 contains radiological data for the BRP6G. Radiological constituents were not considered in this BRA, (see Section 6.2.4 under uncertainties).

Ecological COPCs

Tables 6.5 and 6.6 contain the lists of COPCs used for the ecological risk assessment. The COPCs used for the ecological risk assessment are presented in Table 6.5 (surface soil 0 to 2 feet) and Table 6.6 (shallow subsurface soil 0 to 5 feet).

Human health COPCs

Table 6.7 lists essential nutrients which were eliminated based on RDA or SADI. Daily intake for essential nutrients was calculated based on child ingestion of 200 mg of soil at the maximum detected concentration or adult ingestion of 2 liters of water at the maximum detected groundwater concentration.

Table 6.8 lists compounds eliminated because their maximum concentration was less than Risk Based Concentration (RBC). Risk Based Concentrations developed by the EPA are contaminant concentrations in tap water, ambient air, fish, and soil which produce a cancer risk of 1E-06 or a hazard quotient of 1. In essence the EPA has used the risk equations in conjunction with standard exposure variables to back calculate concentrations which produce threshold risk (i.e., cancer risk of 1E-06 or a hazard quotient of 1). EPA Region III updates and publishes RBC periodically. This BRA uses the RBC table published 1/31/95 (EPA, 1995a). This BRA specifically uses the tap water RBC to screen BRP6G groundwater and the residential soil RBC to screen BRP6G soil.

Compounds that could not be evaluated because there was no slope factor or reference dose factor values (IRIS, HEAST or EPA provisional) are listed in Table 6.9. Where possible a provisional slope factor or reference dose were obtained from the EPA Environmental Criteria and Assessment Office. Provisional reference doses were obtained for aluminum, iron, and 2-hexanone. Compounds that have no provisional slope factor or reference dose factor values are discussed qualitatively in Section 6.2.2.2 and in Appendix C6.

Table 6.10 contains the list of COPCs used in the risk calculations. In most instances the exposure point concentration for the 0 to 5 feet soil interval is greater than the exposure point concentration for the 0 to 2 feet surface soil interval. The exposure point concentration for anthracene, 2-hexanone, and PCB 1254 in the 0 to 2 feet soil interval was slightly higher than in the 0 to 5 feet soil interval. For each COPC the greater of the two exposure point concentrations (i.e., 0 to 2 feet or 0 to 5 feet) was used to calculate risk.

6.2 Human Health Evaluation

6.2.1 Exposure Assessment

In order to assess risk to human health the contaminated media must be identified and a conceptual site model must be developed. The conceptual site model (CSM) describes how contaminants are transported and transferred to a human receptor. The uptake of contaminants is then calculated using the model as its basis. The CSM for the BRP6G is and the quantification of human exposure is described in the following sections.

6.2.1.1 Exposure Setting

The Central Shops Area is an active industrial/material storage area located near the center of SRS. The BRP6G is located on the south eastern boundary of the Central Shops Area and is more than 7 miles from the Savannah River, which is the SRS boundary nearest the BRP6G. Pit

631-6G was an unlined earthen pit constructed in 1951 for disposal and incineration of potentially hazardous substances, such as metals and organic solvents. The BRP6G was removed from service and backfilled in 1955.

The BRP6G pit is located to the south and immediately adjacent to an active excess materials lay-down yard. The lay-down yard routinely accepts industrial materials for storage. In addition, it is located approximately 100 meters southeast of the Ford Building Seepage Basin, and is also located southeast and downgradient of the Ford Building Waste Site. The Ford Building Seepage Basin received wastewater from equipment repair which contained low levels of radioactivity and trace quantities of non-radioactive organic and inorganic compounds. The FFA field start for Ford Seepage Basin RFI/RI is scheduled for 10/20/97. The Ford Building Waste Site history of disposal is unknown, but it is suspected that work on radioactive regulated equipment may have occurred there. The FFA field start for the Ford Building Waste Site RFI/RI is scheduled for 6/30/97. The BRP6G is situated both topographically and hydrologically downgradient of these facilities and waste units (see Plate 1-1, Figure 2-1 and Figure 3-7).

Immediately south of the waste unit (<30 meters) are railroad tracks and right of way, which are believed to have received routine herbicide treatments in the past. Upgradient drainage water run-off from the lay-down yard and Ford Building area migrates toward the BRP6G pit and consolidates into a drainage feature which has eroded through a portion of the pit. This feature could serve as a potential migration/transport pathway (see Figure 3-2).

6.2.1.2 Potentially Exposed Populations/Human Receptors

An evaluation was performed for scenarios including both actual and hypothetical receptors. The potentially exposed receptors which were evaluated include:

- current groundwater sampler
- current material yard worker

- hypothetical on-unit industrial worker
- hypothetical on-unit resident adult
- hypothetical on-unit resident child
- current off-SRS resident (qualitative evaluation only)

The current industrial use exposure scenarios are best described by the current material yard workers and current groundwater samplers. The following paragraphs provide a brief description of the human health exposure scenarios. The risk to the current off-SRS resident is evaluated in a qualitative manner.

Current groundwater sampler

The current groundwater sampler exposure scenario addresses risks to workers who visit the site on an infrequent or occasional basis. The current sampler is an adult who takes samples from contaminated groundwater. Ingestion of drinking water from contaminated sources will not be included because controls are in place to prevent such consumption.

Current material yard worker

The current material storage yard worker exposure scenario addresses risks to workers who spend a majority of the work week relatively close to the BRP6G. The current material storage yard worker is an adult who works in the excess material storage yard located adjacent to the BRP6G. Ingestion of drinking water from contaminated sources will not be included because controls are in place to prevent such consumption.

Hypothetical on-unit industrial worker

The on-unit industrial exposure scenario addresses long-term risks to workers who are exposed routinely to contaminants within an industrial site. Worker exposures are expected to be lower than those under the residential scenarios, because workers' exposure is less. The hypothetical on-unit industrial worker is an adult who works in an industrial material yard similar to the existing excess material storage yard adjacent to the BRP6G. Ingestion of drinking water from contaminated sources is included.

Hypothetical on-unit resident adult and child

The hypothetical on-unit resident exposure scenario addresses long term risks to individuals expected to have unrestricted use of the site after cleanup. It assumes that residents live onsite and are exposed chronically, both indoors and outdoors, to unit contaminants. The hypothetical on-unit resident will include adults and children who are exposed to all of the contaminated media. This scenario is consistent with regulatory guidance documents.

Current off-SRS resident (qualitative evaluation only)

The current off-SRS residents exposure scenario addresses long-term risks to residents living at the SRS boundary. Off-SRS resident exposures are lower than those under the on-unit residential scenarios, because pathways are incomplete or concentrations are diluted during transport off-SRS. The current off-SRS residents are adults and children who live downwind (prevailing wind direction) at the SRS boundary.

6.2.1.3 Exposure Routes and Pathways

The primary source of contamination from the BRP6G is soil which was contaminated as a result of past disposal practices. Contaminants may be released from the pit via leaching to groundwater, windblown dust, vegetative uptake, and volatilization. The specific media of concern for human health and ecological risk assessments are:

- Groundwater
- Surface Soil
- Excavation/Burrowing Animal Soil

There is no wetland or surface water associated with the BRP6G. The nearest surface water, (Pen Branch) is approximately 1.2 miles from the BRP6G (see Figure 6-6). Due to the gentle slope at the BRP6G the majority of the rain fall on the unit percolates into the soil instead of flowing away from the unit. Due to the long distance drainage must flow prior to reaching the nearest surface water any drainage from the unit seeps into the ground prior to reaching Pen Branch. Pathways involving surface water are not complete for the BRP6G.

Volatilization of contaminants from the soil was examined and eliminated as a pathway based on the soil gas investigation at BRP6G (Pirkle and Masdea, 1991; see Appendix A). The species monitored were light hydrocarbons (C_1-C_4), gasoline range aromatic hydrocarbons (BTXE), and selected chlorinated organics. The objective of the survey was to determine the presence and extent, or absence of contamination in near surface soil gases. Samples were generally obtained from depths of 36 inches to 48 inches. Only three isolated, and very low, observations of volatile organics (i.e., toluene at 0.33 ppmv and xylene at 0.10 and 0.20 ppmv) were made at the southeast end of pit 631-6G. Light hydrocarbons were low and fairly uniformly distributed across the area with slightly elevated levels in the area of the volatile organic observations. Considering the low volatiles levels within soil gasses the air concentrations above the unit were assumed to be negligible.

The following paragraphs describe which exposure routes and pathways are applicable to the receptors evaluated in the BRA. A graphical depiction of the human health CSM for the Central Shops Burning Rubble Pit is presented in Figure 6-1.

Current groundwater sampler

The primary exposure pathways for evaluation relative to the current groundwater sampler include:

- exposure to contaminated soils (incidental ingestion, inhalation of windblown dust, and incidental dermal contact)

- exposure to groundwater (incidental dermal contact, and inhalation of volatile constituents).

A drinking water pathway is not credible for the groundwater sampler since shallow groundwater is not used as a source of drinking water at SRS.

Current material yard worker

The primary exposure pathways for evaluation relative to the current material yard worker include:

- exposure to contaminated soils (incidental ingestion, and inhalation of windblown dust).

The material yard worker does not visit the unit, but works in the laydown storage yard adjacent to the BRP6G (see Plate 1-1 aerial photograph). Therefore, this worker does not directly contact soils associated with the unit and is only exposed to windblown dust. A drinking water pathway is not credible for the current material yard worker since shallow groundwater is not used as a source of drinking water at SRS.

Hypothetical on-unit industrial worker

The primary pathways proposed for evaluation relative to the hypothetical industrial worker include:

- exposure to contaminated soils (incidental ingestion, and inhalation of windblown dust)
- exposure to groundwater (ingestion)

Dermal contact with contaminated soil was not evaluated in the BRA because the SRS standard hypothetical on-unit industrial worker is assumed to be working in an industrial building or plant and does not come into direct contact with contaminated soil. This standard hypothetical worker was allowed to inhale and ingest dust that would be carried inside an industrial building. In addition, this standard industrial worker ingests 1 liter of contaminated water per day.

Hypothetical on-unit resident adult and child

The primary pathways proposed for evaluation relative to the hypothetical onsite resident (adult and child) include:

- exposure to contaminated soils (incidental ingestion, inhalation of windblown dust, dermal contact, and ingestion of home grown produce)
- exposure to groundwater (ingestion, dermal contact, and inhalation of volatile contaminants)

Current off-SRS resident (qualitative evaluation only)

The primary pathways relative to the current off-SRS resident include:

- exposure to contaminated soils (inhalation of windblown dust)
- exposure to groundwater (ingestion, dermal contact, and inhalation of volatile contaminants).

The BRP6G is located on the southeastern boundary of the Central Shops Area and is more than 7 miles from the Savannah River, which is the SRS boundary nearest the BRP6G. Windblown dust from the BRP6G would have to travel a least 7 miles to expose an off-SRS resident to soil contaminants. Over this distance the contaminants are diluted to negligible concentrations (see Figure 6-6).

Groundwater from the water table aquifer beneath the BRP6G must travel approximately 1.2 miles before outcropping to the nearest stream (i.e., Pen Branch, see Figure 6-6). While traveling through the aquifer, contaminants are sorbed to soil particles. After outcropping it combines with other surface water and must flow another 9 miles before reaching the Savannah River. While flowing, contaminants are diluted and possibly degraded further by biological mechanism, oxidation, exposure to sunlight. By the time contaminants reach the Savannah River they are diluted to negligible concentrations.

6.2.1.4 Quantification of Exposure

The Reasonable Maximum Exposure (RME) estimate represents the highest exposure that is reasonably expected to occur in a small, but definable "high-end" segment of the potentially exposed population. The chemical-specific RME intakes, or doses, were calculated for the human health receptors based on methodology provided in EPA risk assessment guidance (EPA, 1989a; 1991a). The equations used to calculate intakes, or doses, are presented in Appendix C4.

The RME is calculated by using parameters that represent the 95th percentile for a population or by using best professional judgment in the absence of unit-specific data (EPA, 1991a). The parameters used in this BRA are presented in Table 6.11. References to the guidance that the parameter values are based on are also presented in Table 6.11. Standard EPA values were used when applicable. The bases for the RME parameters are discussed in Appendix C5.

The chemical-specific soil or groundwater concentration (exposure point concentration) used to calculate RME intake is the 95 percent upper confidence limit of the arithmetic mean (UL95) concentration or the maximum detected concentration, whichever is smaller (EPA, 1992a). The procedure for calculating the UL95 concentration is presented in Appendix C3.

6.2.2 Toxicity Assessment

6.2.2.1 Toxicity Information

Human health slope factors (SFs) and reference doses (RfDs) were obtained from the Electronic Handbook of Risk Assessment Values (EHRAV) version dated 6/1/95, which uses the EPA's on-line service in conjunction with the Integrated Risk Information System (IRIS) database and Health Effects Assessment Summary Tables (HEAST) publication.

Toxicity profiles for COPCs used to calculate risk (see Table 6-10) at the BRP6G are provided in Appendix C6.

For this BRA, the highly studied tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) will be used in conjunction with a Toxicity Equivalency Factor to assess the risk associated with dioxin (i.e., octachlorodibenzo-p-dioxin) found at the BRP6G. The Toxicity Equivalency Factor (TEF) method relates the toxicity of the 209 CDDs and CDFs to 2,3,7,8-TCDD. In the TEF method the concentration of each dioxin congener is multiplied by the appropriate TEF to give its 2,3,7,8-TCDD equivalent concentration. The 2,3,7,8-TCDD equivalent concentration is used in conjunction with the 2,3,7,8-TCDD slope factor to calculate cancer risk. The TEF for octachlorodibenzo-p-dioxin is 0.001 (EPA, 1989e).

6.2.2.2 Chemicals for Which No EPA Toxicity Values are Available

Several COPCs were not quantitatively evaluated in the BRA because there are no EPA toxicity values available. These COPCs and sampling data for these constituents are presented in Table 6.9. The following paragraphs provide information that is available for these constituents.

Acenaphthylene

Acenaphthylene is a polynuclear aromatic hydrocarbon (PAH). It is generated by combustion of aromatic hydrocarbon fuels doped with pyridine. Industrial exposure occurs in settings involving coal tar processing. More human health information is provided in the toxicity profile presented in Appendix C6.

4-Chloro-m-cresol

4-Chloro-m-cresol is a member of the group of halogenated phenolic compounds. It is used in germicides and disinfectants, glues, gums, paints, inks, and in the manufacture of textiles and leather goods. It may also be inadvertently released as an end product from water (potable water, wastewater, cooling water) which has undergone chlorine treatment. More human health information is provided in the toxicity profile presented in Appendix C6.

4-Chlorophenyl phenyl ether

No information specific to 4-Chlorophenyl phenyl ether was found in literature. Toxicity information regarding chlorinated phenyl ethers is provided in Appendix C6.

Lead

Lead is an important commercial metal that is insoluble in water, but is soluble in nitric acid and in hot concentrated sulfuric acid. The amount of lead that can remain in solution in water is a function of the pH and the dissolved salt content.

A great deal of information on the health effects of lead has been obtained through decades of medical observation and scientific research. By comparison to most other environmental toxicants, the degree of uncertainty about the health effects of lead is quite low. Some of these effects may occur at blood lead levels so low as to be essentially without a threshold. The EPA's RfD Work Group considers it inappropriate to develop an RfD for inorganic lead.

Although the risk posed by lead is not quantitatively evaluated in this BRA, the lead levels detected in soil and groundwater associated with the BRP6G are compared to the current soil screening level (400 mg/kg) and the action level in drinking water (15 µg/l). The comparison shows lead not to be a significant problem at this waste unit. More human health information regarding lead is provided in the toxicity profile presented in Appendix C6.

Media	Maximum Detected	Average	UL 95	Screening/Action Level
Lead in soil (0 ft to 2 ft)	120 mg/kg	16.56 mg/kg	27.87 mg/kg	400 mg/kg
Lead in soil (0 ft to 5 ft)	301 mg/kg	17.12 mg/kg	27.30 mg/kg	400 mg/kg
Lead in groundwater	89.1 μg/l *	4.28 μg/l	7.50 μg/l	15 μg/l

* Maximum detection for lead in groundwater is from a bailed sample and is believed to be spurious. All other detections from impacted wells were below 11.8 μg/l.

2-Methylnaphthalene

2-Methylnaphthalene is used in the synthesis of organic chemicals and pesticides. The database for toxicological information is very limited. This compound is not known or expected to be carcinogenic based on similarities with naphthalene. More human health information is provided in the toxicity profile presented in Appendix C6.

Silica

Silica, also known as silicon dioxide (SiO_2), commonly occurs in quartz, sand, flint, agate and many other minerals. It is a major ingredient in glass. Silica is relatively inert and innocuous.

Sulfate

The sulfate ion is a major anion occurring in natural waters. It is of importance in public water supplies because of its cathartic effect upon humans when present in excessive amounts. For this reason, there is a Secondary Maximum Contaminant Level (SMCL) of 250 mg/l. (Sawyer and McCarty, 1978).

6.2.3 Risk Characterization

The calculation of cancer risk and hazard quotient for each COPC is presented in Appendix C.7. The Tables group the calculations according to exposure scenario (i.e., receptor) and exposure route.

In most instances the exposure point concentration for the 0 to 5 feet soil interval is greater than the exposure point concentration for the 0 to 2 feet surface soil interval (see Table 6.10). For each COPC the greater of the two exposure point concentrations (i.e., 0 to 2 feet or 0 to 5 feet) was used to calculate risk.

Total exposure cancer risk from multiple pathways is calculated by summing the risk from individual pathways. Total potential for noncarcinogenic effects was calculated for each scenario (i.e., receptor) by summing the hazard indices from all pathways for a given exposure period. Summing the risk in this manner assumes that all pathways apply concurrently and that all body organs are affected equally. This assumption is conservative.

Figure 6-2 presents the total risk for the two current use scenarios, that is the current groundwater sampler and current material yard worker. Figures 6-3 and 6-4 present the total risk for the hypothetical resident and hypothetical industrial worker scenarios.

The screening for the human health risk assessment eliminated all but thirteen COPCs, arsenic, anthracene, beryllium, benzo(g,h,i)perylene, 2-hexanone, iron, octachlorodibenzo-p-dioxin, and PCB1254 in the soil, and aluminum, bis(2-ethylhexyl)phthalate, bromodichloromethane, chloroform, and dibromochloromethane in the groundwater. Under the current land use, these COPCs do not appear to pose a significant risk. Only the current groundwater sampler (risk of 1.9E-06) has a risk exceeding 1.0E-06, and this risk is near the lower bound of the de minimus risk range (i.e., 1.0E-06 - 1.0E-04). Under the hypothetical land uses, both the industrial scenario and residential scenario exceeded a risk of 1.0E-06. Risk to the industrial worker was calculated to be 1.5E-05, due mainly to ingestion of groundwater. Total risk under the residential scenario was 7.9E-05 for adult and child combined and 3.2E-05 for the resident child only scenario.

6.2.4 Human Health Assessment Uncertainties

Uncertainties Leading to Potential Over Estimation of Risk.

Scenario specific assumptions concerning exposure pathways, duration of exposure, and COPC concentration term result in a reasonable maximum exposure (RME). The RME represents the highest exposure that is reasonably expected to occur in a small but definable "high-end" segment of the potentially exposed population, which by definition leads to a conservative estimation of risk.

Contaminant concentrations generally will decrease with time due to degradation, dispersion, and dilution. COPC concentrations used in the BRA are present day concentrations which were not reduced to account for degradation, dilution, or dispersion in any media. Neglecting this effect will add some degree of over estimation of risk for the hypothetical uses which may occur in the future.

Arsenic was included as a COPC in BRP6G soils and quantitatively assessed in the risk assessment since it failed the twice background mean test. A statistical comparison was made between the background and site-related arsenic populations, provided in Appendix C8. Two statistical tests were conducted in tandem to compare both the means and tails of the two population distributions. The means test for the 0-2 foot interval indicated that the on unit data was not significantly elevated as compared to the background data, with 95% confidence. However, the data set was not adequate to use the tails test. The tandem test for the 0-5 foot interval indicated that the on unit data and the background data could not be shown to be of the same population with 90% confidence (i.e., it passed the tails test but failed the means test). Therefore, arsenic should be retained as a soils COPC. Arsenic data used to calculate risk is presented in Appendix C9.

Arsenic was included as a COPC in BRP6G groundwater and quantitatively assessed in the risk assessment even though there was only 1 hit in the groundwater out a total of 27 samples. This hit may have been spurious and not representative of actual conditions as it came from a bailed sample.

Including arsenic in groundwater as a COPC appears to have caused risk to be overestimated. Arsenic data used to calculate risk is presented in Appendix C9.

Beryllium was included as a COPC in BRP6G soils and quantitatively assessed in the risk assessment since it failed the twice background mean test. A statistical comparison was made between the background and site-related beryllium populations, provided in Appendix C8. The results of the tandem statistical testing indicated that the site-related population is not significantly different than the background population. Based on this analysis, beryllium should not be considered a site-related contaminant of concern. Treating beryllium as a COPC significantly impacts the cumulative risks calculated for the hypothetical industrial worker and hypothetical resident scenarios, as beryllium contributes to the carcinogenic risk in excess of 1E-06. Beryllium data used to calculate risk is presented in Appendix C9.

The two sampling events for wells CBR-4D, -5D, and -6D utilized bailing as means for collecting groundwater samples. Numerous studies have shown that turbidity introduced into groundwater samples when a bailer is used can elevate contaminant concentrations (EPA, 1995b; EPA, 1995c). This sampling method has significantly influenced concentrations of several inorganic constituents in groundwater analyses. Specific analytes of concern that are elevated include: aluminum, beryllium, iron, lead, and manganese. Excluding aluminum, iron, and manganese results from the six bailed samples would allow these contaminants to be screened out of the risk assessment based on the two times average background rule. In the case of beryllium and lead, removal of one maximum bailed sample would allow the groundwater contaminant to be screened out of the risk assessment based on the two times average background rule. Aluminum, beryllium, iron, lead, and manganese data used to calculate risk is presented in Appendix C9.

Lead has no slope factor or reference dose and therefore does not have a calculated risk. Lead in the groundwater is at levels less than site specific background even though the maximum hit is greater than 2 times average background. The maximum lead hit was a bailed sample and is believed to be a result of inclusion of soil particles in the sample. Exclusion of the one maximum sample from the bailed well would allow lead to be screened out of the BRA. The site specific background levels for lead in groundwater are elevated in comparison to the wells downgradient from the unit. Lead data used to calculate risk is presented in Appendix C9

The hazard indices for aluminum, iron, and 2-hexanone were calculated using provisional reference doses. The uncertainty associated with these provisional reference doses is believed to be very conservative.

For the current groundwater sampler inhaling VOC vapors from groundwater the calculation of the contaminant concentration term was simplified, which may cause significant over estimation of risk for this exposure route. Intake from inhalation of VOCs released from groundwater during groundwater sampling was calculated using Henry's Law (see Appendix C4, equation 11). Contaminant concentration in air calculated using Henry's Law is conservative because it assumes that there is no dispersion after the VOC vapor is released from the groundwater and the transfer from the liquid phase to the gas phase occurs immediately (i.e., the air containing the VOC vapor is fully saturated and saturation occurs immediately). In reality the transfer from liquid to gas takes time, and dispersion does occur lowering the concentration of VOCs in the air. This pathway is the risk driver for the current groundwater sampler (see Figure 6-2). The risk calculated for this scenario would be reduced significantly by employing another model to determine VOC concentration.

There is a hypothetical on-unit resident evaluated in this BRA. However, the Central Shops Burning Rubble Pit is located within a current industrial area as supported by the proposed land use map for SRS documented in the SRS Citizens Advisory Board proposal (SRS Citizens Advisory Board Recommendation No. 2, 1/24/95). Therefore, industrial land use may be the most reasonable future scenario for this waste unit. Consideration of the on-unit resident may lead to over estimation of risk if the residential use scenario does not develop.

Bis (2-ethylhexyl) phthalate is a lubricant used in vacuum pumps which are commonly used in analytical laboratories. This COPC may be a result of laboratory contamination. No statistical evaluation of bis (2-ethylhexyl) phthalate has been performed for the BRP6G data but bis (2-ethylhexyl) phthalate has been a lab contamination problem in other SRS data sets. Application of the blank concentration 10 times rule for common laboratory contaminants (Section 6.1.2, step 5) was applied to the BRP6G data set and should have eliminated blank contamination problems. If laboratory contamination has occurred risk may have been overestimated. This COPC is a risk driver for groundwater pathways associated with the on-unit resident scenario. Bis (2-ethylhexyl) phthalate data used to calculate risk is presented in Appendix C9.

Sampling of soils at the BRP6G occurred in two phases. Surface soil samples were collected from a depth of 0 to 2 feet during the first phase and 0 to 1 feet during the second phase. If contamination increases with depth the 0 to 2 feet samples would cause overestimation of risk. If contamination decreases with depth the 0 to 2 feet samples would cause underestimation of risk. The inclusion of soils from depths of 1 to 2 feet in the determination of surface contamination adds some uncertainty to the determination of risk. At the BRP6G the data suggests that contaminant concentrations increase with depth.

For this BRA total exposure cancer risk from multiple pathways was calculated by summing the risk from individual pathways. Total potential for noncarcinogenic effects was calculated for each scenario by summing the hazard indices from all pathways for a given exposure period. The combining of risk across pathways is inherently uncertain and generally leads to an over estimate of risk because: 1) summing the risk across pathways combines risks as if they are additive, and 2) summing risk assumes that all COPCs will be at their reasonable maximum exposure for all pathways at all times. Because relatively few COPCs were evaluated in this BRA over estimation due to combining risk across pathways should be small.

Uncertainties Leading to Potential Under Estimation of Risk.

For this BRA it was assumed that radioactive materials were not disposed of at BRP6G, and that any radionuclides present at the unit are consistent with the background. Based on this assumption, risks due to radionuclides were not evaluated. During the site investigation sample analysis was performed for gross alpha, nonvolatile beta, total alpha-emitting radium, and tritium. Results of these tests do not allow radiological risk to be completely eliminated based on comparison of maximum detected to 2 times background criteria (refer to Table 6.4 for summary of results from radiological analyses). However, we have maintained the assumption that radioactive materials were not disposed of at BRP6G, which may lead to underestimation of risk. Any radiological risk is believed to be associated with the Ford Building Seepage Basin and/or the Ford Building Waste Site.

In this BRA it is assumed that any contaminants which are mobile have already migrated to the groundwater and that contaminant concentrations are decreasing with time. Immobile contaminants are likely bound to soils. No modeling was performed for transport of contamination from soil to groundwater. Contaminant concentrations in soils were compared to soil screening levels to determine if a potential exists for future groundwater contamination due to leaching from soils. This comparison is presented in Table 5.2 and discussed in Section 5.4. The assumption that immobile contaminants are bound to soils and that contaminant concentrations are decreasing with time are probably good assumptions considering the presence of groundwater contaminants and the age of the unit. If contaminant concentrations are falling then the risk calculated in this BRA represents a worse case scenario, but to date it is uncertain whether groundwater contaminant concentrations are rising or falling.

The overall setting, within the vicinity of an active industrial area and other inactive waste sites, increases the complexity and uncertainty of the background reference levels. If background levels determined for either the soil or groundwater are elevated then risk attributable to the unit could be underestimated for inorganic compounds (i.e., those compounds screened out of the risk assessment based on the two time background rule). However, relatively few contaminants were screened away based on the two times background rule (see Table 6-2).

An upgradient well, CBR-1D, was used to determine background levels for this unit (see Figure 1-16). The side gradient well CBR-4D was initially intended for use as a background well. The contaminant levels in CBR-4D inhibit its intended use as a background well. CBR-4D is believed to be influenced by the waste unit. The fact that only one well was used to determine groundwater background levels causes uncertainty. Ideally a second upgradient well would be used to statistically strengthen the determination of average background levels in the groundwater. In addition, if Well CBR-1D has been affected by upgradient contaminant sources or by BRP6G, it will lead to elevated background levels and underestimation of risk for exposure to groundwater. Specific contaminants which appear to be elevated in the site specific background well are lead, zinc, copper, and sulfate. The background well CBR-1D showed occasional hits for the following organic constituents: chloroform, pyrene, toluene, and 2-chlorophenol. Downgradient wells detect these organic constituents and others at higher concentrations than background. This indicates that the upgradient groundwater may be impacted somewhat by other activities occurring upgradient.

Drainage water and sediment samples were collected from the drainage ditch (locations CS6G-23 through 33) to determine the nature and extent of contamination associated with BRP6G, but were not evaluated in the human health risk assessment. If all contamination in the drainage ditch were from BRP6G, then contaminant levels in the drainage ditch should be lower than at the unit because the contaminants were transported from the unit and diluted to some degree. If this is the case then neglecting the risk due to drainage sediments should introduce little error in the risk assessment. However, the drainage ditch may contain potential contaminants from a large area not attributable to the BRP6G. In addition, buried contaminants (i.e., deeper than 5 feet) may have been exposed and carried into the drainage ditch due to erosion across the unit. Soils at depths greater than 5 feet were not evaluated in this BRA. It is assumed that these soils will not be disturbed or brought to the surface where receptors can be exposed. This assumption may cause under estimation of risk at the unit.

Several COPCs detected at the BRP6G were not quantitatively evaluated because no reference dose (RfD) or slope factor (SF) is available (see Table 6.9). This has probably caused underestimation of risk for some of these COPCs. For example, a great deal of information on the health effects of lead has been obtained through decades of medical observation and scientific research. By comparison to most other environmental toxicants, the degree of uncertainty about the health effects of lead is quite low. It appears that some of these effects may occur at blood lead levels so low as to be essentially without a threshold. The EPA's RfD Work Group considers it inappropriate to develop an RfD for inorganic lead. In this BRA lead was not evaluated, but probably poses some degree of risk. Some of the other COPCs without an RfD or SF may also pose a risk.

Volatilization of contaminants from contaminated soil was not quantitatively evaluated as a pathway in this BRA. It was assumed that the risk posed by VOCs in the air above the pit is negligible. This assumption is based on the soil gas investigation at BRP6G (Pirkle and Masdea, 1991; see Appendix A). The species monitored during the soil gas survey were light hydrocarbons (C1-C4), gasoline range aromatic hydrocarbons (BTXE), mercury, and selected chlorinated organics. The objective of the survey was to determine the presence and extent, or absence of contamination in near surface soil gases. Samples were generally obtained from depths of 36 inches to 48 inches. Only three isolated, and very low, observations of aromatic hydrocarbons (i.e., toluene at 0.33 ppmv and xylene at 0.10 and 0.20 ppmv) were made at the southeast end of pit 631-6G. Light hydrocarbons were low and fairly uniformly distributed across the area with slightly elevated levels in the area of the aromatic hydrocarbons observations. Mercury concentrations were generally low and perhaps representative of background. It should be noted that this was a screening survey and that level III air sampling data was not collected above the BRP6G. The assumption that the risk posed by VOCs in the air above the pit is negligible may possibly lead to under estimation of risk.

6.3 Screening Ecological Risk Assessment

6.3.1 Introduction

The screening ecological risk assessment (ERA) was performed primarily in accordance with Steps 1 and 2 of the draft Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (EPA, 1994). This guidance document provides a structured approach, defined by eight basic steps, for conducting ecological risk assessments. Steps 1 and 2 of the process constitute a screening-level ecological risk assessment and determine the scope of this ecological assessment for the BRP6G. The purpose of the screening ERA is to determine, based on available data, the potential risk to ecological receptors from contaminants present at the BRP6G. The ERA is structured to result in three possible decisions for the BRP6G based on ecological concerns: (1) no further action is required; (2) remedial action is required; or (3) further investigation is required. The decision is made and documented as Scientific/Management Decision Point (SMDP) "A" as specified in the draft EPA guidance (U. S. EPA, 1994) and the Savannah River Site Implementation Plan for the Ecological Risk Assessment Guidance for Superfund (WSRC, 1995).

Detailed ecological investigations for site-specific receptors (Steps 3-8) were neither performed nor required in this screening tier of the 1994 ecological risk assessment process (EPA, 1994). Should the ecological risk assessment process need to continue based on the results of the screening ERA, the risk to ecological receptors would be further evaluated through problem formulation; conceptual model development; site assessment and field investigation; risk characterization; and risk management (i.e., Steps 3-8 of the EPA, 1994). If little or no risk is identified at SMDP A, the ERA process is complete. If remediation is warranted, the screening risk assessment may provide adequate justification to proceed and a full baseline ecological risk assessment may not be required.

This ERA meets the intent of the following guidance:

- Risk Assessment Guidance for Superfund, Volume II. Environmental Evaluation Manual. Interim Final. (EPA, 1989).

- Framework for Ecological Risk Assessment (EPA, 1992a).

- General Interim Guidance for Ecological Assessments at Superfund Sites in Region IV (EPA, 1992b).

- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Review Draft (EPA, 1994).

6.3.2 Problem Formulation

6.3.2.1 Site Description and General Ecology

The BRP6G is located on the southern boundary of the Central Shops Area, an active industrial/material storage area. The BRP6G is located to the south and immediately adjacent to an active excess materials lay-down yard, approximately 100 meters southeast of the Ford Building Seepage Basin, a radiologically contaminated, inactive waste unit. The BRP6G is situated both topographically and hydrologically down-gradient of these facilities. Immediately south of the waste unit (< 30 meters) are railroad tracks and associated right-of-way, which are believed to receive routine mowing and herbicide treatments.

Surface drainage at the BRP6G is generally to the south-southwest. There is evidence of surficial sheet flow and sedimentation from the upgradient lay-down yard, and site management currently includes placement of erosion control fencing. Upgradient surface water run-off drainage from the lay-down yard and Ford Building area migrates toward the BRP6G pit. This drainage is a consolidation of the Ford building's CS-008 permitted outfall and run-off from the upgradient lay down yard. A drainage conduit has been added at the site to control and eliminate further erosion across the site. This conduit accepts run-off from the drainage pipe under the dirt road to the north of the site and discharges to a drainage ditch along the railroad track embankment. This ditch drains to an intermittent stream that ultimately discharges to Pen Branch approximately 1.2 miles to the southeast.

The BRP6G unit has visible signs of erosion, which were lessened by recent placement of the conduit. This erosion could serve as a potential contaminant migration/transport route. The overall setting of the BRP6G, however, increases the complexity of both the background reference determination and contaminant source definition since the drainage area represents potential contaminants from a large area not attributable to the BRP6G. No wetlands or surface water bodies are present at the BRP6G.

The area within the physical boundary of BRP6G is a highly disturbed area with sparse ground cover comprised primarily of grass and sedge species. The area north of the unit is extensively disturbed due to industrial use and development since the 1950's and, therefore, offers limited wildlife habitat. A small forested area exists to the west of the unit, and a heavily forested pine plantation habitat exists to the south of the unit beyond the railroad tracks.

A Threatened, Endangered, and Sensitive (TES) Species Survey was conducted for the unit and surrounding area in the summer of 1994 (USFS, 1994). The survey focused on species included in the <u>Savannah River Site Proposed, Threatened, Endanger, and Sensitive Plants and Animals</u> listing (USFS, 1994; SRFS, 1994). The survey revealed that the waste unit itself contains no TES habitat, nor were any TES species observed at or immediately adjacent to the waste unit. The survey results also indicated that habitats in the vicinity of BRP6G do not meet the needs of most SRS listed TES plant or animal species. Some upland plant species could potentially occur in the area, but no specimens were found during the survey and there is a fairly low potential of occurrence.

The forested regions of the survey area were dominated by loblolly pine (*Pinus taeda*) and included water oak (*Quercus nigra*), white oak (*Quercus alba*), sycamore (*Plantanus occidentalis*), black gum (*Nyssa sylvatica*), black cherry (*Prunus serotina*), scarlet oak (*Quercus coccinea*), black oak (*Quercus velutina*), American elm (*Ulmus americana*), and Nuttall oak (*Quercus nuttallii*). The midstory consists primarily of young loblolly pine, various oaks, hickories (*Carya* spp.), and sweet gum (*Liquidambar styraciflua*). Ground cover species invading open areas include Japanese honeysuckle (*Lonicera japonica*), poison ivy (*Rhus radicans*), greenbrier (*Smilax* spp.), blackberry (*Rubus* spp.), ragweed (*Ambrosia artemisiifolia*), muscadine (*Vitis rotundifolia),* and peppervine (*Ampelopsis arborea*).

The BRP6G and land immediately surrounding the unit offer limited habitat for small mammals, ground-level feeding birds, and their predators (avian, mammalian, and reptilian). This is based on the disturbed nature of the waste unit and the industrial-type activities which occur in the area surrounding the unit. The forested regions of the survey area provide habitat for species that feed and/or nest in mature pine canopies (songbirds and squirrels, for example). The open canopy associated with the forested regions has resulted in dense mid- and ground-story growth which provides habitat for certain small mammals, songbirds, and white-tailed deer (*Odocoileus virginianus*). Birds identified by song during the TES species survey include the blue jay (*Cyanocitta cristata*), Carolina chickadee *(Parus carolinensis*), Carolina wren (*Thryothorus ludovicianus*), common crow *(Corvus brachyrhynchos*), mourning dove (*Zenaida macroura*), northern cardinal (*Cardinalis cardinalis*), summer tanager (*Piranga ruba*), and tufted titmouse (*Parus bicolor*).

6.3.2.2 Problem Formulation Statement for the BRP6G

This ERA was initiated as a result of the scheduled RFI/RI program at the SRS and was not triggered by an unplanned release or by a confirmed adverse ecological effect. No observed effects attributable to unit contaminants have been identified during characterization activities. The assessment is based on an evaluation of potential chemical stressors, identified as a result of the RFI/RI characterization, and is limited by that information. Sampling indicates that the presence of chemical stressors is primarily limited to surface and subsurface soil. This screening ERA was conducted to determine the potential risk to ecological receptors from contaminants in surface and subsurface soil. Risks were estimated for the potentially complete exposure pathways associated with these media.

The conceptual site model (CSM) is presented as Figure 6-5. The CSM depicts the following: primary sources of contamination, release mechanisms and transport pathways, environmental media impacted (secondary sources of contamination), environmental release mechanisms and transport pathways for secondary sources, exposure pathways, exposure routes, exposure points, and potential receptors. The CSM indicates potential exposures, including complete and incomplete exposure pathways. A complete exposure pathway consists of the following elements: a source and mechanism of contaminant release to the environment, an environmental transport medium for the released contaminants, a point of contact with the contaminated medium, and a route of entry of the contaminant into the receptor at the exposure point. As mentioned previously, only complete and likely exposure pathways, denoted by an "X" in the CSM, are evaluated in the screening ERA.

6.3.3 Ecological Endpoints and Exposure Assessment

6.3.3.1 Ecological Endpoints

In order to assess whether significant adverse ecological effects may occur at the BRP6G as a result of exposure of ecological receptors to chemicals of potential concern (COPCs), ecological endpoints are selected. An ecological endpoint is a characteristic of an ecological component that may be affected by exposure to a stressor, such as a chemical contaminant. *Assessment endpoints* represent environmental values to be protected. *Measurement endpoints* are measurable responses to a stressor that are related to the valued characteristics chosen as assessment endpoints (U.S. EPA, 1992). Assessment endpoints generally refer to characteristics of populations and ecosystems, and it is usually impractical to measure changes in these characteristics as a part of an assessment (Suter, 1993). Consequently, measurement endpoints are selected that can be measured and extrapolated to predict effects on assessment endpoints (U.S. EPA, 1992a). This section describes the process used in selecting assessment endpoints for this unit.

Suter (1993) has suggested five criteria that should be considered in selecting assessment endpoints suitable for a specific ecological risk assessment. Three of these (numbers 1, 2, and 4) are listed as considerations in selecting assessment endpoints in the Framework for Ecological Risk Assessment (U.S. EPA, 1992a).

The criteria utilized in selecting the assessment endpoints for the BRP6G are described below and are based on Suter (1993):

1. Ecological relevance. The assessment endpoint should have biological/ecological significance to a higher level of the ecological hierarchy.

2. Susceptibility to the contaminant(s). The assessment endpoint should be susceptible to exposure to the contaminant(s) and should be responsive to such exposure.

3. Accessibility to prediction and/or measurement. The response of the assessment endpoint should be measurable, or it should be predictable from measurements of related responses, responses of other species, or responses of other levels of the hierarchy of ecological organization.

4. Societal relevance. Ideally, the assessment endpoint should be understood and valued by the public and decision makers.

5. Definable in clear, operational terms. The operational definition of the assessment endpoint should include a subject (e.g., a native species, a population, or a community)

and a characteristic of the subject (e.g., a reduction in population size or community diversity).

The above criteria were the basis for evaluation of potential assessment endpoints to be used in assessment of ecological risk at the BRP6G. Potential receptor species likely to be exposed to unit-related chemicals were judged by these criteria as part of the process of selecting the most appropriate assessment endpoints for this unit. The results of this analysis indicate that small mammal species inhabiting the area of the unit are the most appropriate assessment endpoint species for evaluation of ecological risk associated with exposure to soils.

In addition, effects on individual species may be used to identify potential effects on assessment endpoints at higher levels of ecological organization. Potential reduction in the abundance of individuals within species (i.e., population size) and potential reduction in the number of species comprising the ecological community (i.e., biodiversity) at the unit are the assessment endpoints selected for evaluation of effects at the community level. The rationale for selecting these population- and community-level assessment endpoints is discussed below for each numbered criterion:

1. Ecological relevance. Native small mammal species are likely to be preyed upon by predators and to compete with other animals for food. An increase in mortality or decrease in fecundity of individual small mammals in the area as a result of exposure to toxicants will affect the size and productivity of small mammal populations. In turn, decreases in small mammal populations may alter the food supply of individual predators or competitors in the area, thereby affecting other members of the ecological community.

2. Susceptibility. To be susceptible to significant exposure to soils, a potential assessment endpoint species should be in intimate contact with soils for long periods of time, and/or should consume plants or animals which may have bioaccumulated unit-related chemicals.

3. Accessibility to prediction. Because the toxicological database is more extensive for rodents than for any other terrestrial group, native rodents have a much greater database for evaluating potential toxicity effects from exposure to soils at the unit than other native taxa.

4. Definable. The assessment endpoints for this ERA were defined for operational purposes as a reduction in resident small mammal populations.

The assessment and measurement endpoints were determined based on the selection criteria discussed above. Endpoints must also be appropriate to the scale of the investigation. BRP6G is an operable unit-level investigation. While some wide-ranging species may periodically use the BRP6G, these organisms are not dependent on it and are not a focus of the screening ERA. The following paragraphs discuss the specific small mammal receptor chosen for the BRP6G ecological assessment, the meadow vole.

Small mammals generally have small home ranges, which could result in significant exposures if these ranges overlap or are encompassed by the contaminated area. Small animals which utilize the unit as a significant part of their range are more likely than larger mammals or birds to be directly exposed to COPCs through ingestion of contaminated media, such as incidental ingestion of soil or sediment while burrowing or grooming. Small animals also can be exposed through the food chain, such as through ingestion of plants or invertebrates which have bioconcentrated chemicals from the soil. Small mammals are the receptors likely to have the greatest potential exposures to COPCs in soil. Therefore, toxicity effects of COPCs on small mammals is the measurement endpoint for assessing ecological risk from soils.

The meadow vole was chosen as the small mammal to evaluate for the BRP6G screening ERA. The meadow vole was chosen to represent a possible receptor for which potential ecological impacts may be assessed as appropriate for a screening-level ERA. Even though other trophic levels and potential indicator taxa may be present at the unit, the meadow vole represents a species with adequate information available to establish potential risk in accordance with U.S. EPA guidance (EPA, 1994). The meadow vole, the most widely-distributed small, grazing herbivore in North America, typically inhabits grassy fields, marshes, and bogs. Due to the presence of grassy open areas at the BRP6G, and the wide distribution of meadow voles in North America, the meadow vole was selected to represent small herbivorous mammals at the unit.

Native vole species meet susceptibility requirements because they burrow in the soil and feed on plants and insects within a small home range. In addition, a multitude of studies of closely related laboratory rodents has demonstrated their sensitivity to a wide variety and large number of chemicals. Because of the close phylogenetic relationship of native voles to commonly studied laboratory mice and rats, toxicity data based on these laboratory species (measurement endpoints) are relevant, useful, and relatively low in uncertainty, compared to less similar species, for predicting potential effects which may occur in populations of native species.

The societal relevance of native vole populations as assessment endpoints for soils resides principally in their role as primary consumers within the community: They feed mainly on plants and provide food for secondary consumers. Maintenance of the biological health of natural communities is generally considered of societal importance, and removal of voles (or other small mammals) from their role in the community could have adverse effects on the health of the community.

6.3.3.2 Exposure Assessment

The objective of the exposure assessment is to evaluate the potential exposure of ecological receptors to unit-related chemicals. The process includes description of the spatial distribution of COPCs at the unit, description of the spatial and temporal distribution of ecological receptors, and quantification of exposures which may result from overlap of these distributions.

For this exposure scenario, a burrowing primary consumer (meadow vole) was selected to address the increased level and duration of soil exposure that a burrowing receptor would experience, as recommended by U.S. EPA (1994). Life history and habitat requirement information on this indicator species is presented below (U.S. EPA, 1993):

Habitat preference: Grassy fields, marshes, and bogs.

Reproduction: Breeds throughout year, gestation 21 days, 1-10 young/litter.

Food Preferences: Seeds and fruit, various grasses, sedges, and weeds.

It is assumed that the meadow vole will experience daily, long-term exposure to the soil, either directly or by consuming plants with contaminants in their tissues. Conservative assumptions for meadow voles were used in order to be protective of the health of upper-level receptors, which is consistent with U.S. EPA guidance (U.S. EPA, 1994).

The meadow vole consumes 0.35 grams of food per gram of body weight daily (i.e., a 17 g animal consumes 5.95 g). It is assumed that the vole spends 100% of its time in the area of contamination. In keeping with the conservatism of the ERA, the lowest adult body weight and highest ingestion rate reported in the Wildlife Exposure Factors Handbook (U.S. EPA, 1993) were used. Also, based on factors provided in the handbook, the diet of the vole was determined to consist primarily of leafy vegetation (76%) and roots and fruits (24%). Additional exposure through incidental ingestion of soil was also calculated, based on an estimated percent soil in diet of 2.4% of the daily food ingestion rate, as reported in U.S. EPA (1993).

It was assumed that ingestion of contaminated plant tissue and incidental ingestion of soil are the most significant routes of exposure for the meadow vole. Additional exposure may occur through dermal and inhalation routes, however, these exposures are expected to make only a minimal contribution to total intake at the BRP6G. As stated in an example in U.S. EPA (1994), the significance of dermal exposure is uncertain, and "grooming would most likely result in ingestion of the contaminant prior to actual dermal contact." It is expected that the highly conservative nature of the ingestion pathway assumptions will compensate for the slight effect from these routes of exposure.

6.3.4 Media and Chemicals of Potential Concern

The media sampled at the BRP6G were groundwater, surface soil (depth 0-2 feet), and subsurface soil (depth 0-5 feet). Because wetlands and surface water are not present at the BRP6G, no surface water or sediment samples are evaluated. Since a potential exists for surface water run-off, this component is contained in the CSM (Figure 6-5) as a potential exposure pathway, but it is not evaluated in this screening ERA. Ecological exposure pathways to groundwater and deep subsurface soil (greater than 6 feet below the ground surface) are incomplete, meaning that the potential ecological receptors will not experience direct contact with contaminants detected in these media. Deep subsurface soil (greater than 6 feet) exceeds the depth of most burrowing animals and plant root exposure, and groundwater is not known to discharge to surface water in the vicinity of the unit. Exposure pathways are complete for surface soil (0 to 2 feet), and also for shallow subsurface soil (0 to 5 feet), assuming future human excavation of soil. Thus, potential ecological receptors may experience direct contact with contaminants contained within these media. Surface soil and shallow subsurface soil (henceforth called subsurface soil) at the BRP6G are therefore considered the media of ecological concern.

The chemicals detected in the surface and subsurface soil at BRP6G are listed in Table 6.5 and Table 6.6, respectively. The analytes listed are those constituents remaining after completion of the background screen, where maximum concentration levels were compared to the mean background concentration multiplied by a factor of 2. Inorganic analytes with maximum concentrations less than 2 times the background mean were eliminated from further consideration and are not included in Tables 6.5 and 6.6.

Exposure point concentrations for the COPCs were based on the maximum detected concentration or the 95% upper confidence limit (UL95) of the mean, whichever was less, for both surface and subsurface soils the BRP6G. See Tables 6.12 and 6.13.

6.3.5 Risk Calculation

Tables 6.14 through 6.29 present the values and calculations used to estimate the ecological risk associated with surface and subsurface soils at the BRP6G. The specific calculations and table references are discussed below.

As discussed previously, it was assumed that ingestion of contaminated plant tissue and incidental ingestion of soil are the most significant routes of exposure for the meadow vole. Plant uptake of soil contaminants was estimated by calculating bioconcentration factors (BCFs) for both leafy vegetation and for roots, vegetables, and fruits.

For organic chemicals, BCF values for leafy vegetables (BCF) were calculated by using the following equation (Travis and Arms, 1988):

$$\log(BCF) = 1.588 - 0.578 \times \log(K_{ow})$$

For root vegetables and fruits, the BCF values for organic chemicals were calculated by using the following equation (Travis and Arms, 1988):

$$BCF_r = BCF_f = RCF/(K_{oc} \times f_{oc})$$

Where:

BCF_r = BCF for root vegetables

BCF_f = BCF for fruits

RCF = Root concentration factor (unitless)

K_{OC} = Organic carbon/water partition coefficient (unitless), chemical-specific

f_{oc} = Fraction of organic carbon in soil (unitless)(assumed to be 2.0%)

K_{oc} and log K_{ow} values for the COPCs is surface and subsurface soils are shown in Tables 6.14 and 6.15, respectively.

The RCF was calculated as follows (Travis and Arms, 1988):

$$\log(RCF - 0.82) = 0.77 \times \log(K_{OW}) - 1.52$$

An adjustment was made to the values in order to account for dry weight/wet weight differences. The BCF values are expressed in terms of dry weight, whereas the meadow vole intake is expressed as wet weight. Therefore, adjustments were made by multiplying the vegetable- or fruit-specific dry weight/wet weight ratio by the BCF value. The applicable dry weight/wet weight ratios (as described in Baes et al., 1984) are:

leafy vegetables	0.05
root (and fruit) vegetables	0.12

After the BCF values determined for leafy and root/fruit vegetation are multiplied by their respective dry weight/wet weight ratio, they are then multiplied by the exposure concentrations in soil to estimate the levels of each chemical in plant tissue.

BCFs for inorganic chemicals could not be calculated using K_{OW} and K_{OC} values, as these partitioning coefficients are not commonly available for inorganic chemicals. Therefore, soil-to-plant transfer factors (reported in NRC, 1992) were used to estimate metal concentrations in plants.

The daily ingestion rate, dietary composition, and percent digestibility of the diet (based on data from EPA, 1993) were used to estimate a daily contaminant intake from plant ingestion for the meadow vole. The calculated intakes for leafy vegetation and roots/fruits were added to the intakes from incidental ingestion of soil to determine a total daily intake for the vole. Calculations of total intakes from soil, leafy vegetation, and roots and fruits are shown in Tables 6.27 and 6.28.

The principal method used to estimate the potential for ecological risk posed by each COPC was the calculation of hazard quotients (HQs). This method compares estimated contaminant intakes (in the numerator) to toxicity benchmark levels (in the denominator) by calculating a quotient. The preferred toxicity benchmark value for a screening ERA is a no-observed-adverse-effect level (NOAEL) from a chronic (long-term) study, preferably based on a species (e.g., the laboratory mouse) closely related to the assessment endpoint (meadow vole). If an appropriate NOAEL was not available in the literature for a given COPC, an appropriate lowest-observed-adverse-effect level (LOAEL) was used, but it was modified by dividing it by an uncertainty factor of 10. If acute studies (<90 days) were used, another uncertainty factor of 10 was applied. Surrogate values were used where appropriate for those chemicals with no appropriate existing ecological toxicity data. The derivation of toxicity benchmark values for COPCs in surface and subsurface soils is shown in Tables 6.25 and 6.26, respectively.

The calculations for contaminant intakes from plant root and fruit consumption, leafy vegetation consumption, and incidental ingestion by a meadow vole are presented in Tables 6.16 through 6.24 for both surface and subsurface soil. Sample calculations for each exposure pathway (i.e., ingestion of roots and fruits, ingestion of leafy vegetables, and incidental ingestion of soil) are presented in Tables 6.18, 6.21, and 6.24, respectively.

6.3.6 Risk Characterization

Risk characterization integrates the results of the exposure assessment and the risk calculation in order to characterize the potential ecological risks which the COPCs may pose to assessment endpoints. Based on the magnitude of the calculated ecological HQs, a determination was made as to whether each COPC poses only negligible ecological risk and requires no further evaluation, or whether it has a potential to pose risk and warrants a more unit-specific, realistic investigation to ascertain the significance of the risk it may pose. If the HQ for a COPC exceeded a value of one, that contaminant was designated as a chemical of concern (COC). In addition, other relevant characteristics of each COPC, particularly bioaccumulation/ biomagnification potential (as indicated by BCFs), were weighed in determining whether a contaminant warranted classification as a COC. Accordingly, those COPCs having an HQ less than one but having a BCF which exceeds the benchmark value of 300 were evaluated, and those determined to have a significant potential to pose ecological risk through bioaccumulation/biomagnification were classified as COCs. Also in this section, uncertainty in the screening ERA is analyzed and discussed.

6.3.6.1 Risk Estimation

Risk estimation utilizes the ecological HQ values calculated for each COPC, as well as other toxicological information, to characterize the potential ecological risk which may be associated with each COPC. HQs are expressed as the ratio of a potential exposure level to an ecological toxicity benchmark value. Generally, the greater this ratio, or quotient, the greater the likelihood of an adverse effect. For terrestrial receptors, which are the focus of this ERA, the exposure level is expressed as an estimated daily intake of chemical per kilogram of body weight per day.

A quotient of one is considered the threshold level at which adverse effects may occur. The screening toxicity benchmarks on which the HQs are based are derived to be very conservative: they are based on the lowest available NOAELs for any serious effect on any potential receptor species or surrogate species and are representative of chronic exposures. Due to the conservatism of the inputs to the HQ calculation, HQs between 1 and 10 were considered to represent some limited potential for adverse effects, and HQs between 10 and 100 were considered to indicate a significant potential for adverse effects. Risk calculations for each COPC in surface soil and subsurface soil at the unit are shown in Tables 6.27 and 6.28, respectively.

The results of the HQ calculations provide a conservative estimate of the potential for ecological risk. However, other available information also is used in the risk characterization step to determine whether the potential for ecological impacts from each COPC is significant and warrants a more focused evaluation, or whether it is negligible (U.S. EPA, 1994).

The potential for bioaccumulation and ecological persistence of each COPC were evaluated by assessing the magnitude and significance of its measured or calculated BCF. BCF values and their basis for all of the COPCs in surface and subsurface soil at the unit are shown in Table 6.29. A BCF value of 300 is established as a general benchmark for identifying COPCs which may bioaccumulate. However, additional analysis is required in order to determine whether each COPC thus identified might actually pose significant ecological risk as a result of bioaccumulation in individuals and populations, and as a result of biomagnification through the food chain.

For example, although a contaminant may be present at a level below that at which it has been found to produce chronic toxicity in tested species (HQ < 1), it may nevertheless be of concern if it is resistant to metabolic detoxification and depuration (e.g., excretion). These characteristics may result in bioaccumulation of the contaminant in the organism over a long period of time until it reaches toxic levels, and/or in biomagnification of the contaminant within the food chain until it reaches toxic levels in organisms at higher trophic levels. On the other hand, if a contaminant has a high BCF but is readily metabolized, it is unlikely to pose ecological risk through bioaccumulation and biomagnification. This situation may occur when the BCF is based on studies of shorter duration than the time required for metabolic degradation of the chemical, or when the BCF has been calculated from log K_{ow} or other physicochemical parameters which do not account for detoxification and/or depuration of the chemical by the organism.

Because most of the toxicity benchmarks used in calculating HQs are based on chronic, long-term exposures, the potential effects of bioconcentration on toxicity are largely accounted for in the HQ evaluation. Consequently, those screening COPCs with an HQ less than one but with a BCF greater than 300 were further evaluated for possible classification as COPCs only if available information indicated that they exhibit a strong tendency toward bioaccumulation/biomagnification and are likely to produce toxic effects in those populations subject to these processes. For example, certain metals exhibit a high BCF value because they are essential nutrients and are homeostatically maintained at levels within organisms that are higher than in the environment. Other chemicals that exhibit high BCFs based on physicochemical properties or short-term studies do not bioaccumulate over the long term or biomagnify in the food chain because they undergo gradual depuration and/or biodegradation by organisms.

Under current conditions, ecological receptors are unlikely to be exposed to soil deeper than two feet below ground surface. Therefore, soil data from the surface down to this depth were considered to be of greatest significance in characterizing current risk at the BRP6G. Under hypothetical future land use conditions in which home construction and agricultural/horticultural activities may occur, deeper soils (two to five feet in depth) could be excavated and distributed on the surface such that ecological receptors might then be exposed to contaminants from these depths. Therefore, soil data from the depth interval 0 to 5 feet were used to characterize ecological risk that potentially could occur as a result of exposure to these deeper soils under hypothetical future conditions.

Risk Estimates Based on Hazard Quotients

Of the 51 COPCs identified in surface soil, only three metals (copper, lead, and vanadium) had calculated HQs greater than one (see Table 6.27). The magnitude of the quotients for copper (21) and lead (118) are indicative of a significant potential for adverse effects, while the quotient for vanadium (0.3) is indicative of only a limited potential for adverse effects. the toxicity benchmark for vanadium (TB = 0.3 mg/kg-day) is derived from a study using a dissolved salt of vanadium in water (ATSDR, 1992). The form of vanadium in soils is likely to be much less bioavailable when ingested by the meadow vole. Given the small quotient and the conservative intake assumptions and toxicity benchmark derivation, vanadium in surface soils should pose minimal risk to ecological receptors.

Of the 52 COPCs identified in subsurface soil, five metals (barium, copper, lead, selenium, and vanadium) had calculated HQs greater than one (see Table 6.28) and were thereby classified as COCs. The magnitude of the quotients for copper (52), lead (127), and vanadium (23) are indicative of a significant potential for adverse effects, while the quotients for barium (2) and selenium (2) are indicative of a very limited potential for adverse effects. Like vanadium, the toxicity benchmarks for barium (TB = 0.7 mg/kg-day; ATSDR, 1992) and selenium (TB = 0.025 mg/kg-day; ATSDR, 1994) were derived from studies using forms of these elements (barium acetate and selenate), which are likely to be more bioavailable than the compounds usually associated with soils. Thus, based on the small quotients, conservative intake assumptions, and conservative toxicity benchmark derivation, barium and selenium in subsurface soils should pose minimal risk to ecological receptors.

Hazard quotients could not be calculated for the inorganics calcium, iron, magnesium, potassium, and sodium, nor for the organic 4-chlorophenyl phenyl ether. These inorganics are essential nutrients that are known to be low in toxicity. Therefore, they are considered to pose essentially no ecological risk.

The very low intake of 4-chlorophenyl phenyl ether suggests a minimal amount of risk, unless the compound is extremely toxic. The highly toxic metal lead has a toxicity benchmark of 1E-03. Thus, even if 4-chlorophenyl phenyl ether had a toxicity benchmark of the same magnitude as lead, the resulting quotient would be less than 1.0. Based on its chemical characteristics, 4-chlorophenyl phenyl ether is likely to be less toxic than lead.

Copper and lead may have a significant potential for ecological effects and will, therefore, be further evaluated in Section 6.3.6.3 (Risk Description).

Risk Estimates Based on Bioaccumulation/Biomagnification Potential

Twenty of the COPCs in surface and subsurface soils at the BRP6G [4-chlorophenyl phenyl ether, arsenic, benzo(b)fluoranthene, benzo(k)fluoranthene, cadmium, cobalt, dibenzofuran, dieldrin, fluoranthene, indeno(1,2,3-cd)pyrene, iron, manganese, mercury, methoxychlor, octachlorodibenzo-p-dioxin (OCDD), p,p-DDE, p,p-DDT, PCB-1254, potassium, and zinc] have BCF values that exceed the benchmark value of 300 (Table 6.29), although their HQ values are less than one.

Dieldrin, DDE, DDT, and methoxychlor are organochlorine pesticides, which generally have been found to be very persistent in the environment. Dieldrin, DDE, DDT, and methoxychlor have BCFs of 2700, 12,400, 20,644, and 8300, respectively. Dieldrin, DDT, and DDE are persistent in the environment, bioaccumulate in organisms, and biomagnify in the higher trophic levels of ecosystems (ATSDR, 1992). However, based on the very low magnitude of the HQ values for dieldrin, DDE, and DDT, the degree of bioaccumulation which would be necessary for toxic levels to be reached makes it is very unlikely that the detected levels of these pesticides pose ecological risk at this unit. Evidence suggests that higher organisms transform and eliminate methoxychlor at a fairly rapid rate (ATSDR, 1992). Thus, methoxychlor would not be expected to biomagnify or pose ecological risk at the BRP6G.

Studies have shown that dibenzofuran can bioconcentrate in aquatic organisms, but that depuration is rapid (HSDB, 1995). Rapid depuration indicates that long-term bioaccumulation and biomagnification are unlikely. Little information is available on bioconcentration, bioaccumulation, and biomagnification of octachlorodibenzo-p-dioxin isomers from soil. The BCF presented (869) is calculated from the log K_{ow}. Although most 2,3,7,8-substituted dioxins are lipophilic, highly toxic, and resistant to degradation, OCDD appears to be the least toxic of these congeners. Thus, based on the low levels present in the soil of this unit and the low potential for terrestrial food chain biomagnification, dibenzofuran OCDD do not appear to pose risk to assessment endpoints through bioaccumulation and biomagnification.

The PAHs, fluoranthene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3,-cd) pyrene, have high BCFs based on calculations from log K_{ow} values. However, most measured BCFs for PAHs in aquatic animals are significantly lower. PAHs have been found to bioconcentrate and bioaccumulate in aquatic and terrestrial plants and animals. However, biomagnification of PAHs does not appear to be a significant process because these compounds are extensively metabolized by organisms at higher trophic levels of aquatic and terrestrial food chains (ATSDR, 1993). Therefore, because of a low potential for biomagnification and the fact that PAHs tend to adsorb strongly to soil (HSDB 1995), fluoranthene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3,-cd) pyrene in soil at this unit are not expected to pose a risk to assessment endpoints.

Other organics with BCFs greater than 300 include 4-chlorophenyl-phenyl-ether (742) and PCB-1254 (110,000). 4-chlorophenyl-phenyl-ether was observed to bioconcentrate in rainbow trout (HSDB, 1996). No information was available about terrestrial accumulation or biomagnification. However, 4-chlorophenyl-phenyl-ether is known to biodegrade in soils (HSDB, 1996). The low BCF exceedance combined with a very small intake (1E-05 mg/kg-day) suggest 4-chlorophenyl-phenyl-ether would pose minimal risk at BRP6G. PCB-1254 is a known toxic, lipophilic compound which exhibits a high degree of persistence, bioaccumulation, and biomagnification

(ATSDR, 1993). Although the magnitude of the calculated quotient is small (10^{-4}), the large BCF (10^{+6}) indicates a potential risk to the assessment endpoints at BRP6G.

The bioaccumulation factor of 1000 reported for cobalt is based on a study with freshwater fish (ATSDR, 1992). Uptake of cobalt from soil by plants has been reported; however, the translocation of cobalt from the roots to above-ground parts of the plants is not significant in most soils (ATSDR, 1992). Also, there is little biomagnification of cobalt in higher-trophic-level animals (ATSDR, 1992), and cobalt is an essential nutrient of animals. Consequently, cobalt in soil at this area is not considered to pose a risk to terrestrial receptors.

The bioaccumulation factor reported for manganese (40,000) is based on a study of invertebrates (ATSDR, 1992). However, studies indicate that manganese is bioconcentrated primarily in lower trophic levels and biomagnification of manganese does not appear to be significant (ATSDR, 1992). Therefore, manganese in soil is not considered to pose significant risk to terrestrial receptors based on its potential to bioaccumulate.

The BCF of 350 for arsenic was recorded in a marine invertebrate; higher aquatic organisms do not tend to bioconcentrate arsenic (ATSDR, 1991). Eisler (1988) reports that arsenic is bioconcentrated but is not biomagnified in the food chain. Therefore, arsenic at the levels detected in soil is not considered to pose risk to assessment endpoints (terrestrial receptors). In addition, the presence of arsenic is not unusual since arsenic is a naturally occurring compound in the earth's crust and is a major component of insecticides, herbicides, and algicides (ATSDR, 1991). Prior to construction of SRS, this area was farmed, primarily for corn and cotton. Common pesticides used at that time included lead arsenate, lead arsenite, and copper acetoarsenite. Thus, arsenic in the BRP6G soils may not be unit-related.

The BCF for mercury is conservatively based on methylmercury, the most toxic and bioaccumulative form. The actual speciation of mercury in the BRP6G soils is unknown. Although mercury is known to bioaccumulate and to biomagnify in aquatic food chains, its bioaccumulation/biomagnification potential in terrestrial food chains appears to be small (ATSDR, 1992). Accordingly, mercury in BRP6G soils is estimated to pose minimal risk to the assessment endpoint.

Cadmium is known to bioconcentrate in all levels of the food chain (ATSDR, 1993). Bioaccumulation has been reported in aquatic invertebrates, fish, grasses, food crops, earthworms, poultry, cattle, horses, and wildlife. However, since cadmium accumulates in the liver and kidneys of vertebrates and not in muscle tissue, biomagnification may be insignificant (ATSDR, 1993). Although biomagnification is uncertain, the known potential to bioconcentrate combined with a HQ of 0.97 (Table 6.30) suggests the potential for risk to the assessment endpoint.

Iron is an essential nutrient of low toxicity. It is homeostatically maintained in organisms at levels greater than background. Thus, iron is not expected to pose risk to the assessment endpoint.

Other inorganics exceeding the BCF benchmark value of 300 are potassium and zinc. Both are essential nutrients whose levels are homeostatically controlled by organisms, both are very low in toxicity, and neither biomagnify (ATSDR, 1992). Therefore, potassium and zinc do not pose risk to terrestrial receptors at this unit.

6.3.6.2 Uncertainties

Ecological risk assessment is a complex process, which relies on many assumptions regarding exposure and the effects of exposure. These assumptions result in unquantifiable uncertainties, which may contribute to an overestimation or underestimation of risk. The major sources of uncertainties are described below.

- Data on factors affecting exposure rates are insufficient and often unavailable and, therefore, assumptions were made regarding the level of exposure to ecological receptors. In this assessment, conservative assumptions were made that a meadow vole would consume 100% of its diet from soil in the area of highest contamination, incidental soil ingestion would occur at 2.4 percent of the daily food ingestion rate, and that 100% of the ingested chemicals in soil and 55% of the ingested chemicals in plants (based on the percent digestibility of the diet provided in U.S. EPA, 1993) would be absorbed through the GI tract. These conservative assumptions may lead to an overestimation of risk.

- Receptor-specific data for exposure effects is lacking. This necessitated the extrapolation of toxic effect data from laboratory studies of mice, rats, and other laboratory animals to ecological receptors at the BRP6G. This may lead to an over- or underestimation of risk, for the following reasons:

  - Toxicity values generated by laboratory studies may involve less than lifetime exposures.

  - Laboratory studies typically expose animals to a single chemical by a single route. Animals living in a contaminated environment may simultaneously contact multiple chemicals by several routes of exposure.

  - For practical purposes, laboratory animals are exposed to much higher doses and/or exposure concentrations than animals in the wild. Exposure concentration can have significant effects on biotransformation and the ultimate expression of toxicity. In other words, it is important to recognize that the dose-response (stress-response) relationship for any given chemical may not be linear in all regions of the curve.

  - Responses to the same dose of chemical are not necessarily comparable between different species or even different strains of the same species. Wild populations are inherently more genetically diverse than lab animals, making comparisons even more difficult.

- In the laboratory, chemicals are often administered in a very bioavailable forum to maximize uptake by the organism. In nature, chemicals are likely to be less bioavailable. This may over-estimate risk.
- In nature, ecological receptors may experience continuous, long-term exposure to relatively low concentrations of contaminants, whereas many lab studies focus on short-term, relatively high concentrations or high dose exposures. This may lead to an underestimation of risk.
- The effects of chemical interactions on toxicity are not known. It is assumed that toxic chemicals have an additive effect, but some chemicals may magnify toxic effects by acting synergistically, while other chemicals may interact to negate toxic effects. Risk may be over- or underestimated, depending on the chemical interactions involved.
- Due to the mobility of animals within home ranges and migration routes, the exposure to contamination can vary among species and individuals. Assuming continuous exposure may lead to an overestimation of risk.
- Data on toxicological effects for plants (primary producers) are unavailable; therefore, a qualitative assessment of impacts to plants had to be based on overt evidence of stress. Slight underestimation of risk may result.
- Since information on the chemical sensitivities of most biota is unavailable, it cannot be determined if risks were assessed to be protective of the most sensitive species potentially present at the site. If species at the site are more sensitive to contaminants than standard laboratory animals, risks may be underestimated.

- Trophic effects may occur as chemical stressors are transferred up the ecological food-chain. A lack of data on bioconcentration factors (BCFs) and bioaccumulation factors (BAFs) for terrestrial animals, as well as on site-specific food-webs, precludes precise estimation of upper trophic-level effects. Highly conservative assumptions for lower trophic-level ecological receptors were used to be protective of secondary and tertiary consumers.

6.3.6.3 Risk Description

The results of the risk estimation step indicated that, of the COPCs identified in soil at the unit, copper and lead have a potential to pose risk to assessment endpoints based on their toxicity at the exposure point concentrations detected in surface and subsurface soil. In addition, cadmium and PCB-1254 were estimated to pose risk to assessment endpoints at the BRP6G due to their potential for bioaccumulation or biomagnification. Although lead and copper exceeded an HQ of 1, the toxicity information used to derive the benchmarks was based on conservative laboratory studies where highly bioavailable forms of these metals were administered to the test organism. In the lead study, lead acetate was administered via water (ATSDR, 1993) and in the copper study, copper gluconate was also administered via water (ATSDR, 1990). The administered forms of these metals, lead acetate and copper gluconate, are likely to be much more bioavailable than the forms which generally exist in soils.

Lead in soils exists primarily as insoluble precipitates, stable organic-metal complexes with soil organic matter, or bound in the crystalline matrices of soils and rocks. The transport of these species is limited, except under highly acidic conditions (ATSDR, 1993). Copper binds strongly to soils and is less affected by pH than other metals. Complexation with soil organic matter or association with other metal precipitates typically would account for a large portion of the copper in soil (ATSDR, 1990). These forms of lead and copper would result in much lower bioavailability of these metals and would serve to minimize potential risk to the ecological receptors at the unit.

PCB-1254 and cadmium have BCFs greater than the benchmark level of 300; however, neither has a HQ greater than one. The HQ less than one indicates no risk to the proximate assessment endpoint from exposure to concentrations present in soil. PCB-1254 tissue concentrations would have to bioaccumulate/biomagnify by several orders of magnitude to present a possible risk to receptors, which is unlikely. The BCF for cadmium (326) is only slightly greater than the benchmark of 300. Since this value is based on limited laboratory data and the calculated HQ is below one, the potential risk to ecological receptors is considered low.

Furthermore, in interpreting the ecological significance of these findings, it is necessary to consider that the unit has been highly impacted physically by past human activities, it supports only sparse vegetation, and it provides minimal habitat for voles or other wildlife. The potential for toxic effects among members of the very limited, on-unit populations of small mammals does not translate into significant ecological risk to more significant endpoints, such as the biodiversity of the ecological community encompassing the unit. Therefore, the COPCs detected in surface and subsurface soils do not pose significant risk to the assessment endpoints, and no COPCs are designated as ecological COCs.

6.4 ASCAD Summary

As discussed in earlier sections of this report, the BRP6G waste unit is part of the ASCAD grouping of burning rubble pits. Because the disposal histories are similar, the BRAs for this ASCAD grouping will be similar in the types and the levels of contaminants found in the media, resulting in similar risks to the receptors. Potential differences may occur due to the location of a particular waste unit. For example, the conceptual site models may vary based on potential exposure pathways involving surface water contamination. Human and ecological exposures could occur at BRPs that lie near streams or rivers.

FIGURES

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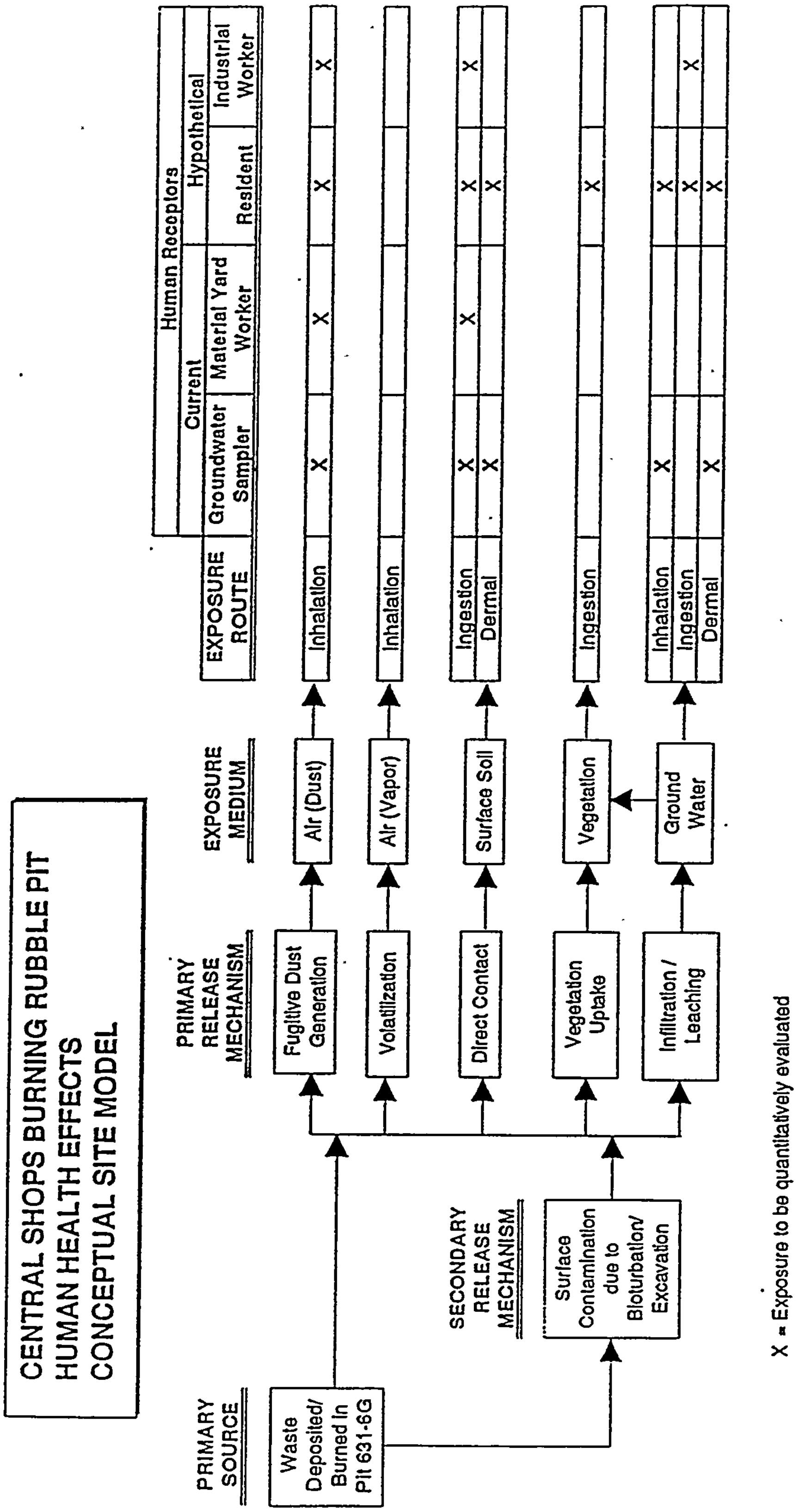

EXPOSURE ROUTE	Human Receptors			
	Current		Hypothetical	
	Groundwater Sampler	Material Yard Worker	Resident	Industrial Worker
Inhalation	X	X	X	X
Inhalation				
Ingestion	X	X	X	X
Dermal	X		X	
Ingestion			X	
Inhalation	X		X	
Ingestion			X	X
Dermal	X		X	

Figure 6-1 Human Health Conceptual Site Model

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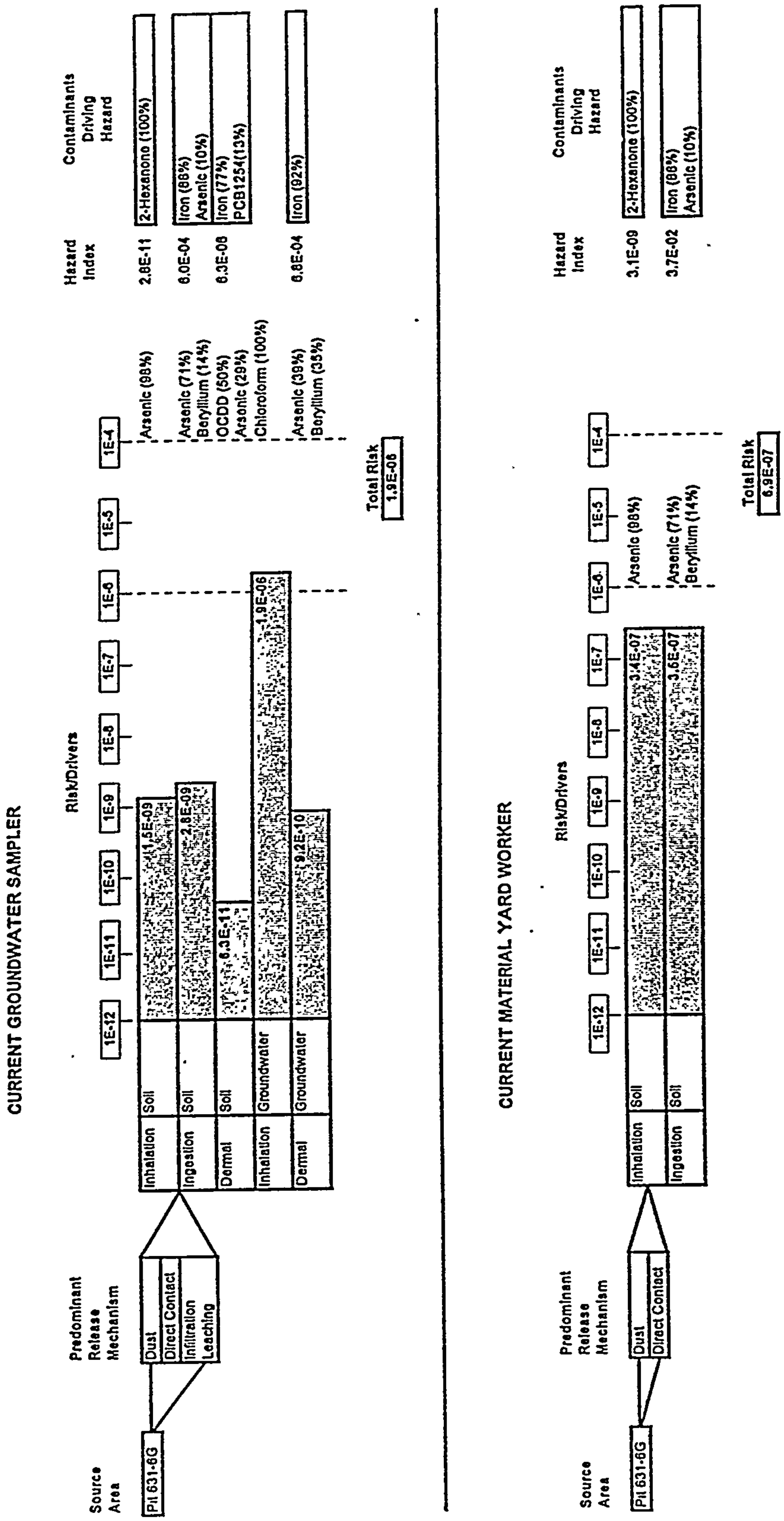

Figure 6-2 Current Groundwater Sampler; Current Material Yard Worker

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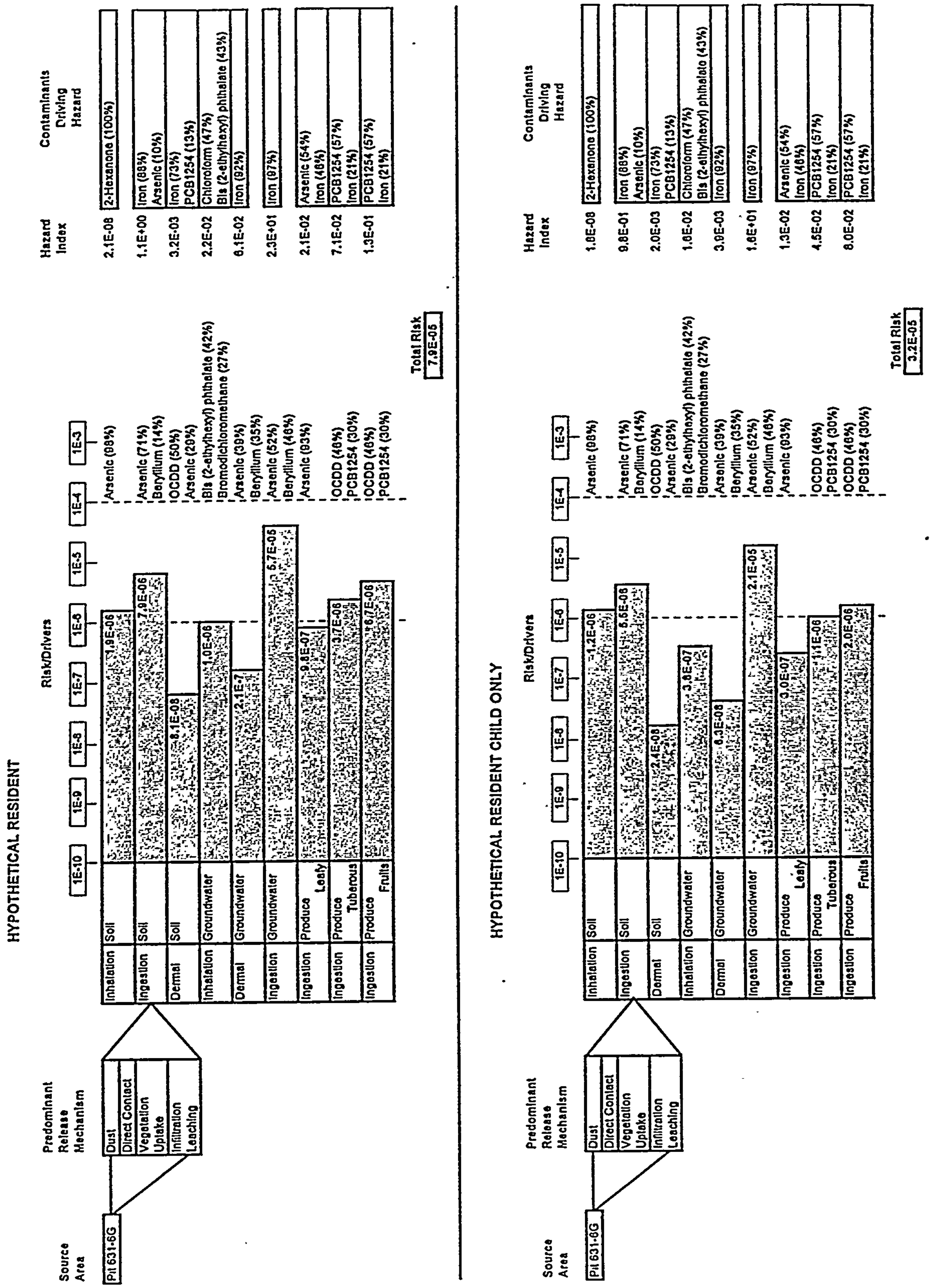

Figure 6-3 Hypothetical Resident; Hypothetical Resident Child Only

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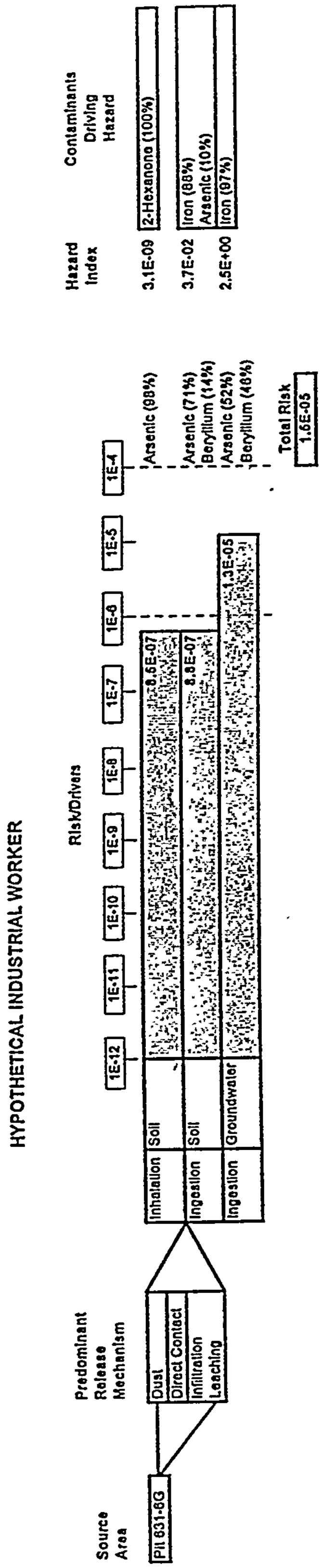

Figure 6-4 Hypothetical Industrial Worker

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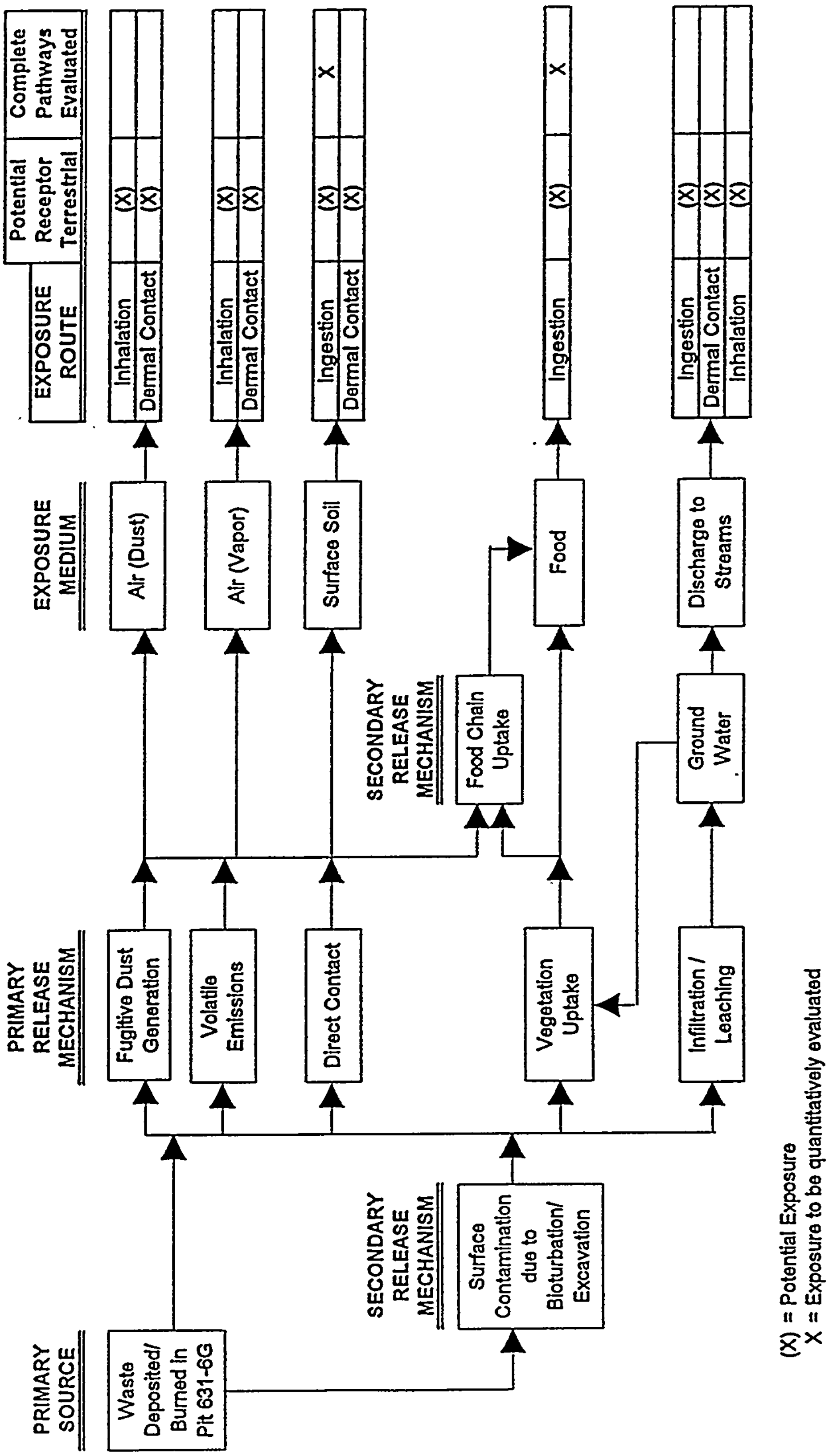

Figure 6-5 Central Shops Burning Rubble Pit Ecological Conceptual Site Model

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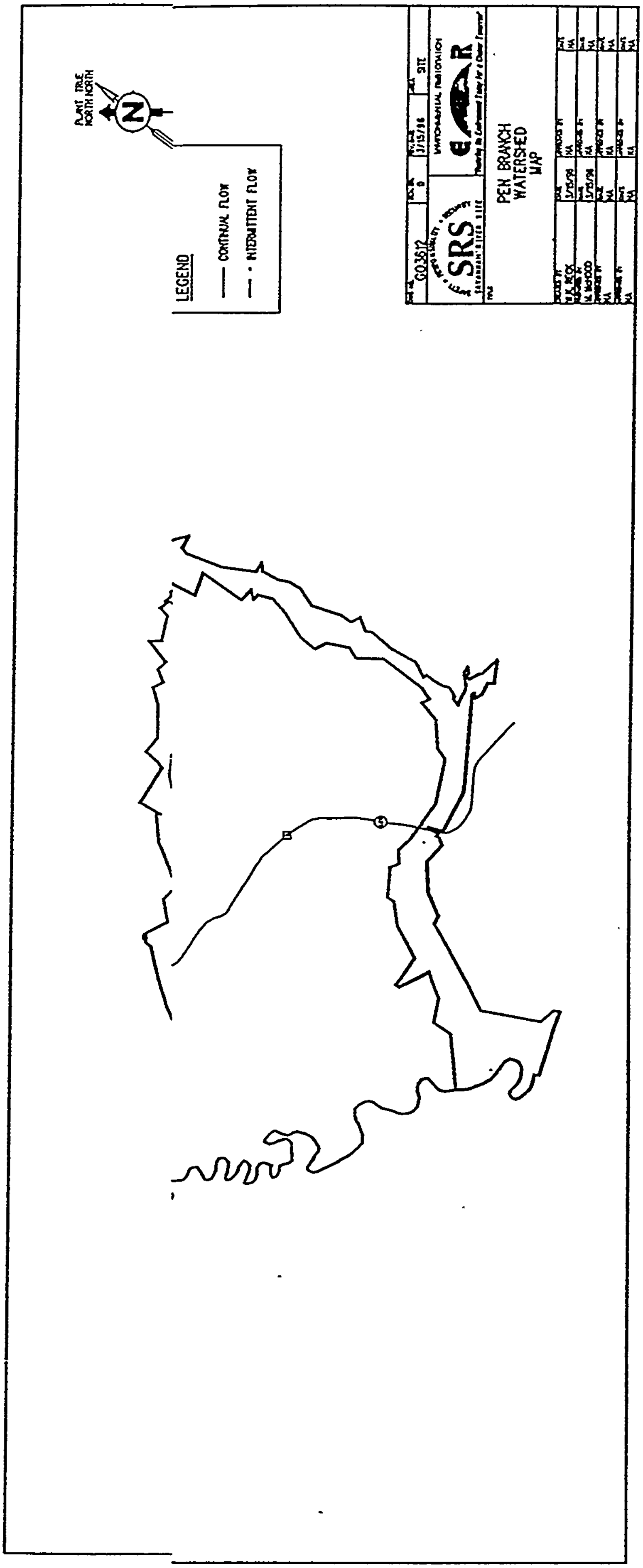

Figure 6-6 Pen Branch Water Shed Map

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TABLES

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Table 6.1 - Sample Grouping

Media of Concern / Exposure Group	Sub-group	Sub-group Number	Depth (feet)	Sample ID/ Well ID
Groundwater (includes wells installed during characterization and the 4 most recent sampling events of existing wells)	Potentially impacted (Downgradient and Sidegradient)	1		
			NA	CBR-2D
			NA	CBR-3D
			NA	CBR-4
			NA	CBR-5
			NA	CBR-6
	Background CBR-1 (Upgradient)	2		
			NA	CBR-1D
Surface Soil	Potentially impacted	3		
			0 - 2	CS6G-01
			0 - 2	CS6G-02
			0 - 2	CS6G-03
			0 - 2	CS6G-04
			0 - 2	CS6G-05
			0 - 2	CS6G-06
			0 - 2	CS6G-07
			0 - 2	CS6G-08
			0 - 2	CS6G-09
			0 - 2	CS6G-11
			0 - 2	CS6G-12
			0 - 2	CS6G-13
			0 - 2	CS6G-14
			0 - 2	CS6G-15
			0 - 2	CS6G-16
			0 - 2	CS6G-17
			0 - 2	CS6G-22
	Background	4		
			0 - 2	CS6G-10
			0 - 2	CS6G-18
			0 - 2	CS6G-19
			0 - 2	CS6G-20
			0 - 2	CS6G-21

Table 6.1 - Sample Grouping (continued)

Media of Concern / Exposure Group	Sub-group	Sub-group Number	Depth (feet)	Sample ID/ Well ID
Excavation / Burrowing Animal Soil	Potentially impacted	5		
			0 - 5	CS6G-01
			0 - 5	CS6G-02
			0 - 5	CS6G-03
			0 - 5	CS6G-04
			0 - 5	CS6G-05
			0 - 5	CS6G-06
			0 - 5	CS6G-07
			0 - 5	CS6G-08
			0 - 5	CS6G-09
			0 - 5	CS6G-11
			0 - 5	CS6G-12
			0 - 5	CS6G-13
			0 - 5	CS6G-14
			0 - 5	CS6G-15
			0 - 5	CS6G-16
			0 - 5	CS6G-17
			0 - 5	CS6G-22
	Background	6		
			0 - 5	CS6G-10
			0 - 5	CS6G-18
			0 - 5	CS6G-19
			0 - 5	CS6G-20
			0 - 5	CS6G-21

Table 6.2 - Eliminated Analytes with Maximum Less Than 2 Times Background

Central Shops Burning/Rubble Pit 631-6G

Analyte	Units	Maximum	# Hits	Total # Samples	Average Background	2X Background	Exposure Group	RBC
Aluminum	mg/kg	17700	25	25	12175.56	24351.12	0-2 ft	78000
Aluminum	mg/kg	21300	37	37	14357.14	28714.28	0-5 ft	78000
Beryllium	mg/kg	0.23	25	25	0.16	0.32	0-2 ft	0.15
Cobalt	µg/L	2.25	12	15	1.4	2.8	Groundwater	2200
Copper	µg/L	26.3	14	15	48.73	97.46	Groundwater	1400
Nickel	µg/L	3.08	8	15	2.6	5.2	Groundwater	730
Potassium	µg/L	1830	24	27	1238.33	2476.66	Groundwater	
Zinc	µg/L	51.2	15	15	51.23	102.46	Groundwater	11000

Table 6.3 - Eliminated Analytes with Low Frequency of Detection

Central Shops Burning/Rubble Pit 631-6G

Analyte	Units	Maximum	# Hits	Total # Samples	Average Background	Exposure Group	Frequency of Detect, %	RBC
Chloromethane (Methylchloride)	µg/L	5.31	2	27	Not Detected	Groundwater	7.4	1.4
2-Methyl-4,6-dinitrophenol	µg/L	1.34	1	15	Not Detected	Groundwater	6.7	

Table 6.4 - Radiological Analytes Not Considered in Risk Assessment

Central Shops Burning/Rubble Pit 631-6G

Analyte	Units	UL95	Maximum	# Hits	Total # Samples	Average Background	Exposure Group
Grossalpha	pCi/L	1.223	6.1	9	22	0.56	Groundwater
Grossalpha	pCi/g	14.39	24.3	22	22	13.27	0-2 ft
Grossalpha	pCi/g	14.827	26.7	32	32	15.81	0-5 ft
Nonvolatilebeta	pCi/L	4.139	12.2	15	22	1.6	Groundwater
Nonvolatilebeta	pCi/g	22.023	715	21	24	7	0-2 ft
Nonvolatilebeta	pCi/g	14.934	715	31	35	8.32	0-5 ft
Radium, total alpha-emitting	pCi/L	0.58	0.8	4	8	0.39	Groundwater
Radium-226	pCi/L	0.429	0.42	4	4	No Data	Groundwater
Radium-228	pCi/L	0.817	0.3	1	4	No Data	Groundwater
Tritium	pCi/L	26600.15	12100	27	27	4.85	Groundwater

Table 6.5 - Ecological Chemicals of Potential Concern for Surface Soils at Central Shops Burning/Rubble Pit 631-6G

Analyte	Units	Exposure Conc.	Number of Detects	Number of Observations	Frequency of Detection %	Average Background Conc.	Screening Background Conc.
2-Hexanone	mg/kg	2.28E-04	1	7	14.3	ND	ND
2-Methylnaphthalene	mg/kg	2.68E-03	2	16	12.5	ND	ND
4-Chloro-m-cresol	mg/kg	2.16E-03	1	9	11.1	ND	ND
4-Chlorophenyl phenyl ether	mg/kg	1.21E-03	1	16	6.3	ND	ND
Acetone	mg/kg	3.08E-02	21	21	100.0	1.68E+01	3.35E+01
Antimony	mg/kg	1.66E+00	3	25	12.0	1.57E+00	3.14E+00
Arsenic	mg/kg	1.97E+00	4	25	16.0	ND	ND
Barium	mg/kg	3.44E+01	25	25	100.0	2.67E+01	5.34E+01
Benzene	mg/kg	5.98E-04	12	25	48.0	2.00E-02	4.00E-02
Benzo (b)fluoranthene	mg/kg	4.05E-03	3	25	12.0	ND	ND
Benzo (k)fluoranthene	mg/kg	2.67E-03	2	25	8.0	ND	ND
Benzoic acid	mg/kg	1.65E-02	7	25	28.0	1.44E+01	2.88E+01
Bis (2-ethylhexyl)phthalate	mg/kg	6.84E-03	1	17	5.9	ND	ND
Calcium	mg/kg	4.56E+02	25	25	100.0	2.28E+02	4.57E+02
Carbondisulfide	mg/kg	1.97E-04	4	25	16.0	ND	ND
Chloroform	mg/kg	4.16E-03	15	23	65.2	2.50E-01	5.00E-01
Chromium	mg/kg	2.58E+01	25	25	100.0	1.45E+01	2.89E+01
Cobalt	mg/kg	1.17E+00	24	25	96.0	7.80E-01	1.56E+00
Copper	mg/kg	6.87E+02	25	25	100.0	4.22E+01	8.43E+01
Cyanide	mg/kg	1.49E-01	3	15	20.0	ND	ND
Di-n-butyl-phthalate	mg/kg	4.92E-03	1	1	100.0	ND	ND
Dibenzofuran	mg/kg	1.12E-03	1	15	6.7	ND	ND
Dichloromethane	mg/kg	6.34E-04	6	17	35.3	ND	ND
Dieldrin	mg/kg	1.11E-03	4	25	16.0	9.70E-01	1.94E+00
Diethylphthalate	mg/kg	2.27E-02	5	11	45.5	ND	ND
Ethylbenzene	mg/kg	6.60E-05	4	22	18.2	ND	ND
Fluoranthene	mg/kg	7.50E-03	7	20	35.0	7.20E-01	1.44E+00
Indeno (1,2,3-c,d)pyrene	mg/kg	2.03E-03	2	25	8.0	ND	ND
Iron	mg/kg	1.43E+04	25	25	100.0	1.35E+04	2.70E+04
Lead	mg/kg	2.79E+01	25	25	100.0	9.47E+00	1.89E+01
Magnesium	mg/kg	1.66E+02	25	25	100.0	1.57E+02	3.13E+02
Manganese	mg/kg	8.58E+01	25	25	100.0	3.26E+01	6.52E+01
Mercury	mg/kg	2.18E-02	5	22	22.7	2.89E+01	5.78E+01
Methyl ethyl ketone	mg/kg	1.95E-04	2	7	28.6	ND	ND
Nickel	mg/kg	1.46E+01	24	25	96.0	2.48E+00	4.96E+00
OCDD	mg/kg	1.36E-03	8	25	32.0	3.30E-01	6.60E-01
p,p'-DDE	mg/kg	1.85E-03	9	25	36.0	8.40E-01	1.68E+00
p,p'-DDT	mg/kg	1.54E-03	2	25	8.0	1.64E-00	3.28E+00
PCB1254	mg/kg	2.30E-02	2	25	8.0	ND	ND
Potassium	mg/kg	1.11E+02	23	25	92.0	1.20E+02	2.40E+02
Pyrene	mg/kg	9.24E-03	8	20	40.0	6.48E-00	1.30E+01
Selenium	mg/kg	2.60E+00	2	25	8.0	2.05E+00	4.10E+00
Silver	mg/kg	3.79E-01	3	25	12.0	6.10E-01	1.22E+00
Sodium	mg/kg	8.84E+00	3	25	12.0	7.80E-00	1.56E+01
Tetrachloroethylene	mg/kg	3.30E-05	2	25	8.0	ND	ND
Thallium	mg/kg	2.35E+00	4	20	20.0	1.90E-00	3.80E+00
Toluene	mg/kg	4.11E-03	4	4	100.0	ND	ND
Trichloroethylene	mg/kg	4.90E-05	2	25	8.0	1.00E-02	2.00E-02
Vanadium	mg/kg	3.73E+01	25	25	100.0	3.32E-01	6.63E+01
Xylenes	mg/kg	6.15E-04	13	23	56.5	5.00E-02	1.00E-01
Zinc	mg/kg	4.45E+01	25	25	100.0	7.82E+00	1.56E+01

ND - No Data

Table 6.6 - Ecological Chemicals of Potential Concern for Shallow Subsurface Soil at Central Shops Burning/Rubble Pit 631-6G

Analyte	Units	RME Exposure Conc.	Number of Detects	Number of Observations	Frequency of Detection %	Average Background Conc.	Screening Background Conc.
2-Hexanone	mg/kg	1.94E-04	1	9	11.1	ND	ND
2-Methylnaphthalene	mg/kg	2.34E-03	3	24	12.5	ND	ND
4-Chloro-m-cresol	mg/kg	1.32E-03	1	13	7.7	ND	ND
Acetone	mg/kg	2.83E-02	33	33	100.0	1.47E+01	2.94E+01
Antimony	mg/kg	1.65E+00	5	37	13.5	1.86E+00	3.72E+00
Arsenic	mg/kg	2.38E+00	7	37	18.9	1.15E+00	2.30E+00
Barium	mg/kg	3.85E+01	37	37	100.0	2.33E+01	4.66E+01
Benzene	mg/kg	2.65E-03	19	37	51.4	4.00E-02	8.00E-02
Benzo (b)fluoranthene	mg/kg	2.88E-03	3	37	8.1	ND	ND
Benzo (k)fluoranthene	mg/kg	1.97E-03	2	37	5.4	ND	ND
Benzoic acid	mg/kg	1.37E-02	8	37	21.6	1.02E+01	2.03E+01
Beryllium	mg/kg	1.61E-01	37	37	100.0	1.50E-01	3.00E-01
Cadmium	mg/kg	3.25E-01	3	37	8.1	1.60E-01	3.20E-01
Calcium	mg/kg	7.21E+02	37	37	100.0	2.36E+02	4.72E+02
Carbon disulfide	mg/kg	1.72E-04	6	37	16.2	1.30E-01	2.60E-01
Chloroform	mg/kg	4.61E-03	22	35	62.9	3.10E-01	6.20E-01
Chromium	mg/kg	2.44E+01	37	37	100.0	1.79E+01	3.57E+01
Cobalt	mg/kg	1.10E+00	36	37	97.3	7.70E-01	1.54E+00
Copper	mg/kg	3.22E+02	37	37	100.0	2.21E+01	4.41E+01
Cyanide	mg/kg	1.11E-01	3	21	14.3	ND	ND
Di-n-butyl-phthalate	mg/kg	4.92E-03	1	1	100.0	ND	ND
Dibenzofuran	mg/kg	1.74E-03	2	23	8.7	ND	ND
Dichloromethane	mg/kg	8.15E-04	11	24	45.8	ND	ND
Dieldrin	mg/kg	9.21E-04	5	37	13.5	8.00E-01	1.60E+00
Diethylphthalate	mg/kg	1.31E-02	8	17	47.1	ND	ND
Ethylbenzene	mg/kg	8.50E-05	8	34	23.5	1.00E-02	2.00E-02
Fluoranthene	mg/kg	5.94E-03	8	30	26.7	5.60E-01	1.12E+00
Indeno (1,2,3-c,d)pyrene	mg/kg	1.51E-03	2	37	5.4	ND	ND
Iron	mg/kg	2.02E+04	37	37	100.0	1.71E+04	3.43E+04
Lead	mg/kg	2.73E+01	37	37	100.0	8.97E+00	1.79E+01
Magnesium	mg/kg	2.10E+02	37	37	100.0	1.69E+02	3.39E+02
Manganese	mg/kg	1.03E+02	37	37	100.0	2.31E+01	4.61E+01
Mercury	mg/kg	2.80E-02	10	34	29.4	2.99E+01	5.99E+01
Methoxychlor	mg/kg	5.36E-03	2	37	5.4	ND	ND
Methyl ethyl ketone	mg/kg	1.39E-03	4	9	44.4	ND	ND
Nickel	mg/kg	1.09E+01	36	37	97.3	2.59E+00	5.18E+00
OCDD	mg/kg	4.06E-03	14	37	37.8	9.60E-01	1.92E+00
p,p'-DDE	mg/kg	1.92E-03	12	37	32.4	7.20E-01	1.44E+00
p,p'-DDT	mg/kg	1.36E-03	2	37	5.4	1.41E+00	2.82E+00
PCB1254	mg/kg	1.93E-02	2	37	5.4	ND	ND
Potassium	mg/kg	1.31E+02	35	37	94.6	1.20E+02	2.40E+02
Pyrene	mg/kg	7.72E-03	11	30	36.7	4.44E+00	8.88E+00
Selenium	mg/kg	3.62E+00	8	37	21.6	2.72E+00	5.44E+00
Silver	mg/kg	5.02E-01	5	37	13.5	6.30E-01	1.26E+00
Sodium	mg/kg	2.53E+01	4	37	10.8	7.41E+00	1.48E+01
Tetrachloroethylene	mg/kg	2.70E-05	2	37	5.4	3.00E-02	6.00E-02
Thallium	mg/kg	2.16E+00	4	29	13.8	1.86E+00	3.72E+00
Toluene	mg/kg	4.45E-03	6	6	100.0	ND	ND
Trichloroethylene	mg/kg	3.60E-05	2	37	5.4	1.00E-02	2.00E-02
Vanadium	mg/kg	4.30E+01	37	37	100.0	4.12E+01	8.24E+01
Xylenes	mg/kg	6.92E-04	21	35	60.0	4.00E-02	8.00E-02
Zinc	mg/kg	5.00E+01	37	37	100.0	6.57E+00	1.31E+01

ND - No data

Table 6.7 - Eliminated Essential Nutrients with Maximum Less Than Recommended Daily Allowance or Safe and Adequate Daily Intake

Central Shops Burning/Rubble Pit 631-6G

Analyte	Units	UL 95	Maximum	# Hits	Total # Samples	Average Background	Exposure Group	Ingested (mg/day)	RDA (mg/day)	Safe & Allow. Intake (mg/day)
Calcium	µg/L	1306.674	4090	25	27	613	Groundwater	7.8438	800-1200	NA
Calcium	mg/kg	456.156	1980	25	25	228.3	0-2 ft	0.3797	800-1200	NA
Calcium	mg/kg	720.831	19400	37	37	235.92	0-5 ft	3.7205	800-1200	NA
Chloride	µg/L	3198.834	4590	21	21	2118.33	Groundwater	8.8027	1100-3300	NA
Magnesium	µg/L	733.63	1280	25	27	298.33	Groundwater	2.4548	280-400	NA
Magnesium	mg/kg	165.688	329	25	25	156.65	0-2 ft	0.0631	280-400	NA
Magnesium	mg/kg	209.763	2430	37	37	169.38	0-5 ft	0.4660	280-400	NA
Manganese	µg/L	38.346	297	22	27	8.21	Groundwater	0.5696	NA	2-5
Manganese	mg/kg	102.848	681	37	37	23.07	0-5 ft	0.1306	NA	2-5
Potassium	mg/kg	110.561	250	23	25	120.04	0-2 ft	0.0479	NA	1875-5625
Potassium	mg/kg	130.652	851	35	37	120.13	0-5 ft	0.1632	NA	1875-5625
Sodium	µg/L	3971.231	9740	27	27	3050	Groundwater	18.6795	NA	1100-3300
Sodium	mg/kg	8.839	36.8	3	25	7.8	0-2 ft	0.0071	NA	1100-3300
Sodium	mg/kg	25.264	274	4	37	7.41	0-5 ft	0.05254795	NA	1100-3300

Ingested dose calculated from ingestion of 200 mg soil or 2 L of water and using maximum detect.

<u>Ingestion of soil</u>

$$\text{Ingested (mg/day)} = \frac{CS*IR*FI*ET*EF*ED*CF}{AT*AD}$$

<u>Ingestion of groundwater</u>

$$\text{Ingested (mg/day)} = \frac{CW*IR*EF*ED*CF}{AT*AD}$$

Table 6.8 - Eliminated Analytes with Maximum Less Than Risk Based Concentration

Central Shops Burning/Rubble Pit 631-6G

Analyte	Units	Maximum	# Hits	Total # Samples	Average Background	Exposure Group	RBC
1,1,2,2-Tetrachloroethane	mg/kg	0.00005	1	25	Not Detected	0-2 ft	25
1,1,2,2-Tetrachloroethane	mg/kg	0.00005	1	37	Not Detected	0-5 ft	25
1,2,4-Trichlorobenzene	µg/L	0.12	1	15	Not Detected	Groundwater	190
1,2-Dichloroethylene	µg/L	2	2	17	Not Detected	Groundwater	61
1,4-Dichlorobenzene	mg/kg	0.034	1	24	Not Detected	0-5 ft	27
2-Chlorophenol	µg/L	0.13	2	15	0.04	Groundwater	180
Acetone	µg/L	4.05	1	15	Not Detected	Groundwater	3700
Acetone	mg/kg	0.0625	21	21	0.01675	0-2 ft	7800
Acetone	mg/kg	0.0625	33	33	0.01469	0-5 ft	78000
Antimony	mg/kg	4.16	3	25	1.57	0-2 ft	31
Antimony	mg/kg	4.16	5	37	1.86	0-5 ft	31
Barium	µg/L	53.1	27	27	22.71	Groundwater	2600
Barium	mg/kg	97.4	25	25	26.68	0-2 ft	5500
Barium	mg/kg	290	37	37	23.28	0-5 ft	5500
Benzene	mg/kg	0.00265	12	25	0.00002	0-2 ft	22
Benzene	mg/kg	0.00265	19	37	0.00004	0-5 ft	22
Benzene	µg/L	0.07	1	27	Not Detected	Groundwater	0.36
Benzo (a)pyrene	mg/kg	0.00954	1	25	Not Detected	0-2 ft	0.088
Benzo (a)pyrene	mg/kg	0.00954	1	37	Not Detected	0-5 ft	0.088
Benzo (b)fluoranthene	mg/kg	0.0271	3	25	Not Detected	0-2 ft	0.88
Benzo (b)fluoranthene	mg/kg	0.0271	3	37	Not Detected	0-5 ft	0.88
Benzo (k)fluoranthene	mg/kg	0.0185	2	25	Not Detected	0-2 ft	8.8
Benzo (k)fluoranthene	mg/kg	0.0185	2	37	Not Detected	0-5 ft	8.8
Benzoicacid	mg/kg	0.0579	7	25	0.01439	0-2 ft	310000
Benzoicacid	mg/kg	0.0579	8	37	0.01015	0-5 ft	310000
Benzylalcohol	µg/L	0.36	2	15	Not Detected	Groundwater	11000
Bis (2-ethylhexyl)phthalate	mg/kg	0.0781	1	17	Not Detected	0-2 ft	46
Bis (2-ethylhexyl)phthalate	mg/kg	0.0781	1	25	Not Detected	0-5 ft	46
Butylbenzyl phthalate	µg/L	0.33	1	13	Not Detected	Groundwater	7300
Cadmium	mg/kg	2.87	3	37	0.16	0-5 ft	39
Cadmium	mg/kg	0.5	1	25	0.15	0-2 ft	39
Cadmium	µg/L	4.07	1	25	Not Detected	Groundwater	18
Carbondisulfide	µg/L	11.8	4	15	Not Detected	Groundwater	21
Carbondisulfide	mg/kg	0.00074	4	25	Not Detected	0-2 ft	7800
Carbondisulfide	mg/kg	0.00074	6	37	0.00013	0-5 ft	7800
Chloroform	mg/kg	0.00416	15	23	0.00025	0-2 ft	100
Chloroform	mg/kg	0.00461	22	35	0.00031	0-5 ft	100
Chromium	µg/L	67	3	27	1.81	Groundwater	180
Chromium	mg/kg	108	25	25	14.46	0-2 ft	390
Chromium	mg/kg	108	37	37	17.85	0-5 ft	390
Cobalt	mg/kg	2.62	24	25	0.78	0-2 ft	4700
Cobalt	mg/kg	6.35	36	37	0.77	0-5 ft	4700
Copper	mg/kg	1380	25	25	42.17	0-2 ft	2900
Copper	mg/kg	1380	37	37	22.07	0-5 ft	2900
Cyanide	µg/L	0.81	1	11	0.81	Groundwater	730
Cyanide	mg/kg	0.703	3	15	Not Detected	0-2 ft	1600
Cyanide	mg/kg	0.703	3	21	Not Detected	0-5 ft	1600
Di-n-butylphthalate	µg/L	0.51	1	3	Not Detected	Groundwater	3700
Di-n-butylphthalate	mg/kg	0.0232	1	1	Not Detected	0-2 ft	7800
Di-n-butylphthalate	mg/kg	0.0232	1	1	Not Detected	0-5 ft	7800
Dibenzofuran	mg/kg	0.00372	1	15	Not Detected	0-2 ft	310
Dibenzofuran	mg/kg	0.00771	2	23	Not Detected	0-5 ft	310
Dichloromethane	µg/L	0.41	4	13	Not Detected	Groundwater	4.1
Dichloromethane	mg/kg	0.00215	6	17	Not Detected	0-2 ft	85

Table 6.8 - Eliminated Analytes with Maximum Less Than Risk Based Concentration

Central Shops Burning/Rubble Pit 631-6G (continued)

Analyte	Units	Maximum	# Hits	Total # Samples	Average Background	Exposure Group	RBC
Dichloromethane	mg/kg	0.00368	11	24	Not Detected	0-5 ft	85
Dieldrin	mg/kg	0.0048	4	25	0.00097	0-2 ft	0.04
Dieldrin	mg/kg	0.0048	5	37	0.0008	0-5 ft	0.04
Diethylphthalate	mg/kg	0.0227	5	11	Not Detected	0-2 ft	63000
Diethylphthalate	mg/kg	0.0227	8	17	Not Detected	0-5 ft	63000
Dimethylphthalate	mg/kg	0.00856	1	22	Not Detected	0-2 ft	780000
Dimethylphthalate	mg/kg	0.00856	1	32	Not Detected	0-5 ft	780000
Endosulfanl	mg/kg	0.00469	1	25	0.00053	0-2 ft	470
Endosulfanl	mg/kg	0.00469	1	37	0.00052	0-5 ft	470
Endrin	mg/kg	0.00315	1	25	Not Detected	0-2 ft	23
Endrin	mg/kg	0.00315	1	37	Not Detected	0-5 ft	23
Ethylbenzene	mg/kg	0.00025	4	22	Not Detected	0-2 ft	7800
Ethylbenzene	mg/kg	0.00039	8	34	0.00001	0-5 ft	7800
Ethylbenzene	µg/L	0.08	1	27	Not Detected	Groundwater	1300
Fluoranthene	mg/kg	0.028	7	20	0.00072	0-2 ft	3100
Fluoranthene	mg/kg	0.028	8	30	0.00056	0-5 ft	3100
Fluorene	µg/L	0.91	1	15	Not Detected	Groundwater	1500
Fluorene	mg/kg	0.00428	1	25	Not Detected	0-2 ft	3100
Fluorene	mg/kg	0.00428	1	37	Not Detected	0-5 ft	3100
Indeno (1,2,3-c,d)pyrene	mg/kg	0.00998	2	25	Not Detected	0-2 ft	0.88
Indeno (1,2,3-c,d)pyrene	mg/kg	0.00998	2	37	Not Detected	0-5 ft	0.88
Manganese	mg/kg	172	25	25	32.61	0-2 ft	390
Mercury	mg/kg	0.0746	5	22	0.02892	0-2 ft	23
Mercury	mg/kg	0.13	10	34	0.02994	0-5 ft	23
Mercury	µg/L	0.18	1	27	0.05	Groundwater	11
Methoxychlor	mg/kg	0.01	2	37	Not Detected	0-5 ft	390
Methoxychlor	mg/kg	0.00924	1	25	Not Detected	0-2 ft	390
Methylethylketone	mg/kg	0.00032	2	7	Not Detected	0-2 ft	47000
Methylethylketone	mg/kg	0.00307	4	9	Not Detected	0-5 ft	47000
Methylisobutylketone	mg/kg	0.00034	1	21	Not Detected	0-2 ft	6300
Methylisobutylketone	mg/kg	0.00034	1	31	Not Detected	0-5 ft	6300
N-Nitrosodiphenylamine	mg/kg	0.00464	1	25	Not Detected	0-2 ft	130
N-Nitrosodiphenylamine	mg/kg	0.00464	1	37	Not Detected	0-5 ft	130
Nickel	mg/kg	350	24	25	2.48	0-2 ft	1600
Nickel	mg/kg	350	36	37	2.59	0-5 ft	1600
p,p'-DDE	mg/kg	0.00577	9	25	0.00084	0-2 ft	1.9
p,p'-DDE	mg/kg	0.00909	12	37	0.00072	0-5 ft	1.9
p,p'-DDT	mg/kg	0.0055	2	25	0.00164	0-2 ft	1.9
p,p'-DDT	mg/kg	0.0055	2	37	0.00141	0-5 ft	1.9
PCB1260	mg/kg	0.0312	1	25	Not Detected	0-2 ft	0.083
PCB1260	mg/kg	0.0312	1	37	Not Detected	0-5 ft	0.083
Phenols	µg/L	6.6	1	12	Not Detected	Groundwater	22000
Pyrene	µg/L	0.29	3	14	0.2	Groundwater	1100
Pyrene	mg/kg	0.0291	8	20	0.00648	0-2 ft	2300
Pyrene	mg/kg	0.0291	11	30	0.00444	0-5 ft	2300
Selenium	mg/kg	8.36	2	25	2.05	0-2 ft	390
Selenium	mg/kg	14.3	8	37	2.72	0-5 ft	390
Selenium	µg/L	1.31	1	24	Not Detected	Groundwater	180
Silver	mg/kg	1.81	3	25	0.61	0-2 ft	390
Silver	mg/kg	3.77	5	37	0.63	0-5 ft	390
Tetrachloroethylene	mg/kg	0.00015	2	25	Not Detected	0-2 ft	12
Tetrachloroethylene	mg/kg	0.00015	2	37	0.00003	0-5 ft	12
Tetrachloroethylene	µg/L	0.06	1	27	Not Detected	Groundwater	1.1
Thallium	mg/kg	4.4	4	20	1.9	0-2 ft	6.3

Table 6.8 - Eliminated Analytes with Maximum Less Than Risk Based Concentration

Central Shops Burning/Rubble Pit 631-6G (continued)

Analyte	Units	Maximum	# Hits	Total # Samples	Average Background	Exposure Group	RBC
Thallium	mg/kg	4.4	4	29	1.86	0-5 ft	6.3
Toluene	µg/L	0.17	7	22	0.18	Groundwater	750
Toluene	mg/kg	0.00411	4	4	Not Detected	0-2 ft	16000
Toluene	mg/kg	0.00591	6	6	Not Detected	0-5 ft	16000
Trichloroethylene	mg/kg	0.00026	2	25	0.00001	0-2 ft	58
Trichloroethylene	mg/kg	0.00026	2	37	0.00001	0-5 ft	58
Trichloroethylene	µg/L	0.06	1	27	Not Detected	Groundwater	1.6
Vanadium	µg/L	224	8	13	0.71	Groundwater	260
Vanadium	mg/kg	84.3	25	25	33.15	0-2 ft	550
Vanadium	mg/kg	102	37	37	41.18	0-5 ft	550
Xylenes	mg/kg	0.00397	13	23	0.00005	0-2 ft	160000
Xylenes	mg/kg	0.00397	21	35	0.00004	0-5 ft	160000
Zinc	mg/kg	281	25	25	7.82	0-2 ft	23000
Zinc	mg/kg	433	37	37	6.57	0-5 ft	23000

Table 6.9 - Eliminated Analytes with No Available Slope Factor or Reference Dose

Central Shops Burning/Rubble Pit 631-6G

Analyte	Units	Maximum	# Hits	Total # Samples	Average Background	Exposure Group
2-Methylnaphthalene	mg/kg	0.00927	2	16	Not Detected	0-2 ft
2-Methylnaphthalene	mg/kg	0.00927	3	24	Not Detected	0-5 ft
4-Chloro-m-cresol	mg/kg	0.00531	1	9	Not Detected	0-2 ft
4-Chloro-m-cresol	mg/kg	0.00531	1	13	Not Detected	0-5 ft
4-Chlorophenyl phenyl ether	mg/kg	0.00749	1	16	Not Detected	0-2 ft
4-Chlorophenyl phenyl ether	mg/kg	0.00749	1	24	Not Detected	0-5 ft
Acenaphthylene	mg/kg	0.0103	1	25	Not Detected	0-2 ft
Acenaphthylene	mg/kg	0.0103	1	37	Not Detected	0-5 ft
Lead	µg/L	89.1	12	25	20.97	Groundwater
Lead	mg/kg	120	25	25	9.47	0-2 ft
Lead	mg/kg	301	37	37	8.97	0-5 ft
Silica, total recoverable	µg/L	15700	12	12	11933.33	Groundwater
Sulfate	µg/L	9800	12	21	448.16	Groundwater

Table 6.10 - COPCs Used in the Calculation of Risk & Hazard

Central Shops Burning/Rubble Pit 631-6G

Analytes and COPCs in Groundwater

Analyte	Unit	Number of Detects	Total Number of Samples	Detection Limit Range for Undetects	Maximum Detected Concentration	UL 95	Exposure Concentration (a)	Average Concentration (Background)
Aluminum	µg/L	23	27	10-26	41400	4117.97	4117.97	118.65
Arsenic	µg/L	1	27	0.75-2.5	5.1	1.32	1.32	Not Detected
Beryllium	µg/L	9	12	0.17-1.5	0.41	0.46	0.41	0.16
Bis (2-ethylhexyl)phthalate	µg/L	4	13	0.13-0.5	6.11	2.10	2.10	Not Detected
Bromodichloromethane	µg/L	4	27	0.01-2.5	0.3	0.93	0.30	Not Detected
Chloroform	µg/L	9	27	0.01-2.5	1.15	3.70	1.15	0.36
Dibromochloromethane	µg/L	3	27	0.01-2.5	0.18	0.93	0.18	Not Detected
Iron	µg/L	.24	25	9.1	94900	73747.85	73747.85	427.6

Analytes and COPCs in Surface Soil (0-2 ft)

Analyte	Unit	Number of Detects	Total Number of Samples	Detection Limit Range for Undetects	Maximum Detected Concentration	UL 95	Exposure Concentration (a)	Average Concentration (Background)
2-Hexanone	mg/kg	1	7	0.1-0.12	0.00038	0.000228	0.000228	Not Detected
Anthracene	mg/kg	1	25	0.21-0.25	0.0146	0.000554	0.000554	Not Detected
Arsenic	mg/kg	4	25	0.74-0.9	7.92	1.97	1.97	Not Detected
Benzo (g,h,i)perylene	mg/kg	1	25	0.21-0.25	0.0219	0.000643	0.000643	Not Detected
Iron	mg/kg	25	25	No undetects	31400	14302.98	14302.98	13487.78
OCDD	mg/kg	8	25	0.05	0.00759	0.001358	0.001358	0.00033
PCB1254	mg/kg	2	25	10.6-12	0.115	0.02302	0.023023	Not Detected

Analytes and COPCs in Shallow Subsurface Soil (0-5 ft)

Analyte	Unit	Number of Detects	Total Number of Samples	Detection Limit Range for Undetects	Maximum Detected Concentration	UL 95	Exposure Concentration (a)	Average Concentration (Background)
2-Hexanone	mg/kg	1	9	0.1-0.12	0.00038	0.000194	0.000194	Not Detected
Anthracene	mg/kg	1	37	0.21-0.33	0.0146	0.000405	0.000405	Not Detected
Arsenic	mg/kg	7	37	0.74-1.24	9.22	2.379	2.379	1.15
Benzo (g,h,i)perylene	mg/kg	1	37	0.21-0.33	0.0219	0.000445	0.000445	Not Detected
Beryllium	mg/kg	37	37	No detects	0.37	0.161	0.161	0.15
Iron	mg/kg	37	37	No detects	49300	20218.560	20218.56	17127.86
OCDD	mg/kg	14	37	0.05-0.07	0.0194	0.004	0.004064	0.00096
PCB1254	mg/kg	2	37	10.6-16.6	0.115	0.01925	0.019254	Not Detected

(a) Exposure concentration is the lesser of the maximum detected and the UL 95.

Table 6.11 - Human Health Exposure Parameters

Exposure Scenario - A. Current Groundwater Sampler

Factors	Units	Soil	GW	Reference
Body Wt. (BW)	kg	70	70	1, 2
Exposure Duration (ED)	yr	5	5	assumed
Exposure Frequency (EF)	d/yr	4	4	assumed
Exposure Time (ET)	hr/d	4.5	4.5	assumed
Adherence Factor Soil to Skin (AF)	mg/cm^2	0.2 (sand)	NA	3, 4
Skin Surface Area Available For Contact (SA)	cm^2	2,320 see legend note [b]	2,320 see legend note [b]	3
Ingestion Rate (IR)	see legend note [a]	50	NA	2
Inhalation Rate (IR)	m^3/hr	2.5	2.5	2
Fraction Ingested from Contaminated Source (FI)	unitless	1.0	NA	assumed
Absorption Factor (ABS)	unitless	1% organics; 0.1% inorganics	NA	4
Dermal Permeability Constant (PC)	cm/hr	NA	Contaminant Specific	3

LEGEND

NA not applicable

a Ingestion rates for soil are expressed in mg/d; groundwater in 1/d.

b Head and forearms

REFERENCES:
(1) EPA, 1989c
(2) EPA, 1991a
(3) EPA, 1992b
(4) EPA, 1994b

Table 6.11 - Human Health Exposure Parameters (Continued)

Exposure Scenario - B. Current Material Yard Worker

Factors	Units	Soil	Reference
Body Wt. (BW)	kg	70	1, 2
Exposure Duration (ED)	yr	10	assumed
Exposure Frequency (EF)	d/yr	250	2
Exposure Time (ET)	hr/d	8	assumed
Adherence Factor Soil to Skin (AF)	mg/cm^2	NA	
Skin Surface Area Available For Contact (SA)	cm^2	NA	
Ingestion Rate (IR)	mg/d	50	2
Inhalation Rate (IR)	m^3/hr	2.5	2
Fraction Ingested from Contaminated Source (FI)	unitless	1.0	assumed
Absorption Factor (ABS)	unitless	NA	
Dermal Permeability Constant (PC)	cm/hr	NA	

LEGEND

NA not applicable

REFERENCES:
(1) EPA, 1989c
(2) EPA, 1991a
(3) EPA, 1992b
(4) EPA, 1994b

Table 6.11 - Human Health Exposure Parameters (Continued)

Exposure Scenario - C. Hypothetical Industrial Worker

Factors	Units	Soil	GW	Reference
Body Wt. (BW)	kg	70	70	1, 2
Exposure Duration (ED)	yr	25	25	2
Exposure Frequency (EF)	d/yr	250	250	2
Exposure Time (ET)	hr/d	8	NA	assumed
Adherence Factor Soil to Skin (AF)	mg/cm^2	NA	NA	
Skin Surface Area Available For Contact (SA)	cm^2	NA	NA	
Ingestion Rate (IR)	see legend note[a]	50	1.0	2
Inhalation Rate (IR)	m^3/hr	2.5	NA	2
Fraction Ingested from Contaminated Source (FI)	unitless	1.0	NA	assumed
Absorption Factor (ABS)	unitless	NA	NA	
Dermal Permeability Constant (PC)	cm/hr	NA	NA	

LEGEND

NA not applicable

a Ingestion rates for soil are expressed in mg/d; groundwater in l/d.

REFERENCES:
(1) EPA, 1989c
(2) EPA, 1991a
(3) EPA, 1992b
(4) EPA, 1994b

Table 6.11 - Human Health Exposure Parameters (Continued)

Exposure Scenario - D. Hypothetical On-Unit Resident Adult

Factors	Units	Soil	GW	Vegetation	Reference
Body Wt. (BW)	kg	70	70	70	1, 2
Exposure Duration (ED)	yr	24	24	24	2
Exposure Frequency (EF)	d/yr	350	350	350	2
Exposure Time (ET)	hr/d	15	0.2[b]	NA	1, 3
Adherence Factor Soil to Skin (AF)	mg/cm^2	0.2 (sand)	NA	NA	3, 4
Skin Surface Area Available For Contact (SA)	cm^2	5,000	20,000	NA	3
Ingestion Rate (IR)	see legend note[a]	100	2.0	113[d] 202[e] 123[f]	1, 2
Inhalation Rate (IR)	m^3/hr	0.83	see legend note[c]	NA	2, 5
Fraction Ingested from Contaminated Source (FI)	unitless	1.0	NA	0.042[d] 0.119[e] 0.487[f]	1
Absorption Factor (ABS)	unitless	1% organics 0.1% inorganics	NA	NA	4
Dermal Permeability Constant	cm/hr	NA	Contaminant Specific	NA	3
Soil-to-Plant Transfer Factor (TF)	unitless	NA	NA	Contaminant Specific	

LEGEND

NA not applicable

a Ingestion rates for soil are expressed in mg/d; groundwater in l/d; homegrown produce in g/d.
b For dermal contact while bathing (12 minutes/day).
c Risk from inhalation of VOCs released from groundwater during domestic use is assumed equal to the ingestion risk.
d leafy vegetables (lettuce and tossed salad)
e tuberous vegetables (white potatoes).
f fruits (tomatoes).

REFERENCES:

(1) EPA, 1989c
(2) EPA, 1991a
(3) EPA, 1992b
(4) EPA, 1994b
(5) BNA, 1992

Table 6.11 - Human Health Exposure Parameters (Continued)

Exposure Scenario - E. Hypothetical On-Unit Resident Child

Factors	Units	Soil	GW	Vegetation	Reference
Body Wt. (BW)	kg	15	15	15	1, 2
Exposure Duration (ED)	yr	6	6	6	2
Exposure Frequency (EF)	d/yr	350	350	350	2
Exposure Time (ET)	hr/d	18	0.2[b]	NA	1, 3
Adherence Factor Soil to Skin (AF)	mg/cm^2	0.2 (sand)	NA	NA	3, 4
Skin Surface Area Available for Contact (SA)	cm^2	1,800	7,300	NA	3
Ingestion Rate (IR)	see legend note[a]	200	1.0	42[d] 75[e] 45[f]	1, 2
Inhalation Rate (IR)	m^3/hr	1.0	see legend note[c]	NA	1, 5
Fraction Ingested from Contaminated Source (FI)	unitless	1.0	NA	0.042[d] 0.119[e] 0.487[f]	1
Absorption Factor (ABS)	unitless	1% organics; 0.1% inorganics	NA	NA	4
Dermal Permeability Constant	cm/hr	NA	Contaminant Specific	NA	3
Soil-to-Plant Transfer Factor (TF)	unitless	NA	NA	Contaminant Specific	

LEGEND

NA not applicable

- a Ingestion rates for soil are expressed in mg/d; groundwater in l/d; homegrown produce in g/d.
- b For dermal contact while bathing (12 minutes/day).
- c Risk from inhalation of VOCs released from groundwater during domestic use is assumed equal to the ingestion risk.
- d leafy vegetables (lettuce and tossed salad)
- e tuberous vegetables (white potatoes).
- f fruits (tomatoes).

REFERENCES:

(1) EPA, 1989c
(2) EPA, 1991a
(3) EPA, 1992b
(4) EPA, 1994b
(5) BNA, 1992

Table 6.12 RME Exposure Point Concentrations for COPCs Soil (Depth 0 - 2 Feet) Central Shops Burning Rubble Pit

COPCs	UNITS	95% UCL	MAX	Exposure Point Concentration
2-Hexanone	mg/kg	2.28E-04	3.80E-04	2.28E-04
2-Methylnaphthalene	mg/kg	2.68E-03	9.27E-03	2.68E-03
4-Chloro-m-cresol	mg/kg	2.16E-03	5.31E-03	2.16E-03
4-Chlorophenyl phenyl ether	mg/kg	1.21E-03	7.49E-03	1.21E-03
Acetone	mg/kg	3.08E-02	6.25E-02	3.08E-02
Antimony	mg/kg	1.66E+00	4.16E+00	1.66E+00
Arsenic	mg/kg	1.97E+00	7.92E+00	1.97E+00
Barium	mg/kg	3.44E+01	9.74E+01	3.44E+01
Benzene	mg/kg	5.98E-04	2.65E-03	5.98E-04
Benzo (b)fluoranthene	mg/kg	4.05E-03	2.71E-02	4.05E-03
Benzo (k)fluoranthene	mg/kg	2.67E-03	1.85E-02	2.67E-03
Benzoicacid	mg/kg	1.65E-02	5.79E-02	1.65E-02
Bis (2-ethylhexyl)phthalate	mg/kg	6.84E-03	7.81E-02	6.84E-03
Calcium	mg/kg	4.56E+02	1.98E+03	4.56E+02
Carbondisulfide	mg/kg	1.97E-04	7.40E-04	1.97E-04
Chloroform	mg/kg	2.06E-02	4.16E-03	4.16E-03
Chromium	mg/kg	2.58E+01	1.08E+02	2.58E+01
Cobalt	mg/kg	1.17E+00	2.62E+00	1.17E+00
Copper	mg/kg	6.87E+02	1.38E+03	6.87E+02
Cyanide	mg/kg	1.49E-01	7.03E-01	1.49E-01
Di-n-butylphthalate	mg/kg	4.92E-03	2.32E-02	4.92E-03
Dibenzofuran	mg/kg	1.12E-03	3.72E-03	1.12E-03
Dichloromethane	mg/kg	6.34E-04	2.15E-03	6.34E-04
Dieldrin	mg/kg	1.11E-03	4.80E-03	1.11E-03
Diethylphthalate	mg/kg	2.35E-02	2.27E-02	2.27E-02
Ethylbenzene	mg/kg	6.60E-05	2.50E-04	6.60E-05
Fluoranthene	mg/kg	7.50E-03	2.80E-02	7.50E-03
Indeno (1,2,3-c,d)pyrene	mg/kg	2.03E-03	9.98E-03	2.03E-03
Iron	mg/kg	1.43E+04	3.14E+04	1.43E+04
Lead	mg/kg	2.79E+01	1.20E+02	2.79E+01
Magnesium	mg/kg	1.66E+02	3.29E+02	1.66E-02
Manganese	mg/kg	8.58E+01	1.72E+02	8.58E-01
Mercury	mg/kg	2.18E-02	7.46E-02	2.18E-02
Methylethylketone	mg/kg	1.95E-04	3.20E-04	1.95E-04
Nickel	mg/kg	1.46E+01	3.50E+02	1.46E+01
OCDD	mg/kg	1.36E-03	7.59E-03	1.36E-03
p,p'-DDE	mg/kg	1.85E-03	5.77E-03	1.85E-03
p,p'-DDT	mg/kg	1.54E-03	5.50E-03	1.54E-03
PCB1254	mg/kg	2.30E-02	1.15E-01	2.30E-02
Potassium	mg/kg	1.11E+02	2.50E+02	1.11E-02
Pyrene	mg/kg	9.24E-03	2.91E-02	9.24E-03
Selenium	mg/kg	2.60E+00	8.36E+00	2.60E-00
Silver	mg/kg	3.79E-01	1.81E-00	3.79E-01
Sodium	mg/kg	8.84E+00	3.68E+01	8.84E-00
Tetrachloroethylene	mg/kg	3.30E-05	1.50E-04	3.30E-05
Thallium	mg/kg	2.35E+00	4.40E+00	2.35E-00
Toluene	mg/kg	4.37E-03	4.11E-03	4.11E-03
Trichloroethylene	mg/kg	4.90E-05	2.60E-04	4.90E-05
Vanadium	mg/kg	3.73E+01	8.43E+01	3.73E-01
Xylenes	mg/kg	6.15E-04	3.97E-03	6.15E-04
Zinc	mg/kg	4.45E+01	2.81E+02	4.45E-01

Table 6.13 RME Exposure Point Concentrations for COPCs Soil (Depth 0 - 5 Feet) Central Shops Burning Rubble Pit

COPCs	UNITS	95% UCL	MAX	Exposure Point Concentration
2-Hexanone	mg/kg	1.94E-04	3.80E-04	1.94E-04
2-Methylnaphthalene	mg/kg	2.34E-03	9.27E-03	2.34E-03
4-Chloro-m-cresol	mg/kg	1.32E-03	5.31E-03	1.32E-03
Acetone	mg/kg	2.83E-02	6.25E-02	2.83E-02
Antimony	mg/kg	1.65E+00	4.16E+00	1.65E+00
Arsenic	mg/kg	2.38E+00	9.22E+00	2.38E+00
Barium	mg/kg	3.85E+01	2.90E+02	3.85E+01
Benzene	mg/kg	2.87E-03	2.65E-03	2.65E-03
Benzo (b)fluoranthene	mg/kg	2.88E-03	2.71E-02	2.88E-03
Benzo (k)fluoranthene	mg/kg	1.97E-03	1.85E-02	1.97E-03
Benzoic acid	mg/kg	1.37E-02	5.79E-02	1.37E-02
Beryllium	mg/kg	1.61E-01	3.70E-01	1.61E-01
Cadmium	mg/kg	3.25E-01	2.87E+00	3.25E-01
Calcium	mg/kg	7.21E+02	1.94E+04	7.21E+02
Carbon disulfide	mg/kg	1.72E-04	7.40E-04	1.72E-04
Chloroform	mg/kg	1.02E-02	4.61E-03	4.61E-03
Chromium	mg/kg	2.44E+01	1.08E+02	2.44E+01
Cobalt	mg/kg	1.10E+00	6.35E+00	1.10E+00
Copper	mg/kg	3.22E+02	1.38E+03	3.22E+02
Cyanide	mg/kg	1.11E-01	7.03E-01	1.11E-01
Di-n-butylphthalate	mg/kg	4.92E-03	2.32E-02	4.92E-03
Dibenzofuran	mg/kg	1.74E-03	7.71E-03	1.74E-03
Dichloromethane	mg/kg	8.15E-04	3.68E-03	8.15E-04
Dieldrin	mg/kg	9.21E-04	4.80E-03	9.21E-04
Diethylphthalate	mg/kg	1.31E-02	2.27E-02	1.31E-02
Ethylbenzene	mg/kg	8.50E-05	3.90E-04	8.50E-05
Fluoranthene	mg/kg	5.94E-03	2.80E-02	5.94E-03
Indeno (1,2,3-c,d)pyrene	mg/kg	1.51E-03	9.98E-03	1.51E-03
Iron	mg/kg	2.02E+04	4.93E+04	2.02E+04
Lead	mg/kg	2.73E+01	3.01E+02	2.73E+01
Magnesium	mg/kg	2.10E+02	2.43E+03	2.10E+02
Manganese	mg/kg	1.03E+02	6.81E+02	1.03E+02
Mercury	mg/kg	2.80E-02	1.30E-01	2.80E-02
Methoxychlor	mg/kg	5.36E-03	1.00E-02	5.36E-03
Methyl ethyl ketone	mg/kg	1.39E-03	3.07E-03	1.39E-03
Nickel	mg/kg	1.09E+01	3.50E+02	1.09E+01
OCDD	mg/kg	4.06E-03	1.94E-02	4.06E-03
p,p'-DDE	mg/kg	1.92E-03	9.09E-03	1.92E-03
p,p'-DDT	mg/kg	1.36E-03	5.50E-03	1.36E-03
PCB1254	mg/kg	1.93E-02	1.15E-01	1.93E-02
Potassium	mg/kg	1.31E+02	8.51E+02	1.31E+02
Pyrene	mg/kg	7.72E-03	2.91E-02	7.72E-03
Selenium	mg/kg	3.62E+00	1.43E+01	3.62E+00
Silver	mg/kg	5.02E-01	3.77E+00	5.02E-01
Sodium	mg/kg	2.53E+01	2.74E+02	2.53E+01
Tetrachloroethylene	mg/kg	2.70E-05	1.50E-04	2.70E-05
Thallium	mg/kg	2.16E+00	4.40E+00	2.16E+00
Toluene	mg/kg	4.45E-03	5.91E-03	4.45E-03
Trichloroethylene	mg/kg	3.60E-05	2.60E-04	3.60E-05
Vanadium	mg/kg	4.30E+01	1.02E+02	4.30E+01
Xylenes	mg/kg	6.92E-04	3.97E-03	6.92E-04
Zinc	mg/kg	5.00E+01	4.33E+02	5.00E+01

Table 6.14 K_{oc} and Log K_{ow} Data for COPCs in Soil (Depth 0 - 2 Feet) Central Shops Burning Rubble Pit

Chemical Name	K_{oc} (ml/g)	LogK_{ow}	Comments
2-Hexanone	14.8	1.38	
2-Methylnaphthalene	7940	4.11	
4-Chloro-m-cresol	604	3.1	
4-Chlorophenyl phenyl ether	7410	4.08	
Acetone	2.2	-0.24	
Antimony	ND	ND	
Arsenic	ND	ND	
Barium	ND	ND	
Benzene	65	2.13	
Benzo (b)fluoranthene	550000	6.06	
Benzo (k)fluoranthene	550000	6.06	
Benzoic acid	54.4	1.87	
Bis (2-ethylhexyl)phthalate	87400	5.11	
Calcium	ND	ND	
Carbon disulfide	54	2	
Chloroform	44	1.97	
Chromium	ND	ND	
Cobalt	ND	ND	
Copper	ND	ND	
Cyanide	0.575	-0.25	
Di-n-butyl-phthalate	1390	3.75	
Dibenzofuran	9120	4.17	
Dichloromethane	8.8	1.51	
Dieldrin	1700	3.5	
Diethylphthalate	69	2.46	
Ethylbenzene	220	3.15	
Fluoranthene	38000	5.2	
Indeno (1,2,3-c,d)pyrene	1600000	6.5	
Iron	ND	ND	
Lead	ND	ND	
Magnesium	ND	ND	
Manganese	ND	ND	
Mercury	ND	ND	
Methyl ethyl ketone	4.51	0.26	
Nickel	ND	ND	
OCDD	4.57E+06	6.91	Substituted 2,3,7,8,-TCDD*
p,p'-DDE	29700	5.69	
p,p'-DDT	243000	5.98	
PCB1254	2140000	6.94	
Potassium	ND	ND	
Pyrene	38000	5.18	
Selenium	ND	ND	
Silver	ND	ND	
Sodium	ND	ND	
Tetrachloroethylene	364	2.53	
Thallium	ND	ND	
Toluene	120	2.69	
Trichloroethylene	126	2.42	
Vanadium	ND	ND	
Xylenes	238	3.2	
Zinc	ND	ND	

ND- No Data

* 2,3,7,8 - Tetrachlorodibenzo-p-dioxin

Table 6.15 K_{oc} and Log K_{ow} Data for COPCs in Soil (Depth 0 - 5 Feet) Central Shops Burning Rubble Pit

Chemical Name	K_{oc} (ml/g)	LogK_{ow}	Comments
2-Hexanone	1.48E+01	1.38	
2-Methylnaphthalene	7.94E+03	4.11	
4-Chloro-m-cresol	6.04E+02	3.1	
Acetone	2.20E+00	-0.24	
Antimony	ND	ND	
Arsenic	ND	ND	
Barium	ND	ND	
Benzene	6.50E+01	2.13	
Benzo (b)fluoranthene	5.50E+05	6.06	
Benzo (k)fluoranthene	5.50E+05	6.06	
Benzoic acid	5.44E+01	1.87	
Beryllium	ND	ND	
Cadmium	ND	ND	
Calcium	ND	ND	
Carbon disulfide	5.40E+01	2	
Chloroform	4.40E+01	1.97	
Chromium	ND	ND	
Cobalt	ND	ND	
Copper	ND	ND	
Cyanide	5.75E-01	-0.25	
Di-n-butylphthalate	1.39E+03	3.75	
Dibenzofuran	9.12E+03	4.17	
Dichloromethane (Methylenechloride)	8.80E+00	1.51	
Dieldrin	1.70E+03	3.5	
Diethylphthalate	6.90E+01	2.46	
Ethylbenzene	2.20E+02	3.15	
Fluoranthene	3.80E+04	5.2	
Indeno (1,2,3-c,d)pyrene	1.60E+06	6.5	
Iron	ND	ND	
Lead	ND	ND	
Magnesium	ND	ND	
Manganese	ND	ND	
Mercury	ND	ND	
Methoxychlor	8.00E+04	4.30E+00	
Methyl ethyl ketone	4.51E+00	0.26	
Nickel	ND	ND	
OCDD	4.57E+06	6.91	Substituted 2,3,7,8,-TCDD*
p,p'-DDE	2.97E+04	5.69	
p,p'-DDT	2.43E+05	5.98	
PCB1254	2.14E+06	6.94	
Potassium	ND	ND	
Pyrene	3.80E+04	5.18	
Selenium	ND	ND	
Silver	ND	ND	
Sodium	ND	ND	
Tetrachloroethylene	3.64E+02	2.53	
Thallium	ND	ND	
Toluene	1.20E+02	2.69	
Trichloroethylene	1.26E+02	2.42	
Vanadium	ND	ND	
Xylenes	2.38E+02	3.2	
Zinc	ND	ND	

ND- No Data

* 2,3,7,8 - Tetrachlorodibenzo-p-dioxin

Table 6.16 Calculation of Contaminant Intake from Plant Root and Fruit Consumption by the Meadow Vole Soil (Depth 0 - 2 feet)

COPC	Units	Exposure Conc*	log (Kow)**	(Koc)*** (ml/g)	RCF +	BCF ++ for root/fruit	contaminant conc. in root/fruit (BCF x soil conc.) (mg/kg PT+++)	prop. root/ fruit veg. in diet	prop. digesti-bility of diet	food ingestion rate (mg PT/ kg BW - day)	unit conversion (1kg/10^6 mg PT)	contaminant intake (mg/kg BW - day)
2-Hexanone	mg/kg	2.28E-04	1.38	1.48E+01	1.17E+00	3.95E+00	1.08E-04	0.24	0.55	3.50E+05	1.00E-06	4.99E-06
2-Methylnaphthalene	mg/kg	2.68E-03	4.11	7.94E+03	4.49E+01	2.83E-01	9.10E-05	0.24	0.55	3.50E+05	1.00E-06	4.20E-06
4-Chloro-m-cresol	mg/kg	2.16E-03	3.1	6.04E+02	8.18E+00	6.77E-01	1.75E-04	0.24	0.55	3.50E+05	1.00E-06	8.09E-06
4-Chlorophenyl phenyl ether	mg/kg	1.21E-03	4.08	7.41E+03	4.27E+01	2.88E-01	4.19E-05	0.24	0.55	3.50E+05	1.00E-06	1.93E-06
Acetone	mg/kg	3.08E-02	-0.24	2.20E+00	8.40E-01	1.91E+01	7.06E-02	0.24	0.55	3.50E+05	1.00E-06	3.26E-03
Antimony	mg/kg	1.66E+00	ND	ND	NA	5.60E-04	1.12E-04	0.24	0.55	3.50E+05	1.00E-06	5.16E-06
Arsenic	mg/kg	1.97E+00	ND	ND	NA	6.00E-03	1.42E-03	0.24	0.55	3.50E+05	1.00E-06	6.55E-05
Barium	mg/kg	3.44E+01	ND	ND	NA	1.50E-02	6.18E-02	0.24	0.55	3.50E+05	1.00E-06	2.86E-03
Benzene	mg/kg	5.98E-04	2.13	6.50E+01	2.14E+00	1.65E+00	1.18E-04	0.24	0.55	3.50E+05	1.00E-06	5.45E-06
Benzo (b)fluoranthene	mg/kg	4.05E-03	6.06	5.50E+05	1.40E+03	1.27E-01	6.20E-05	0.24	0.55	3.50E+05	1.00E-06	2.86E-06
Benzo (k)fluoranthene	mg/kg	2.67E-03	6.06	5.50E+05	1.40E+03	1.27E-01	4.08E-05	0.24	0.55	3.50E+05	1.00E-06	1.88E-06
Benzoic acid	mg/kg	1.65E-02	1.87	5.44E+01	1.65E+00	1.52E+00	3.01E-03	0.24	0.55	3.50E+05	1.00E-06	1.39E-04
Bis (2-ethylhexyl)phthalate	mg/kg	6.84E-03	5.11	8.74E+04	2.61E+02	1.49E-01	1.22E-04	0.24	0.55	3.50E+05	1.00E-06	5.65E-06
Calcium	mg/kg	4.56E+02	ND	ND	NA	3.50E-01	1.92E+01	0.24	0.55	3.50E+05	1.00E-06	8.85E-01
Carbon disulfide	mg/kg	1.97E-04	2	5.40E+01	1.87E+00	1.73E+00	4.09E-05	0.24	0.55	3.50E+05	1.00E-06	1.89E-06
Chloroform	mg/kg	4.16E-03	1.97	4.40E+01	1.81E+00	2.06E+00	1.03E-03	0.24	0.55	3.50E+05	1.00E-06	4.75E-05
Chromium	mg/kg	2.58E+01	ND	ND	NA	4.50E-03	1.39E-02	0.24	0.55	3.50E+05	1.00E-06	6.43E-04
Cobalt	mg/kg	1.17E+00	ND	ND	NA	4.00E-02	5.60E-03	0.24	0.55	3.50E+05	1.00E-06	2.59E-04
Copper	mg/kg	6.87E+02	ND	ND	NA	2.50E-01	2.06E+01	0.24	0.55	3.50E+05	1.00E-06	9.53E-01
Cyanide	mg/kg	1.49E-01	-0.25	5.75E-01	8.39E-01	7.30E+01	1.30E+00	0.24	0.55	3.50E+05	1.00E-06	6.02E-02
Di-n-butyl-phthalate	mg/kg	4.92E-03	3.75	1:39E+03	2.41E+01	8.68E-01	5.12E-04	0.24	0.55	3.50E+05	1.00E-06	2.37E-05
Dibenzofuran	mg/kg	1.12E-03	4.17	9.12E+03	4.99E+01	2.74E-01	3.69E-05	0.24	0.55	3.50E+05	1.00E-06	1.70E-06
Dichloromethane	mg/kg	6.34E-04	1.51	8.80E+00	1.26E+00	7.15E+00	5.44E-04	0.24	0.55	3.50E+05	1.00E-06	2.51E-05
Dieldrin	mg/kg	1.11E-03	3.5	1.70E+03	1.58E+01	4.64E-01	6.18E-05	0.24	0.55	3.50E+05	1.00E-06	2.86E-06
Diethylphthalate	mg/kg	2.27E-02	2.46	6.90E+01	3.19E+00	2.31E+00	6.29E-03	0.24	0.55	3.50E+05	1.00E-06	2.91E-04
Ethylbenzene	mg/kg	6.60E-05	3.15	2.20E+02	8.86E+00	2.01E+00	1.60E-05	0.24	0.55	3.50E+05	1.00E-06	7.37E-07
Fluoranthene	mg/kg	7.50E-03	5.2	3.80E+04	3.06E+02	4.02E-01	3.62E-04	0.24	0.55	3.50E+05	1.00E-06	1.67E-05
Indeno (1,2,3-c,d)pyrene	mg/kg	2.03E-03	6.5	1.60E+06	3.06E+03	9.55E-02	2.32E-05	0.24	0.55	3.50E+05	1.00E-06	1.07E-06
Iron	mg/kg	1.43E+04	ND	ND	NA	1.00E-03	1.72E+00	0.24	0.55	3.50E+05	1.00E-06	7.93E-02
Lead	mg/kg	2.79E+01	ND	ND	NA	9.00E-03	3.01E-02	0.24	0.55	3.50E+05	1.00E-06	1.39E-03
Magnesium	mg/kg	1.66E+02	ND	ND	NA	5.50E-01	1.09E+01	0.24	0.55	3.50E+05	1.00E-06	5.05E-01
Manganese	mg/kg	8.58E+01	ND	ND	NA	1.50E-01	1.54E+00	0.24	0.55	3.50E+05	1.00E-06	7.13E-02
Mercury	mg/kg	2.18E-02	ND	ND	NA	2.00E-01	5.24E-04	0.24	0.55	3.50E+05	1.00E-06	2.42E-05
Methyl ethyl ketone	mg/kg	1.95E-04	0.26	4.51E+00	8.68E-01	9.62E+00	2.25E-04	0.24	0.55	3.50E+05	1.00E-06	1.04E-05
Nickel	mg/kg	1.46E+01	ND	ND	NA	6.00E-02	1.05E-01	0.24	0.55	3.50E+05	1.00E-06	4.87E-03
OCDD	mg/kg	1.36E-03	6.91	4.57E+06	6.32E+03	6.92E-02	1.13E-05	0.24	0.55	3.50E+05	1.00E-06	5.21E-07
p,p'-DDE	mg/kg	1.85E-03	5.69	2.97E+04	7.27E+02	1.22E+00	2.72E-04	0.24	0.55	3.50E+05	1.00E-06	1.26E-05
p,p'-DDT	mg/kg	1.54E-03	5.98	2.43E+05	1.22E+03	2.50E-01	4.63E-05	0.24	0.55	3.50E+05	1.00E-06	2.14E-06

Table 6.16 Calculation of Contaminant Intake from Plant Root and Fruit Consumption by the Meadow Vole Soil (Depth 0 - 2 feet) (continued)

COPC	Units	Exposure Conc*	log (Kow)**	(Koc)*** (ml/g)	RCF †	BCF †† for root/fruit	contaminant conc. in root/fruit (BCF x soil conc.) (mg/kg PT†††)	prop. root/ fruit veg. in diet	prop. digestibility of diet	food ingestion rate (mg PT/ kg BW - day)	unit conversion (1kg/10^6 mg PT)	contaminant intake (mg/kg BW - day)
PCB1254	mg/kg	2.30E-02	6.94	2.14E+06	6.67E+03	1.56E-01	4.30E-04	0.24	0.55	3.50E+05	1.00E-06	1.99E-05
Potassium	mg/kg	1.11E+02	ND	ND	NA	5.50E-01	7.30E+00	0.24	0.55	3.50E+05	1.00E-06	3.37E-01
Pyrene	mg/kg	9.24E-03	5.18	3.80E+04	2.95E+02	3.88E-01	4.30E-04	0.24	0.55	3.50E+05	1.00E-06	1.99E-05
Selenium	mg/kg	2.60E+00	ND	ND	NA	2.50E-02	7.81E-03	0.24	0.55	3.50E+05	1.00E-06	3.61E-04
Silver	mg/kg	3.79E-01	ND	ND	NA	1.30E-03	5.91E-05	0.24	0.55	3.50E+05	1.00E-06	2.73E-06
Sodium	mg/kg	8.84E+00	ND	ND	NA	5.50E-02	5.83E-02	0.24	0.55	3.50E+05	1.00E-06	2.70E-03
Tetrachloroethylene	mg/kg	3.30E-05	2.53	3.64E+02	3.50E+00	4.81E-01	1.90E-06	0.24	0.55	3.50E+05	1.00E-06	8.80E-08
Thallium	mg/kg	2.35E+00	ND	ND	NA	1.20E-04	3.39E-05	0.24	0.55	3.50E+05	1.00E-06	1.57E-06
Toluene	mg/kg	4.11E-03	2.69	1.20E+02	4.38E+00	1.82E+00	9.00E-04	0.24	0.55	3.50E+05	1.00E-06	4.16E-05
Trichloroethylene	mg/kg	4.90E-05	2.42	1.26E+02	3.02E+00	1.20E+00	7.06E-06	0.24	0.55	3.50E+05	1.00E-06	3.26E-07
Vanadium	mg/kg	3.73E+01	ND	ND	NA	1.00E+00	4.48E+00	0.24	0.55	3.50E+05	1.00E-06	2.07E-01
Xylenes	mg/kg	6.15E-04	3.2	2.38E+02	9.61E+00	2.02E+00	1.49E-04	0.24	0.55	3.50E+05	1.00E-06	6.88E-06
Zinc	mg/kg	4.45E+01	ND	ND	NA	9.00E-01	4.81E+00	0.24	0.55	3.50E+05	1.00E-06	2.22E-01

receptor	Meadow vole
food ing. rate (g/g-day)	0.35
BW (g)	17
% area use	100
% digestibility of diet	55
% leafy veg. in diet	76
dry/wet weight ratio	0.12
% frac. org. carbon (foc)	2

* Exposure concentration represents the lesser of the maximum detected concentration or the 95% UCL

**Kow = octanol/water partition coefficient

***Koc = organic carbon partition coefficient

† For organics, log(RCF-0.82) = 0.77 x log(Kow)-1.52, where RCF = root concentration factor (see text). RCF is not calculated for inorganics.

†† BCF = bioconcentration factor, where BCF = RCF/Koc x foc for organics; for inorganics, BCF = soil-to-plant concentration factor from NRC (1992). BCFs are multiplied by the dry/wet weight ratio of 0.12 from Baes et al. (1984) to adjust for the dry/wet weight differences for root vegetables

††† PT = plant tissue

Table 6.17 Calculation of Contaminant Intake from Plant Root and Fruit Consumption by the Meadow Vole Soil (Depth 0-5 Feet)

COPCs	Units	Expo-sure Conc*	log (Kow)**	(Koc)***	RCF+	BCF ++ for root/fruit	contaminant conc. in root/fruit (BCF x soil conc.) (mg/kg PT+++)	prop. root/ fruit veg. in diet	prop. digesti-bility of diet	food ingestion rate (mg PT/ kg BW - day)	unit conversion (1kg/10^6 mg PT)	contaminant intake (mg/kg BW - day)
2-Hexanone	mg/kg	1.94E-04	1.38	1.48E+01	1.17E+00	3.95E+00	9.19E-05	0.24	0.55	3.50E+05	1.00E-06	4.25E-06
2-Methylnaphthalene	mg/kg	2.34E-03	4.11	7.94E+03	4.49E+01	2.83E-01	7.94E-05	0.24	0.55	3.50E+05	1.00E-06	3.67E-06
4-Chloro-m-cresol	mg/kg	1.32E-03	3.1	6.04E+02	8.18E+00	6.77E-01	1.07E-04	0.24	0.55	3.50E+05	1.00E-06	4.94E-06
Acetone	mg/kg	2.83E-02	-0.24	2.20E+00	8.40E-01	1.91E+01	6.47E-02	0.24	0.55	3.50E+05	1.00E-06	2.99E-03
Antimony	mg/kg	1.65E+00	ND	ND	NA	5.60E-04	1.11E-04	0.24	0.55	3.50E+05	1.00E-06	5.13E-06
Arsenic	mg/kg	2.38E+00	ND	ND	NA	6.00E-03	1.71E-03	0.24	0.55	3.50E+05	1.00E-06	7.91E-05
Barium	mg/kg	3.85E+01	ND	ND	NA	1.50E-02	6.93E-02	0.24	0.55	3.50E+05	1.00E-06	3.20E-03
Benzene	mg/kg	2.65E-03	2.13	6.50E+01	2.14E+00	1.65E+00	5.23E-04	0.24	0.55	3.50E+05	1.00E-06	2.42E-05
Benzo (b)fluoranthene	mg/kg	2.88E-03	6.06	5.50E+05	1.40E+03	1.27E-01	4.40E-05	0.24	0.55	3.50E+05	1.00E-06	2.03E-06
Benzo (k)fluoranthene	mg/kg	1.97E-03	6.06	5.50E+05	1.40E+03	1.27E-01	3.00E-05	0.24	0.55	3.50E+05	1.00E-06	1.39E-06
Benzoic acid	mg/kg	1.37E-02	1.87	5.44E+01	1.65E+00	1.52E+00	2.49E-03	0.24	0.55	3.50E+05	1.00E-06	1.15E-04
Beryllium	mg/kg	1.61E-01	ND	ND	NA	1.50E-03	2.90E-05	0.24	0.55	3.50E+05	1.00E-06	1.34E-06
Cadmium	mg/kg	3.25E-01	ND	ND	NA	1.50E-01	5.85E-03	0.24	0.55	3.50E+05	1.00E-06	2.70E-04
Calcium	mg/kg	7.21E+02	ND	ND	NA	3.50E-01	3.03E+01	0.24	0.55	3.50E+05	1.00E-06	1.40E+00
Carbon disulfide	mg/kg	1.72E-04	2	5.40E+01	1.87E+00	1.73E+00	3.57E-05	0.24	0.55	3.50E+05	1.00E-06	1.65E-06
Chloroform	mg/kg	4.61E-03	1.97	4.40E+01	1.81E+00	2.06E+00	1.14E-03	0.24	0.55	3.50E+05	1.00E-06	5.27E-05
Chromium	mg/kg	2.44E+01	ND	ND	NA	4.50E-03	1.32E-02	0.24	0.55	3.50E+05	1.00E-06	6.09E-04
Cobalt	mg/kg	1.10E+00	ND	ND	NA	4.00E-02	5.30E-03	0.24	0.55	3.50E+05	1.00E-06	2.45E-04
Copper	mg/kg	3.22E+02	ND	ND	NA	2.50E-01	9.66E+00	0.24	0.55	3.50E+05	1.00E-06	4.46E-01
Cyanide	mg/kg	1.11E-01	-0.25	5.75E-01	8.39E-01	7.30E+01	9.72E-01	0.24	0.55	3.50E+05	1.00E-06	4.49E-02
Di-n-butyl-phthalate	mg/kg	4.92E-03	3.75	1.39E+03	2.41E+01	8.68E-01	5.12E-04	0.24	0.55	3.50E+05	1.00E-06	2.37E-05
Dibenzofuran	mg/kg	1.74E-03	4.17	9.12E+03	4.99E+01	2.74E-01	5.71E-05	0.24	0.55	3.50E+05	1.00E-06	2.64E-06
Dichloromethane	mg/kg	8.15E-04	1.51	8.80E+00	1.26E+00	7.15E+00	7.00E-04	0.24	0.55	3.50E+05	1.00E-06	3.23E-05
Dieldrin	mg/kg	9.21E-04	3.5	1.70E+03	1.58E+01	4.64E-01	5.13E-05	0.24	0.55	3.50E+05	1.00E-06	2.37E-06
Diethylphthalate	mg/kg	1.31E-02	2.46	6.90E+01	3.19E+00	2.31E+00	3.63E-03	0.24	0.55	3.50E+05	1.00E-06	1.68E-04
Ethylbenzene	mg/kg	8.50E-05	3.15	2.20E+02	8.86E+00	2.01E+00	2.05E-05	0.24	0.55	3.50E+05	1.00E-06	9.49E-07
Fluoranthene	mg/kg	5.94E-03	5.2	3.80E+04	3.06E+02	4.02E-01	2.87E-04	0.24	0.55	3.50E+05	1.00E-06	1.32E-05
Indeno (1,2,3-c,d)pyrene	mg/kg	1.51E-03	6.5	1.60E+06	3.06E+03	9.55E-02	1.73E-05	0.24	0.55	3.50E+05	1.00E-06	8.00E-07
Iron	mg/kg	2.02E+04	ND	ND	NA	1.00E-03	2.43E+00	0.24	0.55	3.50E+05	1.00E-06	1.12E-01
Lead	mg/kg	2.73E+01	ND	ND	NA	9.00E-03	2.95E-02	0.24	0.55	3.50E+05	1.00E-06	1.36E-03
Magnesium	mg/kg	2.10E+02	ND	ND	NA	5.50E-01	1.38E+01	0.24	0.55	3.50E+05	1.00E-06	6.40E-01
Manganese	mg/kg	1.03E+02	ND	ND	NA	1.50E-01	1.85E+00	0.24	0.55	3.50E+05	1.00E-06	8.55E-02
Mercury	mg/kg	2.80E-02	ND	ND	NA	2.00E-01	6.73E-04	0.24	0.55	3.50E+05	1.00E-06	3.11E-05
Methoxychlor	mg/kg	5.36E-03	4.3	8.00E+04	6.26E+01	3.91E-02	2.52E-05	0.24	0.55	3.50E+05	1.00E-06	1.16E-06
Methyl ethyl ketone	mg/kg	1.39E-03	0.26	4.51E+00	8.68E-01	9.62E+00	1.61E-03	0.24	0.55	3.50E+05	1.00E-06	7.44E-05
Nickel	mg/kg	1.09E+01	ND	ND	NA	6.00E-02	7.81E-02	0.24	0.55	3.50E+05	1.00E-06	3.61E-03

Table 6.17 Calculation of Contaminant Intake from Plant Root and Fruit Consumption by the Meadow Vole Soil (Depth 0-5 Feet) (continued)

COPCs	Units	Exposure Conc*	log (Kow)**	(Koc)***	RCF[†]	BCF** for root/fruit	contaminant conc. in root/fruit (BCF x soil conc.) (mg/kg PT***)	prop. root/fruit veg. in diet	prop. digestibility of diet	food ingestion rate (mg PT/kg BW - day)	unit conversion (1kg/10^6 mg PT)	contaminant intake (mg/kg BW - day)
OCDD	mg/kg	4.06E-03	6.91	4.57E+06	6.32E+03	6.92E-02	3.37E-05	0.24	0.55	3.50E+05	1.00E-06	1.56E-06
p,p'-DDE	mg/kg	1.92E-03	5.69	2.97E+04	7.27E+02	1.22E+00	2.82E-04	0.24	0.55	3.50E+05	1.00E-06	1.30E-05
p,p'-DDT	mg/kg	1.36E-03	5.98	2.43E+05	1.22E+03	2.50E-01	4.08E-05	0.24	0.55	3.50E+05	1.00E-06	1.88E-06
PCB1254	mg/kg	1.93E-02	6.94	2.14E+06	6.67E+03	1.56E-01	3.60E-04	0.24	0.55	3.50E+05	1.00E-06	1.66E-05
Potassium	mg/kg	1.31E+02	ND	ND	NA	5.50E-01	8.62E+00	0.24	0.55	3.50E+05	1.00E-06	3.98E-01
Pyrene	mg/kg	7.72E-03	5.18	3.80E+04	2.95E+02	3.88E-01	3.59E-04	0.24	0.55	3.50E+05	1.00E-06	1.66E-05
Selenium	mg/kg	3.62E+00	ND	ND	NA	2.50E-02	1.09E-02	0.24	0.55	3.50E+05	1.00E-06	5.02E-04
Silver	mg/kg	5.02E-01	ND	ND	NA	1.30E-03	7.83E-05	0.24	0.55	3.50E+05	1.00E-06	3.62E-06
Sodium	mg/kg	2.53E+01	ND	ND	NA	5.50E-02	1.67E-01	0.24	0.55	3.50E+05	1.00E-06	7.70E-03
Tetrachloroethylene	mg/kg	2.70E-05	2.53	3.64E+02	3.50E+00	4.81E-01	1.56E-06	0.24	0.55	3.50E+05	1.00E-06	7.20E-08
Thallium	mg/kg	2.16E+00	ND	ND	NA	1.20E-04	3.10E-05	0.24	0.55	3.50E+05	1.00E-06	1.43E-06
Toluene	mg/kg	4.45E-03	2.69	1.20E+02	4.38E+00	1.82E+00	9.73E-04	0.24	0.55	3.50E+05	1.00E-06	4.50E-05
Trichloroethylene	mg/kg	3.60E-05	2.42	1.26E+02	3.02E+00	1.20E+00	5.19E-06	0.24	0.55	3.50E+05	1.00E-06	2.40E-07
Vanadium	mg/kg	4.30E+01	ND	ND	NA	1.00E+00	5.16E+00	0.24	0.55	3.50E+05	1.00E-06	2.39E-01
Xylenes	mg/kg	6.92E-04	3.2	2.38E+02	9.61E+00	2.02E+00	1.68E-04	0.24	0.55	3.50E+05	1.00E-06	7.75E-06
Zinc	mg/kg	5.00E+01	ND	ND	NA	9.00E-01	5.40E+00	0.24	0.55	3.50E+05	1.00E-06	2.49E-01

receptor	Meadow vole
food ing. rate (g/g-day)	0.35
BW (g)	17
% area use	100
% digestibility of diet	55
% leafy veg. in diet	76
dry/wet weight ratio	0.12
% frac. org. carbon (foc)	2

* Exposure concentration represents the lesser of the maximum detected concentration or the 95% UCL

**Kow = octanol/water partition coefficient

***Koc = organic carbon partition coefficient

[†] For organics, log(RCF-0.82) = 0.77 x log(Kow)-1.52, where RCF = root concentration factor (see text). RCF is not calculated for inorganics.

** BCF = bioconcentration factor, where BCF = RCF/Koc x foc for organics; for inorganics, BCF = soil-to-plant concentration factor from NRC (1992). BCFs are multiplied by the dry/wet weight ratio of 0.12 from Baes et al. (1984).to adjust for the dry/wet weight differences for root vegetables.

*** PT = plant tissue

Table 6.18 Sample Calculation of Intake Via Ingestion Of Roots And Fruits

Ingestion for Meadow vole	concentration in roots/ fruits			Area use factor		Proportion roots/fruits in diet		Proportion estimated digestibility		Food ingestion rate			Conversion factor			Calculated intake from roots/fruits	
Pyrene	0.00036	$\frac{\text{mg chem}}{\text{kg PT}}$	X	1	X	0.24	X	0.55	X	350000	$\frac{\text{mg PT}}{\text{kgBW-day}}$	X	$\frac{1}{1.00\text{E}+06}$	$\frac{\text{kg PT}}{\text{mg PT}}$	=	1.66E-05	$\frac{\text{mg chem}}{\text{kg BW-day}}$

Solving for the Root Concentration Factor (RCF):

				log (Kow)						
log(RCF-0.82)	=	(0.77	X	5.18)	-	1.52	=	2.47		
10^log(RCF-0.82)	=			10	^	2.47	=	294.17		
RCF-0.82	=	294.17	;	RCF	=	294.17	+	0.82	=	294.99

Solving for the Bioconcentration Factor (BCF):

		RCF		Koc		foc			BCF
BCF	=	294.99	/ (	3.80E+04	X	0.02	)	=	0.39

		BCF		dry/wet wt. ratio adjustments		exposure concentration			Concentration in root/fruits	
Concentration in roots/fruits	=	0.39	X	0.12	X	0.007717	$\frac{\text{mg chem}}{\text{kg soil}}$	=	3.59E-04	$\frac{\text{mg chem}}{\text{kg PT}}$

Exposure Factors	
Chemical	Pyrene
Exp. conc (mg/kg)	0.007717
Receptor	Meadow vole
Food ing. rate (g/g-day)	0.35
BW (g)	17
% Area use	100
% Digestibility of diet	55
% Leafy veg. in diet	76
Dry/wet weight ratio*	0.12

Meadow vole	TOTAL DAILY INTAKE of	Pyrene	(in roots/fruits)
	1.66E-05	$\frac{\text{mg chem}}{\text{kg BW-day}}$	

* From Baes et al. (1984)
BCF = Bioconcentration factor
PT = plant tissue

Kow = octanol/water partitioning coefficient
Koc = organic carbon partitioning coefficient
foc = fraction organic carbon (assumed to be 2.0%)

Table 6.19 Calculation of Contaminant Intake from Leafy Vegetation Consumption by the Meadow Vole Soil (Depth 0 - 2 feet)

COPC	Units	Expo-sure Conc*	log (Kow)**	BCF$^+$ for leafy vegetation	contaminant concentration in leafy vegetation (BCF x soil conc.) (mg/kg PT**)	proportion leafy vegetation in diet	proportion digestibility of diet	food ingestion rate (mg PT/ kg BW - day)	unit conversion (1kg/10^6 mg PT)	contaminant intake (mg/kg BW - day)
2-Hexanone	mg/kg	2.28E-04	1.38	6.17E+00	7.04E-05	0.76	0.55	3.50E+05	1.00E-06	1.03E-05
2-Methylnaphthalene	mg/kg	2.68E-03	4.11	1.63E-01	2.18E-05	0.76	0.55	3.50E+05	1.00E-06	3.19E-06
4-Chloro-m-cresol	mg/kg	2.16E-03	3.1	6.25E-01	6.74E-05	0.76	0.55	3.50E+05	1.00E-06	9.86E-06
4-Chlorophenyl phenyl ether	mg/kg	1.21E-03	4.08	1.70E-01	1.03E-05	0.76	0.55	3.50E+05	1.00E-06	1.50E-06
Acetone	mg/kg	3.08E-02	-0.24	5.33E+01	8.21E-02	0.76	0.55	3.50E+05	1.00E-06	1.20E-02
Antimony	mg/kg	1.66E+00	ND	1.30E-04	1.08E-05	0.76	0.55	3.50E+05	1.00E-06	1.58E-06
Arsenic	mg/kg	1.97E+00	ND	4.00E-02	3.94E-03	0.76	0.55	3.50E+05	1.00E-06	5.76E-04
Barium	mg/kg	3.44E+01	ND	1.50E-01	2.58E-01	0.76	0.55	3.50E+05	1.00E-06	3.77E-02
Benzene	mg/kg	5.98E-04	2.13	2.27E+00	6.80E-05	0.76	0.55	3.50E+05	1.00E-06	9.95E-06
Benzo (b)fluoranthene	mg/kg	4.05E-03	6.06	1.22E-02	2.47E-06	0.76	0.55	3.50E+05	1.00E-06	3.61E-07
Benzo (k)fluoranthene	mg/kg	2.67E-03	6.06	1.22E-02	1.62E-06	0.76	0.55	3.50E+05	1.00E-06	2.38E-07
Benzoic acid	mg/kg	1.65E-02	1.87	3.21E+00	2.66E-03	0.76	0.55	3.50E+05	1.00E-06	3.89E-04
Bis (2-ethylhexyl)phthalate	mg/kg	6.84E-03	5.11	4.31E-02	1.47E-05	0.76	0.55	3.50E+05	1.00E-06	2.16E-06
Calcium	mg/kg	4.56E+02	ND	3.50E+00	7.98E+01	0.76	0.55	3.50E+05	1.00E-06	1.17E+01
Carbon disulfide	mg/kg	1.97E-04	2	2.70E+00	2.66E-05	0.76	0.55	3.50E+05	1.00E-06	3.90E-06
Chloroform	mg/kg	4.16E-03	1.97	2.81E+00	5.85E-04	0.76	0.55	3.50E+05	1.00E-06	8.56E-05
Chromium	mg/kg	2.58E+01	ND	7.50E-03	9.66E-03	0.76	0.55	3.50E+05	1.00E-06	1.41E-03
Cobalt	mg/kg	1.17E+00	ND	8.10E-02	4.72E-03	0.76	0.55	3.50E+05	1.00E-06	6.91E-04
Copper	mg/kg	6.87E+02	ND	4.00E-01	1.37E+01	0.76	0.55	3.50E+05	1.00E-06	2.01E+00
Cyanide	mg/kg	1.49E-01	-0.25	5.40E+01	4.02E-01	0.76	0.55	3.50E+05	1.00E-06	5.87E-02
Di-n-butylphthalate	mg/kg	4.92E-03	3.75	2.63E-01	6.48E-05	0.76	0.55	3.50E+05	1.00E-06	9.48E-06
Dibenzofuran	mg/kg	1.12E-03	4.17	1.51E-01	8.46E-06	0.76	0.55	3.50E+05	1.00E-06	1.24E-06
Dichloromethane	mg/kg	6.34E-04	1.51	5.19E+00	1.65E-04	0.76	0.55	3.50E+05	1.00E-06	2.41E-05
Dieldrin	mg/kg	1.11E-03	3.5	3.67E-01	2.04E-05	0.76	0.55	3.50E+05	1.00E-06	2.98E-06
Diethylphthalate	mg/kg	2.27E-02	2.46	1.47E+00	1.66E-03	0.76	0.55	3.50E+05	1.00E-06	2.43E-04
Ethylbenzene	mg/kg	6.60E-05	3.15	5.85E-01	1.93E-06	0.76	0.55	3.50E+05	1.00E-06	2.83E-07
Fluoranthene	mg/kg	7.50E-03	5.2	3.82E-02	1.43E-05	0.76	0.55	3.50E+05	1.00E-06	2.10E-06
Indeno (1,2,3-c,d)pyrene	mg/kg	2.03E-03	6.5	6.78E-03	6.87E-07	0.76	0.55	3.50E+05	1.00E-06	1.00E-07
Iron	mg/kg	1.43E+04	ND	4.00E-03	2.86E+00	0.76	0.55	3.50E+05	1.00E-06	4.19E-01
Lead	mg/kg	2.79E+01	ND	5.80E-03	8.08E-03	0.76	0.55	3.50E+05	1.00E-06	1.18E-03
Magnesium	mg/kg	1.66E+02	ND	1.00E+00	8.28E+00	0.76	0.55	3.50E+05	1.00E-06	1.21E+00
Manganese	mg/kg	8.58E+01	ND	5.60E-01	2.40E+00	0.76	0.55	3.50E+05	1.00E-06	3.51E-01
Mercury	mg/kg	2.18E-02	ND	9.00E-01	9.83E-04	0.76	0.55	3.50E+05	1.00E-06	1.44E-04
Methylethylketone	mg/kg	1.95E-04	0.26	2.74E+01	2.67E-04	0.76	0.55	3.50E+05	1.00E-06	3.91E-05
Nickel	mg/kg	1.46E+01	ND	2.80E-01	2.05E-01	0.76	0.55	3.50E+05	1.00E-06	3.00E-02
OCDD	mg/kg	1.36E-03	6.91	3.93E-03	2.67E-07	0.76	0.55	3.50E+05	1.00E-06	3.90E-08

Table 6.19 Calculation of Contaminant Intake from Leafy Vegetation Consumption by the Meadow Vole Soil (Depth 0 - 2 feet) (continued)

COPC	Units	Exposure Conc*	log (Kow)**	BCF† for leafy vegetation	contaminant concentration in leafy vegetation (BCF x soil conc.) (mg/kg PT††)	proportion leafy vegetation in diet	proportion digestibility of diet	food ingestion rate (mg PT/ kg BW - day)	unit conversion (1kg/10^6 mg PT)	contaminant intake (mg/kg BW - day)
p,p'-DDE	mg/kg	1.85E-03	5.69	1.99E-02	1.84E-06	0.76	0.55	3.50E+05	1.00E-06	2.70E-07
p,p'-DDT	mg/kg	1.54E-03	5.98	1.35E-02	1.04E-06	0.76	0.55	3.50E+05	1.00E-06	1.53E-07
PCB1254	mg/kg	2.30E-02	6.94	3.77E-03	4.34E-06	0.76	0.55	3.50E+05	1.00E-06	6.35E-07
Potassium	mg/kg	1.11E+02	ND	1.00E+00	5.53E+00	0.76	0.55	3.50E+05	1.00E-06	8.09E-01
Pyrene	mg/kg	9.24E-03	5.18	3.93E-02	1.81E-05	0.76	0.55	3.50E+05	1.00E-06	2.65E-06
Selenium	mg/kg	2.60E+00	ND	2.50E-02	3.25E-03	0.76	0.55	3.50E+05	1.00E-06	4.76E-04
Silver	mg/kg	3.79E-01	ND	2.70E-04	5.12E-06	0.76	0.55	3.50E+05	1.00E-06	7.49E-07
Sodium	mg/kg	8.84E+00	ND	7.50E-02	3.31E-02	0.76	0.55	3.50E+05	1.00E-06	4.85E-03
Tetrachloroethylene	mg/kg	3.30E-05	2.53	1.34E+00	2.20E-06	0.76	0.55	3.50E+05	1.00E-06	3.22E-07
Thallium	mg/kg	2.35E+00	ND	6.60E-03	7.76E-04	0.76	0.55	3.50E+05	1.00E-06	1.14E-04
Toluene	mg/kg	4.11E-03	2.69	1.08E+00	2.22E-04	0.76	0.55	3.50E+05	1.00E-06	3.25E-05
Trichloroethylene	mg/kg	4.90E-05	2.42	1.55E+00	3.79E-06	0.76	0.55	3.50E+05	1.00E-06	5.54E-07
Vanadium	mg/kg	3.73E+01	ND	1.00E+00	1.87E+00	0.76	0.55	3.50E+05	1.00E-06	2.73E-01
Xylenes	mg/kg	6.15E-04	3.2	5.48E-01	1.68E-05	0.76	0.55	3.50E+05	1.00E-06	2.46E-06
Zinc	mg/kg	4.45E+01	ND	1.40E+00	3.12E+00	0.76	0.55	3.50E+05	1.00E-06	4.56E-01

receptor	Meadow vole
food ing. rate (g/g-day)	0.35
BW (g)	17
% area use	100
% digestibility of diet	55
% leafy veg. in diet	76
dry/wet weight ratio	0.05
% frac. org. carbon (foc)	2

* Exposure concentration represents the lesser of the maximum detected concentration or the 95% UCL.

**Kow = octanol/water partition coefficient

† BCF = biococentration factor, where log BCF = 1.588-(0.578 x log (Kow)) for organics; for inorganics, BCF = soil-to-plant concentration factor from NRC (1992). BCFs are multiplied by the dry/wet weight ratio from Baes et al. (1984) to adjust for dry/wet weight differences in leafy vegetation

†† PT = plant tissue

Table 6.20 Calculation of Contaminant Intake from Leafy Vegetation Consumption by the Meadow Vole Soil (Depth 0 - 5 feet)

COPCs	Units	Expo-sure Conc*	log (Kow)**	BCF+ leafy vegetation	contaminant concentration in leafy vegetation (BCF x soil conc.) (mg/kg PT++)	proportion leafy vegetation in diet	proportion digestibility of diet	food ingestion rate (mg PT/ kg BW - day)	unit conversion (1kg/10^6 mg PT)	contaminant intake (mg/kg BW - day)
2-Hexanone	mg/kg	1.94E-04	1.38	3.09E-01	5.99E-05	0.76	0.55	3.50E+05	1.00E-06	8.76E-06
2-Methylnaphthalene	mg/kg	2.34E-03	4.11	8.15E-03	1.91E-05	0.76	0.55	3.50E+05	1.00E-06	2.79E-06
4-Chloro-m-cresol	mg/kg	1.32E-03	3.1	3.13E-02	4.11E-05	0.76	0.55	3.50E+05	1.00E-06	6.02E-06
Acetone	mg/kg	2.83E-02	-0.24	2.66E+00	7.53E-02	0.76	0.55	3.50E+05	1.00E-06	1.10E-02
Antimony	mg/kg	1.65E+00	ND	1.30E-04	2.15E-04	0.76	0.55	3.50E+05	1.00E-06	3.14E-05
Arsenic	mg/kg	2.38E+00	ND	4.00E-02	9.52E-02	0.76	0.55	3.50E+05	1.00E-06	1.39E-02
Barium	mg/kg	3.85E+01	ND	1.50E-01	5.77E+00	0.76	0.55	3.50E+05	1.00E-06	8.45E-01
Benzene	mg/kg	2.65E-03	2.13	1.14E-01	3.01E-04	0.76	0.55	3.50E+05	1.00E-06	4.41E-05
Benzo (b)fluoranthene	mg/kg	2.88E-03	6.06	6.09E-04	1.75E-06	0.76	0.55	3.50E+05	1.00E-06	2.56E-07
Benzo (k)fluoranthene	mg/kg	1.97E-03	6.06	6.09E-04	1.20E-06	0.76	0.55	3.50E+05	1.00E-06	1.75E-07
Benzoic acid	mg/kg	1.37E-02	1.87	1.61E-01	2.20E-03	0.76	0.55	3.50E+05	1.00E-06	3.22E-04
Beryllium	mg/kg	1.61E-01	ND	1.00E-02	1.61E-03	0.76	0.55	3.50E+05	1.00E-06	2.36E-04
Cadmium	mg/kg	3.25E-01	ND	5.50E-01	1.79E-01	0.76	0.55	3.50E+05	1.00E-06	2.62E-02
Calcium	mg/kg	7.21E+02	ND	3.50E+00	2.52E+03	0.76	0.55	3.50E+05	1.00E-06	3.69E+02
Carbon disulfide	mg/kg	1.72E-04	2	1.35E-01	2.33E-05	0.76	0.55	3.50E+05	1.00E-06	3.40E-06
Chloroform	mg/kg	4.61E-03	1.97	1.41E-01	6.49E-04	0.76	0.55	3.50E+05	1.00E-06	9.49E-05
Chromium	mg/kg	2.44E+01	ND	7.50E-03	1.83E-01	0.76	0.55	3.50E+05	1.00E-06	2.68E-02
Cobalt	mg/kg	1.10E+00	ND	8.10E-02	8.94E-02	0.76	0.55	3.50E+05	1.00E-06	1.31E-02
Copper	mg/kg	3.22E+02	ND	4.00E-01	1.29E+02	0.76	0.55	3.50E+05	1.00E-06	1.88E+01
Cyanide	mg/kg	1.11E-01	-0.25	2.70E+00	3.00E-01	0.76	0.55	3.50E+05	1.00E-06	4.39E-02
Di-n-butyl-phthalate	mg/kg	4.92E-03	3.75	1.32E-02	6.48E-05	0.76	0.55	3.50E+05	1.00E-06	9.48E-06
Dibenzofuran	mg/kg	1.74E-03	4.17	7.53E-03	1.31E-05	0.76	0.55	3.50E+05	1.00E-06	1.92E-06
Dichloromethane	mg/kg	8.15E-04	1.51	2.60E-01	2.12E-04	0.76	0.55	3.50E+05	1.00E-06	3.09E-05
Dieldrin	mg/kg	9.21E-04	3.5	1.84E-02	1.69E-05	0.76	0.55	3.50E+05	1.00E-06	2.47E-06
Diethylphthalate	mg/kg	1.31E-02	2.46	7.33E-02	9.61E-04	0.76	0.55	3.50E+05	1.00E-06	1.41E-04
Ethylbenzene	mg/kg	8.50E-05	3.15	2.93E-02	2.49E-06	0.76	0.55	3.50E+05	1.00E-06	3.64E-07
Fluoranthene	mg/kg	5.94E-03	5.2	1.91E-03	1.14E-05	0.76	0.55	3.50E+05	1.00E-06	1.66E-06
Indeno (1,2,3-c,d)pyrene	mg/kg	1.51E-03	6.5	3.39E-04	5.12E-07	0.76	0.55	3.50E+05	1.00E-06	7.49E-08
Iron	mg/kg	2.02E+04	ND	4.00E-03	8.09E+01	0.76	0.55	3.50E+05	1.00E-06	1.18E+01
Lead	mg/kg	2.73E+01	ND	5.80E-03	1.58E-01	0.76	0.55	3.50E+05	1.00E-06	2.32E-02
Magnesium	mg/kg	2.10E+02	ND	1.00E+00	2.10E+02	0.76	0.55	3.50E+05	1.00E-06	3.07E+01
Manganese	mg/kg	1.03E+02	ND	5.60E-01	5.76E+01	0.76	0.55	3.50E+05	1.00E-06	8.43E+00
Mercury	mg/kg	2.80E-02	ND	9.00E-01	2.52E-02	0.76	0.55	3.50E+05	1.00E-06	3.69E-03
Methoxychlor	mg/kg	5.36E-03	4.3	6.33E-03	3.39E-05	0.76	0.55	3.50E+05	1.00E-06	4.96E-06
Methyl ethyl ketone	mg/kg	1.39E-03	0.26	1.37E+00	1.91E-03	0.76	0.55	3.50E+05	1.00E-06	2.79E-04
Nickel	mg/kg	1.09E+01	ND	2.80E-01	3.04E+00	0.76	0.55	3.50E+05	1.00E-06	4.45E-01

Table 6.20 Calculation of Contaminant Intake from Leafy Vegetation Consumption by the Meadow Vole Soil (Depth 0 - 5 feet) (continued)

COPCs	Units	Expo-sure Conc*	log (Kow)**	BCF' leafy vegetation	contaminant concentration in leafy vegetation (BCF x soil conc.) (mg/kg PT**)	proportion leafy vegetation in diet	proportion digestibility of diet	food ingestion rate (mg PT/ kg BW - day)	unit conversion (1kg/10^6 mg PT)	contaminant intake (mg/kg BW - day)
OCDD	mg/kg	4.06E-03	6.91	1.96E-04	7.98E-07	0.76	0.55	3.50E+05	1.00E-06	1.17E-07
p,p'-DDE	mg/kg	1.92E-03	5.69	9.96E-04	1.91E-06	0.76	0.55	3.50E+05	1.00E-06	2.79E-07
p,p'-DDT	mg/kg	1.36E-03	5.98	6.77E-04	9.20E-07	0.76	0.55	3.50E+05	1.00E-06	1.35E-07
PCB1254	mg/kg	1.93E-02	6.94	1.89E-04	3.63E-06	0.76	0.55	3.50E+05	1.00E-06	5.31E-07
Potassium	mg/kg	1.31E+02	ND	1.00E+00	1.31E+02	0.76	0.55	3.50E+05	1.00E-06	1.91E+01
Pyrene	mg/kg	7.72E-03	5.18	1.96E-03	1.51E-05	0.76	0.55	3.50E+05	1.00E-06	2.22E-06
Selenium	mg/kg	3.62E+00	ND	2.50E-02	9.06E-02	0.76	0.55	3.50E+05	1.00E-06	1.33E-02
Silver	mg/kg	5.02E-01	ND	2.70E-04	1.36E-04	0.76	0.55	3.50E+05	1.00E-06	1.98E-05
Sodium	mg/kg	2.53E+01	ND	7.50E-02	1.89E+00	0.76	0.55	3.50E+05	1.00E-06	2.77E-01
Tetrachloroethylene	mg/kg	2.70E-05	2.53	6.68E-02	1.80E-06	0.76	0.55	3.50E+05	1.00E-06	2.64E-07
Thallium	mg/kg	2.16E+00	ND	6.60E-03	1.42E-02	0.76	0.55	3.50E+05	1.00E-06	2.08E-03
Toluene	mg/kg	4.45E-03	2.69	5.40E-02	2.40E-04	0.76	0.55	3.50E+05	1.00E-06	3.51E-05
Trichloroethylene	mg/kg	3.60E-05	2.42	7.73E-02	2.78E-06	0.76	0.55	3.50E+05	1.00E-06	4.07E-07
Vanadium	mg/kg	4.30E+01	ND	1.00E+00	4.30E+01	0.76	0.55	3.50E+05	1.00E-06	6.30E+00
Xylenes	mg/kg	6.92E-04	3.2	2.74E-02	1.89E-05	0.76	0.55	3.50E+05	1.00E-06	2.77E-06
Zinc	mg/kg	5.00E+01	ND	1.40E+00	7.00E+01	0.76	0.55	3.50E+05	1.00E-06	1.02E+01

receptor	Meadow vole
food ing. rate (g/g-day)	0.35
BW (g)	17
% area use	100
% digestibility of diet	55
% leafy veg. in diet	76
dry/wet weight ratio	0.05
% frac. org. carbon (foc)	2

* Exposure concentration represents the lesser of the maximum detected concentration or the 95% UCL.

**Kow = octanol/water partition coefficient

' BCF = biococentration factor, where log BCF = 1.588-(0.578 x log (Kow)) for organics; for inorganics,
BCF = soil-to-plant concentration factor from NRC (1992). BCFs are multiplied by the dry/wet weight ratio from Baes et al. (1984) to adjust for dry/wet weight differences in leafy vegetation

** PT = plant tissue

Table 6.21 Sample Calculation of Exposure Via Ingestion Of Leafy Vegetables

Ingestion for Meadow vole	conc. in leafy vegetation		Area use factor		Proportion leafy veg. in diet		Proportion estimated degestibility		Food ingestion rate		Conversion factor		Calculated dose from leafy vegetation
2-Hexanone	5.99E-05 $\frac{\text{mg chem}}{\text{kg PT}}$	X	1	X	0.76	X	0.55	X	350000 $\frac{\text{mg PT}}{\text{kgBW-day}}$	X	$\frac{1}{1.00E+06}$ $\frac{\text{kg PT}}{\text{mg PT}}$	=	8.76E-06 $\frac{\text{mg chem}}{\text{kg BW-day}}$

$$\log(\text{BCF}) = 1.588 - (0.578 \times \underset{1.38}{\log(\text{Kow})}) = \underset{0.7904}{\log(\text{BCF})}$$

$$\text{BCF} = 10 \wedge \underset{0.79036}{\log(\text{BCF})} = \underset{6.17}{\text{BCF}}$$

$$\text{Concentration in leafy vegetation} = \underset{6.17}{\text{BCF}} \times \underset{0.05}{\text{dry/wet wt. ratio adjustments}} \times \underset{0.000194}{\text{exposure concentration}} \frac{\text{mg chem}}{\text{kg soil}} = 5.99E-05 \frac{\text{mg chem}}{\text{kg PT}}$$

Exposure Factors	
Chemical	2-Hexanone
Exp. conc (mg/kg)	0.000194
Receptor	Meadow vole
Food ing. rate (g/g-day)	0.35
BW (g)	17
% Area use	100
% Digestibility of diet	55
% Leafy veg. in diet	76
Dry/wet weight ratio*	0.05

* From Baes et al. (1984)
Shading indicates cancelled terms
BCF = Bioconcentration factor

Kow = octanol/water partitioning coefficient
PT = plant tissue

Meadow vole TOTAL DAILY INTAKE of 2-Hexanone (in leafy vegetation)

8.76E-06 $\frac{\text{mg chem}}{\text{kg BW-day}}$

Table 6.22 Calculated Intake from Incidental Ingestion of Surface Soil by the Meadow Vole Soil (Depth 0 - 2 feet)

COPC	Units	Exposure conc.	Daily soil intake (g soil/day)	unit conversion factor	Area use factor	proportion absorption	body weight (kg BW)	contaminant intake (mg /kg BW - day)
2-Hexanone	mg/kg	2.28E-04	1.43E-01	1.00E-03	1	1	0.017	1.92E-06
2-Methylnaphthalene	mg/kg	2.68E-03	1.43E-01	1.00E-03	1	1	0.017	2.25E-05
4-Chloro-m-cresol	mg/kg	2.16E-03	1.43E-01	1.00E-03	1	1	0.017	1.81E-05
4-Chlorophenyl phenyl ether	mg/kg	1.21E-03	1.43E-01	1.00E-03	1	1	0.017	1.02E-05
Acetone	mg/kg	3.08E-02	1.43E-01	1.00E-03	1	1	0.017	2.59E-04
Antimony	mg/kg	1.66E+00	1.43E-01	1.00E-03	1	1	0.017	1.40E-02
Arsenic	mg/kg	1.97E+00	1.43E-01	1.00E-03	1	1	0.017	1.65E-02
Barium	mg/kg	3.44E+01	1.43E-01	1.00E-03	1	1	0.017	2.89E-01
Benzene	mg/kg	5.98E-04	1.43E-01	1.00E-03	1	1	0.017	5.02E-06
Benzo (b)fluoranthene	mg/kg	4.05E-03	1.43E-01	1.00E-03	1	1	0.017	3.41E-05
Benzo (k)fluoranthene	mg/kg	2.67E-03	1.43E-01	1.00E-03	1	1	0.017	2.24E-05
Benzoic acid	mg/kg	1.65E-02	1.43E-01	1.00E-03	1	1	0.017	1.39E-04
Bis (2-ethylhexyl)phthalate	mg/kg	6.84E-03	1.43E-01	1.00E-03	1	1	0.017	5.74E-05
Calcium	mg/kg	4.56E+02	1.43E-01	1.00E-03	1	1	0.017	3.83E+00
Carbon disulfide	mg/kg	1.97E-04	1.43E-01	1.00E-03	1	1	0.017	1.65E-06
Chloroform	mg/kg	4.16E-03	1.43E-01	1.00E-03	1	1	0.017	3.49E-05
Chromium	mg/kg	2.58E+01	1.43E-01	1.00E-03	1	1	0.017	2.16E-01
Cobalt	mg/kg	1.17E+00	1.43E-01	1.00E-03	1	1	0.017	9.79E-03
Copper	mg/kg	6.87E+02	1.43E-01	1.00E-03	1	1	0.017	5.77E+00
Cyanide	mg/kg	1.49E-01	1.43E-01	1.00E-03	1	1	0.017	1.25E-03
Di-n-butylphthalate	mg/kg	4.92E-03	1.43E-01	1.00E-03	1	1	0.017	4.13E-05
Dibenzofuran	mg/kg	1.12E-03	1.43E-01	1.00E-03	1	1	0.017	9.44E-06
Dichloromethane	mg/kg	6.34E-04	1.43E-01	1.00E-03	1	1	0.017	5.33E-06
Dieldrin	mg/kg	1.11E-03	1.43E-01	1.00E-03	1	1	0.017	9.32E-06
Diethylphthalate	mg/kg	2.27E-02	1.43E-01	1.00E-03	1	1	0.017	1.91E-04
Ethylbenzene	mg/kg	6.60E-05	1.43E-01	1.00E-03	1	1	0.017	5.54E-07
Fluoranthene	mg/kg	7.50E-03	1.43E-01	1.00E-03	1	1	0.017	6.30E-05
Indeno (1,2,3-c,d)pyrene	mg/kg	2.03E-03	1.43E-01	1.00E-03	1	1	0.017	1.70E-05
Iron	mg/kg	1.43E+04	1.43E-01	1.00E-03	1	1	0.017	1.20E+02
Lead	mg/kg	2.79E+01	1.43E-01	1.00E-03	1	1	0.017	2.34E-01
Magnesium	mg/kg	1.66E+02	1.43E-01	1.00E-03	1	1	0.017	1.39E+00
Manganese	mg/kg	8.58E+01	1.43E-01	1.00E-03	1	1	0.017	7.20E-01
Mercury	mg/kg	2.18E-02	1.43E-01	1.00E-03	1	1	0.017	1.83E-04
Methylethylketone	mg/kg	1.95E-04	1.43E-01	1.00E-03	1	1	0.017	1.64E-06
Nickel	mg/kg	1.46E+01	1.43E-01	1.00E-03	1	1	0.017	1.23E-01
OCDD	mg/kg	1.36E-03	1.43E-01	1.00E-03	1	1	0.017	1.14E-05

Table 6.22 Calculated Intake from Incidental Ingestion of Surface Soil by the Meadow Vole Soil (Depth 0 - 2 feet) (continued)

COPC	Units	Exposure conc.	Daily soil intake (g soil/day)	unit conversion factor	Area use factor	proportion absorption	body weight (kg BW)	contaminant intake (mg /kg BW - day)
p,p'-DDE	mg/kg	1.85E-03	1.43E-01	1.00E-03	1	1	0.017	1.55E-05
p,p'-DDT	mg/kg	1.54E-03	1.43E-01	1.00E-03	1	1	0.017	1.30E-05
PCB1254	mg/kg	2.30E-02	1.43E-01	1.00E-03	1	1	0.017	1.93E-04
Potassium	mg/kg	1.11E+02	1.43E-01	1.00E-03	1	1	0.017	9.29E-01
Pyrene	mg/kg	9.24E-03	1.43E-01	1.00E-03	1	1	0.017	7.76E-05
Selenium	mg/kg	2.60E+00	1.43E-01	1.00E-03	1	1	0.017	2.19E-02
Silver	mg/kg	3.79E-01	1.43E-01	1.00E-03	1	1	0.017	3.18E-03
Sodium	mg/kg	8.84E+00	1.43E-01	1.00E-03	1	1	0.017	7.42E-02
Tetrachloroethylene	mg/kg	3.30E-05	1.43E-01	1.00E-03	1	1	0.017	2.77E-07
Thallium	mg/kg	2.35E+00	1.43E-01	1.00E-03	1	1	0.017	1.98E-02
Toluene	mg/kg	4.11E-03	1.43E-01	1.00E-03	1	1	0.017	3.45E-05
Trichloroethylene	mg/kg	4.90E-05	1.43E-01	1.00E-03	1	1	0.017	4.12E-07
Vanadium	mg/kg	3.73E+01	1.43E-01	1.00E-03	1	1	0.017	3.14E-01
Xylenes	mg/kg	6.15E-04	1.43E-01	1.00E-03	1	1	0.017	5.17E-06
Zinc	mg/kg	4.45E+01	1.43E-01	1.00E-03	1	1	0.017	3.74E-01

receptor	Meadow vole
food ing. rate (g/g-day)	0.35
BW (g)	17
% soil in diet	2.4
% area use	100
% absorption	100

* Exposure concentration represents the maximum detected concentration for soil or the 95% UCL, whichever was less

Table 6.23 Calculation of Contaminant Intake from Incidental Ingestion of Surface Soil by the Meadow Vole Soil (Depth 0 - 5 feet)

COPCs	Units	Exposure conc.	Daily soil intake (g soil/day)	unit conversion factor	Area use factor	proportion absorption	body weight (kg BW)	contaminant intake (mg /kg BW - day)
2-Hexanone	mgkg	1.94E-04	1.43E-01	1.00E-03	1	1	0.017	1.63E-06
2-Methylnaphthalene	mgkg	2.34E-03	1.43E-01	1.00E-03	1	1	0.017	1.96E-05
4-Chloro-m-cresol	mgkg	1.32E-03	1.43E-01	1.00E-03	1	1	0.017	1.10E-05
Acetone	mgkg	2.83E-02	1.43E-01	1.00E-03	1	1	0.017	2.37E-04
Antimony	mgkg	1.65E+00	1.43E-01	1.00E-03	1	1	0.017	1.39E-02
Arsenic	mgkg	2.38E+00	1.43E-01	1.00E-03	1	1	0.017	2.00E-02
Barium	mgkg	3.85E+01	1.43E-01	1.00E-03	1	1	0.017	3.23E-01
Benzene	mgkg	2.65E-03	1.43E-01	1.00E-03	1	1	0.017	2.23E-05
Benzo (b)fluoranthene	mgkg	2.88E-03	1.43E-01	1.00E-03	1	1	0.017	2.42E-05
Benzo (k)fluoranthene	mgkg	1.97E-03	1.43E-01	1.00E-03	1	1	0.017	1.65E-05
Benzoic acid	mgkg	1.37E-02	1.43E-01	1.00E-03	1	1	0.017	1.15E-04
Beryllium	mgkg	1.61E-01	1.43E-01	1.00E-03	1	1	0.017	1.35E-03
Cadmium	mgkg	3.25E-01	1.43E-01	1.00E-03	1	1	0.017	2.73E-03
Calcium	mgkg	7.21E+02	1.43E-01	1.00E-03	1	1	0.017	6.05E+00
Carbon disulfide	mgkg	1.72E-04	1.43E-01	1.00E-03	1	1	0.017	1.44E-06
Chloroform	mgkg	4.61E-03	1.43E-01	1.00E-03	1	1	0.017	3.87E-05
Chromium	mgkg	2.44E+01	1.43E-01	1.00E-03	1	1	0.017	2.05E-01
Cobalt	mgkg	1.10E+00	1.43E-01	1.00E-03	1	1	0.017	9.27E-03
Copper	mgkg	3.22E+02	1.43E-01	1.00E-03	1	1	0.017	2.70E+00
Cyanide	mgkg	1.11E-01	1.43E-01	1.00E-03	1	1	0.017	9.32E-04
Di-n-butyl-phthalate	mgkg	4.92E-03	1.43E-01	1.00E-03	1	1	0.017	4.13E-05
Dibenzofuran	mgkg	1.74E-03	1.43E-01	1.00E-03	1	1	0.017	1.46E-05
Dichloromethane	mgkg	8.15E-04	1.43E-01	1.00E-03	1	1	0.017	6.85E-06
Dieldrin	mgkg	9.21E-04	1.43E-01	1.00E-03	1	1	0.017	7.74E-06
Diethylphthalate	mgkg	1.31E-02	1.43E-01	1.00E-03	1	1	0.017	1.10E-04
Ethylbenzene	mgkg	8.50E-05	1.43E-01	1.00E-03	1	1	0.017	7.14E-07
Fluoranthene	mgkg	5.94E-03	1.43E-01	1.00E-03	1	1	0.017	4.99E-05
Indeno (1,2,3-c,d)pyrene	mgkg	1.51E-03	1.43E-01	1.00E-03	1	1	0.017	1.27E-05
Iron	mgkg	2.02E+04	1.43E-01	1.00E-03	1	1	0.017	1.70E+02
Lead	mgkg	2.73E+01	1.43E-01	1.00E-03	1	1	0.017	2.29E-01
Magnesium	mgkg	2.10E+02	1.43E-01	1.00E-03	1	1	0.017	1.76E+00
Manganese	mgkg	1.03E+02	1.43E-01	1.00E-03	1	1	0.017	8.64E-01
Mercury	mgkg	2.80E-02	1.43E-01	1.00E-03	1	1	0.017	2.36E-04
Methoxychlor	mgkg	5.36E-03	1.43E-01	1.00E-03	1	1	0.017	4.50E-05
Methyl ethyl ketone	mgkg	1.39E-03	1.43E-01	1.00E-03	1	1	0.017	1.17E-05

Table 6.23 Calculation of Contaminant Intake from Incidental Ingestion of Surface Soil by the Meadow Vole Soil (Depth 0 - 5 feet) (continued)

COPCs	Units	Exposure conc.	Daily soil intake (g soil/day)	unit conversion factor	Area use factor	proportion absorption	body weight (kg BW)	contaminant intake (mg /kg BW · day)
Nickel	mgkg	1.09E+01	1.43E-01	1.00E-03	1	1	0.017	9.12E-02
OCDD	mgkg	4.06E-03	1.43E-01	1.00E-03	1	1	0.017	3.41E-05
p,p'-DDE	mgkg	1.92E-03	1.43E-01	1.00E-03	1	1	0.017	1.61E-05
p,p'-DDT	mgkg	1.36E-03	1.43E-01	1.00E-03	1	1	0.017	1.14E-05
PCB1254	mgkg	1.93E-02	1.43E-01	1.00E-03	1	1	0.017	1.62E-04
Potassium	mgkg	1.31E+02	1.43E-01	1.00E-03	1	1	0.017	1.10E+00
Pyrene	mgkg	7.72E-03	1.43E-01	1.00E-03	1	1	0.017	6.48E-05
Selenium	mgkg	3.62E+00	1.43E-01	1.00E-03	1	1	0.017	3.04E-02
Silver	mgkg	5.02E-01	1.43E-01	1.00E-03	1	1	0.017	4.22E-03
Sodium	mgkg	2.53E+01	1.43E-01	1.00E-03	1	1	0.017	2.12E-01
Tetrachloroethylene	mgkg	2.70E-05	1.43E-01	1.00E-03	1	1	0.017	2.27E-07
Thallium	mgkg	2.16E+00	1.43E-01	1.00E-03	1	1	0.017	1.81E-02
Toluene	mgkg	4.45E-03	1.43E-01	1.00E-03	1	1	0.017	3.73E-05
Trichloroethylene	mgkg	3.60E-05	1.43E-01	1.00E-03	1	1	0.017	3.02E-07
Vanadium	mgkg	4.30E+01	1.43E-01	1.00E-03	1	1	0.017	3.61E-01
Xylenes	mgkg	6.92E-04	1.43E-01	1.00E-03	1	1	0.017	5.81E-06
Zinc	mgkg	5.00E+01	1.43E-01	1.00E-03	1	1	0.017	4.20E-01

receptor	Meadow vole
food ing. rate (g/g-day)	0.35
BW (g)	17
% soil in diet	2.4
% area use	100
% absorption	100

* Exposure concentration represents the lesser of the maximum detected concentration for soil or the 95% UCL.

Table 6.24 Sample Calculation of Intake Via Incidental Ingestion Of Soil by the Meadow Vole

Ingestion for Meadow vole	Exposure concentration		Daily incidental soil intake		Conversion factor		Area use factor		Proportion adsorption		1/BW		Calculated dose from soil ingestion
2-Hexanone	0.000194 $\frac{\text{mg chem}}{\text{kg soil}}$	X	0.143 $\frac{\text{g soil}}{\text{day}}$	X	$\frac{1}{1000}$ $\frac{\text{kg soil}}{\text{g soil}}$	X	1	X	1	X	$\frac{1}{0.017}$ kg BW	=	1.63E-06 $\frac{\text{mg chem}}{\text{g BW-day}}$

		Food ingestion rate (g food/g BW - day)		BW (g BW)		proportion soil in diet (g soil/g food)		Daily intake (g soil/day)
Daily intake (g soil/day)	=	0.35	X	17	X	0.024	=	0.143

Exposure Factors	
Chemical	2-Hexanone
Exp. conc (mg/kg)	0.000194
Receptor	Meadow vole
Food ing. rate (g/g-day)	0.35
BW (g)	17
% soil in diet	2.4
% area use	100
% absorption	100

Meadow vole	TOTAL DAILY INTAKE of	2-Hexanone	(in soil)
	1.63E-06	$\frac{\text{mg chem}}{\text{g BW-day}}$	

Shading indicates cancelled terms
Kow = octanol/water partitioning coefficient

Table 6.25 Toxicity Benchmark Derivation
Soil (Depth 0 - 2 feet)

COPCs	Toxicity Value (mg/kg-d)	Basis of Toxicity Value	Source	Uncertainty Factor	Toxicity Benchmark (mg/kg-d)
2-Hexanone	400	NOAEL, rat, gavage-water, chronic- 40 weeks, hepatic effects	ATSDR,1992	--	400
2-Methylnaphthalene[a]	133	NOAEL, mouse, gavage-oil, chronic- 90 days, systemic effects	ATSDR,1993	--	133
4-Chloro-m-cresol[b]	175	NOAEL, rat, gavage-oil, chronic- 20 week, mortality	ATSDR,1992	--	175
4-Chlorophenyl phenyl ether	ND			--	ND
Acetone	100	NOAEL, rat, diet, chronic-90 days, nephrotoxicity	IRIS, 1995	--	100
Antimony	0.26	NOAEL, rat, water, chronic- 1300 days, systemic-cardiovascular	ATSDR,1992	--	0.26
Arsenic	0.7	NOAEL, rat, water, chronic- 2 years, hematological effects	ATSDR,1993	--	0.7
Barium	0.7	NOAEL, rat, water, chronic- 2 years, systemic effects	ATSDR,1992	--	0.7
Benzene	1	NOAEL, rat, gavage, acute-78 days, leukopenia	ATSDR,1992	0.1	0.1
Benzo (b)fluoranthene[c]	0.15	LOAEL, rat, feed, chronic- 102 weeks, cancer	ATSDR,1993	0.1	0.015
Benzo (k)fluoranthene[c]	0.15	LOAEL, rat, feed, chronic- 102 weeks, cancer	ATSDR,1993	0.1	0.015
Benzoic acid	1	NOAEL, rat, gavage, acute-78 days, leukopenia	ATSDR,1992	0.1	0.1
Bis (2-ethylhexyl)phthalate	13	NOAEL, mouse, diet, chronic-166 days, decreased fertility	ATSDR, 1993	--	13
Calcium	ND			--	ND
Carbondisulfide	100	NOAEL, rat, gavage-oil, acute- 4 weeks, developmental	ATSDR,1992	0.1	10
Chloroform	4	NOAEL, rat, water, acute-28 days, systemic-hematologic effects	ATSDR 1993	0.1	0.4
Chromium	0.46	NOAEL, rat, water, chronic-3 years, systemic-cardiovascular, renal effects	ATSDR 1993	--	0.46
Cobalt	5	NOAEL, rat, diet, acute- 69 days, testicular atrophy	ATSDR,1992	0.1	0.5
Copper	4.2	LOAEL, mouse, water, chronic- 850 days, death	ATSDR 1990	0.1	0.42
Cyanide	30	LOAEL, rat, feed, chronic- 11.5 months, myelin degradation	ATSDR,1993	0.1	3
Di-n-butylphthalate[d]	13	NOAEL, mouse, diet, chronic- 166 days, decreased fertility	ATSDR,1993	--	13
Dibenzofuran[e]	0.001	NOAEL, guinea pig, gavage, acute-42 days, hematologic effects	ATSDR, 1992	0.1	0.0001
Dichloromethane	6	NOAEL, rat, water, chronic-104 weeks, hepatic effects	ATSDR,1993	--	6
Dieldrin	10	NOAEL, mouse, feed, chronic-644 days, hepatic effects	ATSDR, 1993	--	10
Diethylphthalate	3701	NOAEL, rat, feed, acute-12 weeks, hepatic effects	ATSDR,1993	0.1	370.1
Ethylbenzene	4728	LD50, rat, gavage, acute-1 day, death	ATSDR,1990	0.001	4.728
Fluoranthene	125	NOAEL, mouse, feed, chronic-91 days, nephropathy, hepatic effects	IRIS, 1995	--	125
Indeno (1,2,3-c,d)pyrene[c]	0.15	LOAEL, rat, feed, chronic-102 weeks, cancer	ATSDR,1993	0.1	0.015

Table 6.25 Toxicity Benchmark Derivation
Soil (Depth 0 - 2 feet) (continued)

COPCs	Toxicity Value (mg/kg-d)	Basis of Toxicity Value	Source	Uncertainty Factor	Toxicity Benchmark (mg/kg-d)
Iron	ND			--	ND
Lead	0.002	NOAEL, rat, water, chronic-1year, neurological effects	ATSDR,1993	--	0.002
Magnesium	ND			--	ND
Manganese	250	NOAEL, mouse, feed, chronic-103 weeks, gastrointestinal effects	ATSDR,1992	--	250
Mercury	0.02	NOAEL, rat, feed, chronic-2 years, renal effects	ATSDR,1994	--	0.02
Methylethylketone	1771	NOAEL, rat, water, acute- 63 days, decreased fetal body weight	IRIS,1994	0.1	177.1
Nickel	8.6	NOAEL, rat, gavage-water, chronic-91days, systemic effects	ATSDR,1995	--	8.6
OCDD	4000	NOAEL, mouse-oral, acute	HSDB 1995	0.1	400
p,p'-DDE	23	NOAEL, rat, feed, chronic-546 days, cardiovascular, hepatic effects	ATSDR, 1992	--	23
p,p'-DDT	2.4	NOAEL, mouse, chronic-450 days, reproductive effects	ATSDR, 1992	--	2.4
PCB1254	1.25	NOAEL, rat, feed, chronic-104 weeks, systemic effects	ATSDR,1995	--	1.25
Potassium	ND			--	ND
Pyrene	75	NOAEL, mouse, gavage, chronic-91 days, nephropathy	IRIS, 1995	--	75
Selenium	0.025	NOAEL, rat, feed, chronic-2 years, hepatic effects	ATSDR,1994	--	0.025
Silver	181.2	NOAEL, rat, water, acute-2 weeks, death	ATSDR,1990	0.1	18.12
Sodium	ND			--	ND
Tetrachloroethylene	386	LOAEL, mouse, gavage-oil, chronic-78 weeks, renal effects, death	ATSDR,1995	0.1	38.6
Thallium	0.2	NOAEL, rat, gavage, chronic-90 days, systemic effects	ATSDR,1992	--	0.2
Toluene	312	NOAEL, mouse, gavage, chronic-13 weeks, systemic effects	ATSDR,1992	--	312
Trichloroethylene	100	NOAEL, rat-gavage oil, acute-21 days, developmental effects	ATSDR 1995	0.1	10
Vanadium	0.3	NOAEL, rat, water, chronic-3 months, renal effects	ATSDR,1992	--	0.3
Xylenes	500	NOAEL, mouse, gavage-oil, chronic-103 weeks, reproductive effects	ATSDR, 1993	--	500
Zinc	16.3	NOAEL, mouse, feed, chronic-9 months, hematologic effects	ATSDR 1992	--	16.3

ND No data available
(a) Substituted toxicity value for naphthalene
(b) Substituted toxicity value for m-cresol
(c) Substituted toxicity value for benzo(a)pyrene
(d) Substituted toxicity value for bis(2-ethylhexyl)phthalate
(e) Substituted toxicity value for 2,3,7,8-TCDD

Table 6.26 Toxicity Benchmark Derivation
Soil (Depth 0 - 5 feet)

COPCs	Toxicity Value (mg/kg-d)	Basis of Toxicity Value	Source	Uncertainty	Toxicity Benchmark (mg/kg-d)
2-Hexanone	400	NOAEL, rat, gavage-water, chronic- 40 weeks, hepatic effects	ATSDR,1992	--	400
2-Methylnaphthalene[a]	133	NOAEL, mouse, gavage-oil, chronic- 90 days, systemic effects	ATSDR,1993	--	133
4-Chloro-m-cresol[b]	175	NOAEL, rat, gavage-oil, chronic- 20 week, mortality	ATSDR,1992	--	175
Acetone	100	NOAEL, rat, diet, chronic-90 days, nephrotoxicity	IRIS, 1995	--	100
Antimony	0.26	NOAEL, rat, water, chronic- 1300 days, systemic-cardiovascular	ATSDR,1992	--	0.26
Arsenic	0.7	NOAEL, rat, water, chronic- 2 years, hematological effects	ATSDR,1993	--	0.7
Barium	0.7	NOAEL, rat, water, chronic- 2 years, systemic effects	ATSDR,1992	--	0.7
Benzene	1	NOAEL, rat, gavage, acute-78 days, leukopenia	ATSDR,1992	0.1	0.1
Benzo (b)fluoranthene[c]	0.15	LOAEL, rat, feed, chronic- 102 weeks, cancer	ATSDR,1993	0.1	0.015
Benzo (k)fluoranthene[c]	0.15	LOAEL, rat, feed, chronic- 102 weeks, cancer	ATSDR,1993	0.1	0.015
Benzoic acid	1	NOAEL, rat, gavage, acute-78 days, leukopenia	ATSDR,1992	0.1	0.1
Beryllium	0.7	NOAEL, rat, water, chronic- 2 years, systemic	ATSDR,1993	--	0.7
Cadmium	0.03	NOAEL, rat, water, chronic- 18 months, renal effects	ATSDR,1993	--	0.03
Calcium	ND			--	ND
Carbondisulfide	100	NOAEL, rat, gavage-oil, acute- 4 weeks, developmental	ATSDR,1992	0.1	10
Chloroform	4	NOAEL, rat, water, acute-28 days, systemic-hematologic effects	ATSDR 1993	0.1	0.4
Chromium	0.46	NOAEL, rat, water, chronic-3 years, systemic-cardiovascular, renal effects	ATSDR 1993	--	0.46
Cobalt	5	NOAEL, rat, diet, acute- 69 days, testicular atrophy	ATSDR,1992	0.1	0.5
Copper	4.2	LOAEL, mouse, water, chronic- 850 days, death	ATSDR 1990	0.1	0.42
Cyanide	30	LOAEL, rat, feed, chronic- 11.5 months, myelin degradation	ATSDR,1993	0.1	3
Di-n-butylphthalate[d]	13	NOAEL, mouse, diet, chronic- 166 days, decreased fertility	ATSDR,1993	--	13
Dibenzofuran[e]	0.001	NOAEL, guinea pig, gavage, acute-42 days, hematologic effects	ATSDR, 1992	0.1	0.0001
Dichloromethane	6	NOAEL, rat, water, chronic-104 weeks, hepatic effects	ATSDR,1993	--	6
Dieldrin	10	NOAEL, mouse, feed, chronic-644 days, hepatic effects	ATSDR, 1993	--	10
Diethylphthalate	3701	NOAEL, rat, feed, acute-12 weeks, hepatic effects	ATSDR,1993	0.1	370.1
Ethylbenzene	4728	LD50, rat, gavage, acute-1 day, death	ATSDR,1990	0.001	4.728
Fluoranthene	125	NOAEL, mouse, feed, chronic-91 days, nephropathy, hepatic effects	IRIS, 1995	--	125
Indeno (1,2,3-c,d)pyrene[c]	0.15	LOAEL, rat, feed, chronic-102 weeks, cancer	ATSDR,1993	0.1	0.015
Iron	ND			--	ND

Table 6.26 Toxicity Benchmark Derivation
Soil (Depth 0 - 5 feet) (continued)

COPCs	Toxicity Value (mg/kg-d)	Basis of Toxicity Value	Source	Uncertainty	Toxicity Benchmark (mg/kg-d)
Lead	0.002	NOAEL, rat, water, chronic-1year, neurological effects	ATSDR,1993	--	0.002
Magnesium	ND			--	ND
Manganese	250	NOAEL, mouse, feed, chronic-103 weeks, gastrointestinal effects	ATSDR,1992	--	250
Mercury	0.02	NOAEL, rat, feed, chronic-2 years, renal effects	ATSDR,1994	--	0.02
Methoxychlor	69	NOAEL, rat, feed, chronic-78 weeks, systemic effects	ATSDR,1992	--	69
Methylethylketone	1771	NOAEL, rat, water, acute- 63 days, decreased fetal body weight	IRIS,1995	0.1	177.1
Nickel	8.6	NOAEL, rat, gavage-water, chronic-91days, systemic effects	ATSDR,1995	--	8.6
OCDD	4000	NOAEL, mouse-oral, acute	HSDB 1995	0.1	400
p,p'-DDE	23	NOAEL, rat, feed, chronic-546 days, cardiovascular, hepatic effects	ATSDR, 1992	--	23
p,p'-DDT	2.4	NOAEL, mouse, chronic-450 days, reproductive effects	ATSDR, 1992	--	2.4
PCB1254	1.25	NOAEL, rat, feed, chronic-104 weeks, systemic effects	ATSDR,1995	--	1.25
Potassium	ND			--	ND
Pyrene	75	NOAEL, mouse, gavage, chronic-91 days, nephropathy	IRIS, 1995	--	75
Selenium	0.025	NOAEL, rat, feed, chronic-2 years, hepatic effects	ATSDR,1994	--	0.025
Silver	181.2	NOAEL, rat, water, acute-2 weeks, death	ATSDR,1990	0.1	18.12
Sodium	ND			--	ND
Tetrachloroethylene	386	LOAEL, mouse, gavage-oil, chronic-78 weeks, renal effects, death	ATSDR,1995	0.1	38.6
Thallium	0.2	NOAEL, rat, gavage, chronic-90 days, systemic effects	ATSDR,1992	--	0.2
Toluene	312	NOAEL, mouse, gavage, chronic-13 weeks, systemic effects	ATSDR,1992	--	312
Trichloroethylene	100	NOAEL, rat-gavage oil, acute-21 days, developmental effects	ATSDR 1995	0.1	10
Vanadium	0.3	NOAEL, rat, water, chronic-3 months, renal effects	ATSDR,1992	--	0.3
Xylenes	500	NOAEL, mouse, gavage-oil, chronic-103 weeks, reproductive effects	ATSDR, 1993	--	500
Zinc	16.3	NOAEL, mouse, feed, chronic-9 months, hematologic effects	ATSDR 1992	--	16.3

ND No data available
(a) Substituted toxicity value for naphthalene
(b) Substituted toxicity value for m-cresol
(c) Substituted toxicity value for benzo(a)pyrene
(d) Substituted toxicity value for bis(2-ethylhexyl)phthalate
(e) Substituted toxicity value for 2,3,7,8-TCDD

Table 6.27 Calculation of Total Intakes and Hazard Quotients
Soil (Depth 0 - 2 feet)

COPCs	Root/Fruit Intake (mg/kg-day)	Leafy Plant Intake (mg/kg-day)	Incidental Intake (mg/kg-day)	Total Intake (mg/kg-day)	Toxicity Benchmark (mg/kg-day)	Hazard Quotient
2-Hexanone	4.99E-06	1.03E-05	1.92E-06	1.72E-05	400	4.30E-08
2-Methylnaphthalene	4.20E-06	3.19E-06	2.25E-05	2.99E-05	133	2.25E-07
4-Chloro-m-cresol	8.09E-06	9.86E-06	1.81E-05	3.61E-05	175	2.06E-07
4-Chlorophenyl phenyl ether	1.93E-06	1.50E-06	1.02E-05	1.36E-05	ND	ND
Acetone	3.26E-03	1.20E-02	2.59E-04	1.55E-02	100	1.55E-04
Antimony	5.16E-06	1.58E-06	1.40E-02	1.40E-02	0.26	5.37E-02
Arsenic	6.55E-05	5.76E-04	1.65E-02	1.72E-02	0.7	2.46E-02
Barium	2.86E-03	3.77E-02	2.89E-01	3.29E-01	0.7	4.70E-01
Benzene	5.45E-06	9.95E-06	5.02E-06	2.04E-05	0.1	2.04E-04
Benzo (b)fluoranthene	2.86E-06	3.61E-07	3.41E-05	3.73E-05	0.015	2.49E-03
Benzo (k)fluoranthene	1.88E-06	2.38E-07	2.24E-05	2.45E-05	0.015	1.64E-03
Benzoic acid	1.39E-04	3.89E-04	1.39E-04	6.67E-04	0.1	6.67E-03
Bis (2-ethylhexyl)phthalate	5.65E-06	2.16E-06	5.74E-05	6.53E-05	13	5.02E-06
Calcium	8.85E-01	1.17E+01	3.83E+00	1.64E+01	ND	ND
Carbondisulfide	1.89E-06	3.90E-06	1.65E-06	7.44E-06	10	7.44E-07
Chloroform	4.75E-05	8.56E-05	3.49E-05	1.68E-04	0.4	4.20E-04
Chromium	6.43E-04	1.41E-03	2.16E-01	2.19E-01	0.46	4.75E-01
Cobalt	2.59E-04	6.91E-04	9.79E-03	1.07E-02	0.5	2.15E-02
Copper	9.53E-01	2.01E+00	5.77E+00	8.74E+00	0.42	2.08E+01
Cyanide	6.02E-02	5.87E-02	1.25E-03	1.20E-01	3	4.01E-02
Di-n-butylphthalate	2.37E-05	9.48E-06	4.13E-05	7.45E-05	13	5.73E-06
Dibenzofuran	1.70E-06	1.24E-06	9.44E-06	1.24E-05	0.0001	1.24E-01
Dichloromethane (Methylenechloride)	2.51E-05	2.41E-05	5.33E-06	5.45E-05	6	9.09E-06
Dieldrin	2.86E-06	2.98E-06	9.32E-06	1.52E-05	10	1.52E-06
Diethylphthalate	2.91E-04	2.43E-04	1.91E-04	7.25E-04	370.1	1.96E-06
Ethylbenzene	7.37E-07	2.83E-07	5.54E-07	1.57E-06	4.728	3.33E-07
Fluoranthene	1.67E-05	2.10E-06	6.30E-05	8.19E-05	125	6.55E-07
Indeno (1,2,3-c,d)pyrene	1.07E-06	1.00E-07	1.70E-05	1.82E-05	0.015	1.21E-03
Iron	7.93E-02	4.19E-01	1.20E+02	1.21E+02	ND	ND
Lead	1.39E-03	1.18E-03	2.34E-01	2.37E-01	0.002	1.18E+02
Magnesium	5.05E-01	1.21E+00	1.39E+00	3.11E+00	ND	ND
Manganese	7.13E-02	3.51E-01	7.20E-01	1.14E+00	250	4.57E-03
Mercury	2.42E-05	1.44E-04	1.83E-04	3.51E-04	0.02	1.76E-02
Methylethylketone	1.04E-05	3.91E-05	1.64E-06	5.11E-05	177.1	2.89E-07
Nickel	4.87E-03	3.00E-02	1.23E-01	1.58E-01	8.6	1.84E-02
OCDD	5.21E-07	3.90E-08	1.14E-05	1.20E-05	400	2.99E-08
p,p'-DDE	1.26E-05	2.70E-07	1.55E-05	2.84E-05	23	1.23E-06
p,p'-DDT	2.14E-06	1.53E-07	1.30E-05	1.53E-05	2.4	6.36E-06
PCB1254	1.99E-05	6.35E-07	1.93E-04	2.14E-04	1.25	1.71E-04
Potassium	3.37E-01	8.09E-01	9.29E-01	2.07E+00	ND	ND
Pyrene	1.99E-05	2.65E-06	7.76E-05	1.00E-04	75	1.33E-06
Selenium	3.61E-04	4.76E-04	2.19E-02	2.27E-02	0.025	9.08E-01
Silver	2.73E-06	7.49E-07	3.18E-03	3.19E-03	18.12	1.76E-04
Sodium	2.70E-03	4.85E-03	7.42E-02	8.18E-02	ND	ND
Tetrachloroethylene	8.80E-08	3.22E-07	2.77E-07	6.88E-07	38.6	1.78E-08
Thallium	1.57E-06	1.14E-04	1.98E-02	1.99E-02	0.2	9.94E-02
Toluene	4.16E-05	3.25E-05	3.45E-05	1.09E-04	312	3.48E-07
Trichloroethylene	3.26E-07	5.54E-07	4.12E-07	1.29E-06	10	1.29E-07
Vanadium	2.07E-01	2.73E-01	3.14E-01	7.94E-01	0.3	2.65E+00
Xylenes	6.88E-06	2.46E-06	5.17E-06	1.45E-05	500	2.90E-08
Zinc	2.22E-01	4.56E-01	3.74E-01	1.05E+00	16.3	6.46E-02

ND No data

Table 6.28 Calculation of Total Intakes and Hazard Quotients Soil (Depth 0 - 5 feet)

COPCs	Root/Fruit Intake (mg/kg-day)	Leafy Plant Intake (mg/kg-day)	Incidental Intake (mg/kg-day)	Total Intake (mg/kg-day)	Toxicity Benchmark (mg kg-day)	Hazard Quotient
2-Hexanone	4.25E-06	8.76E-06	1.63E-06	1.46E-05	400	3.66E-08
2-Methylnaphthalene	3.67E-06	2.79E-06	1.96E-05	2.61E-05	133	1.96E-07
4-Chloro-m-cresol	4.94E-06	6.02E-06	1.10E-05	2.20E-05	175	1.26E-07
Acetone	2.99E-03	1.10E-02	2.37E-04	1.42E-02	100	1.42E-04
Antimony	5.13E-06	3.14E-05	1.39E-02	1.39E-02	0.26	5.35E-02
Arsenic	7.91E-05	1.39E-02	2.00E-02	3.40E-02	0.7	4.85E-02
Barium	3.20E-03	8.45E-01	3.23E-01	1.17E+00	0.7	1.67E+00
Benzene	2.42E-05	4.41E-05	2.23E-05	9.05E-05	0.1	9.05E-04
Benzo (b)fluoranthene	2.03E-06	2.56E-07	2.42E-05	2.65E-05	0.015	1.77E-03
Benzo (k)fluoranthene	1.39E-06	1.75E-07	1.65E-05	1.81E-05	0.015	1.21E-03
Benzoic acid	1.15E-04	3.22E-04	1.15E-04	5.51E-04	0.1	5.51E-03
Beryllium	1.34E-06	2.36E-04	1.35E-03	1.59E-03	0.7	2.27E-03
Cadmium	2.70E-04	2.62E-02	2.73E-03	2.92E-02	0.03	9.72E-01
Calcium	1.40E+00	3.69E+02	6.05E+00	3.77E+02	ND	ND
Carbondisulfide	1.65E-06	3.40E-06	1.44E-06	6.50E-06	10	6.50E-07
Chloroform	5.27E-05	9.49E-05	3.87E-05	1.86E-04	0.4	4.66E-04
Chromium	6.09E-04	2.68E-02	2.05E-01	2.32E-01	0.46	5.05E-01
Cobalt	2.45E-04	1.31E-02	9.27E-03	2.26E-02	0.5	4.52E-02
Copper	4.46E-01	1.88E+01	2.70E+00	2.20E+01	0.42	5.24E+01
Cyanide	4.49E-02	4.39E-02	9.32E-04	8.97E-02	3	2.99E-02
Di-n-butylphthalate	2.37E-05	9.48E-06	4.13E-05	7.45E-05	13	5.73E-06
Dibenzofuran	2.64E-06	1.92E-06	1.46E-05	1.92E-05	0.0001	1.92E-01
Dichloromethane (Methylenechloride)	3.23E-05	3.09E-05	6.85E-06	7.01E-05	6	1.17E-05
Dieldrin	2.37E-06	2.47E-06	7.74E-06	1.26E-05	10	1.26E-06
Diethylphthalate	1.68E-04	1.41E-04	1.10E-04	4.19E-04	370.1	1.13E-06
Ethylbenzene	9.49E-07	3.64E-07	7.14E-07	2.03E-06	4.728	4.29E-07
Fluoranthene	1.32E-05	1.66E-06	4.99E-05	6.48E-05	125	5.18E-07
Indeno (1,2,3-c,d)pyrene	8.00E-07	7.49E-08	1.27E-05	1.36E-05	0.015	9.04E-04
Iron	1.12E-01	1.18E+01	1.70E+02	1.82E+02	ND	ND
Lead	1.36E-03	2.32E-02	2.29E-01	2.54E-01	0.002	1.27E+02
Magnesium	6.40E-01	3.07E+01	1.76E+00	3.31E+01	ND	ND
Manganese	8.55E-02	8.43E+00	8.64E-01	9.38E+00	250	3.75E-02
Mercury	3.11E-05	3.69E-03	2.36E-04	3.96E-03	0.02	1.98E-01
Methoxychlor	1.16E-06	4.96E-06	4.50E-05	5.11E-05	69	7.41E-07
Methylethylketone	7.44E-05	2.79E-04	1.17E-05	3.65E-04	177.1	2.06E-06
Nickel	3.61E-03	4.45E-01	9.12E-02	5.39E-01	8.6	6.27E-02
OCDD	1.56E-06	1.17E-07	3.41E-05	3.58E-05	400	8.95E-08
p,p'-DDE	1.30E-05	2.79E-07	1.61E-05	2.94E-05	23	1.28E-06
p,p'-DDT	1.88E-06	1.35E-07	1.14E-05	1.34E-05	2.4	5.60E-06
PCB1254	1.66E-05	5.31E-07	1.62E-04	1.79E-04	1.25	1.43E-04
Potassium	3.98E-01	1.91E+01	1.10E+00	2.06E+01	ND	ND
Pyrene	1.66E-05	2.22E-06	6.48E-05	8.36E-05	75	1.12E-06
Selenium	5.02E-04	1.33E-02	3.04E-02	4.42E-02	0.025	1.77E+00
Silver	3.62E-06	1.98E-05	4.22E-03	4.24E-03	18.12	2.34E-04
Sodium	7.70E-03	2.77E-01	2.12E-01	4.97E-01	ND	ND
Tetrachloroethylene	7.20E-08	2.64E-07	2.27E-07	5.63E-07	38.6	1.46E-08
Thallium	1.43E-06	2.08E-03	1.81E-02	2.02E-02	0.2	1.01E-01
Toluene	4.50E-05	3.51E-05	3.73E-05	1.17E-04	312	3.76E-07
Trichloroethylene	2.40E-07	4.07E-07	3.02E-07	9.49E-07	10	9.49E-08
Vanadium	2.39E-01	6.30E+00	3.61E-01	6.90E+00	0.3	2.30E+01
Xylenes	7.75E-06	2.77E-06	5.81E-06	1.63E-05	500	3.27E-08
Zinc	2.49E-01	1.02E+01	4.20E-01	1.09E+01	16.3	6.69E-01

ND No data

Table 6.29 COPC Bioconcentration Data
Soil

COPCs	BCF	Basis of BCF Value	Source
2-Hexanone	6	Log Kow = 1.38	EHRAV, 1996
2-Methylnaphthalene	190	Coho salmon	HSDB, 1996
4-Chloro-m-cresol	19.9	Aquatic organism	ATSDR, 1992
4-Chlorophenyl phenyl ether	742	Log Kow = 4.08	EHRAV, 1996
Acetone	0.69	Haddock	HSDB, 1996
Antimony	200	BAF in freshwater fish	NRC, 1992
Arsenic	350	Log BCF = 2.544	EPA, 1989
Barium	200	BAF in freshwater fish	NRC, 1992
Benzene	24	Kow=2.13	EHRAV, 1996
Benzo (b)fluoranthene	61,100	Log Kow = 6.6	EHRAV, 1996
Benzo (k)fluoranthene	96,300	Log Kow = 6.85	EHRAV, 1996
Benzoic acid	80	Mosquito fish	HSDB, 1996
Beryllium	100	Freshwater fish (unspecified)	ATSDR, 1993
Bis (2-ethylhexyl)phthalate	113	Rainbow trout	HSDB, 1996
Cadmium	326	Log BCF = 2.190	EPA, 1989
Calcium	40	Freshwater fish (BAF)	NRC, 1992
Carbon disulfide	7.9	Aquatic organisms	HSDB, 1996
Chloroform	8	Bluegill sunfish	ATSDR, 1991
Chromium	155	Log BCF = 2.190	EPA, 1989
Cobalt	1000	BAF	ATSDR, 1990
Copper	100	Fish (unspecified)	ATSDR, 1989
Cyanide	0.4	Log Kow = -0.25	EHRAV, 1996
Di-n-butylphthalate	416	Log Kow = 3.25	EHRAV, 1996
Dibenzofuran	869	Log Kow = 4.17	EHRAV, 1996
Dichloromethane (Methylene chloride)	8	Log Kow = 1.51	EHRAV, 1996
Dieldrin	2700	Fish (unspecified)	ATSDR, 1993
Diethylphthalate	117	Bluegill sunfish	HSDB, 1996
Ethylbenzene	145	Fish (unspecified)	HSDB, 1996
Fluoranthene	5272	Log Kow = 5.20	EHRAV, 1996

**Table 6.29 COPC Bioconcentration Data
Soil (continued)**

COPCs	BCF	Basis of BCF Value	Source
Indeno (1,2,3-c,d)pyrene	51,286	Log Kow = 6.5	EHRAV, 1996
Iron	2,000	Freshwater Fish (BAF)	NRC, 1992
Lead	179	Log BCF = 2.25	EPA, 1989
Magnesium	ND		
Manganese	40,000	Invertebrates	ATSDR, 1990
Mercury	40,000	Log BCF = 4.602	EPA, 1989
Methoxychlor	8,300	Fathead minnow	ATSDR, 1992
Methylethylketone	0.92	Log Kow = 0.26	EHRAV, 1996
Nickel	50	Log BCF = 1.699	EPA, 1989
OCDD	22,300	Fathead minnow	HSDB, 1996
p,p'-DDE	12,400	Log Kow = 5.69	EHRAV, 1996
p,p'-DDT	20,644	Log Kow = 5.98	EHRAV, 1996
PCB1254	110,000	Log Kow = 6.94	EHRAV, 1996
Potassium	1000	Freshwater fish (BAF)	NRC, 1992
Pyrene	6.2	BAF in fish	ATSDR,1989
Selenium	170	BAF in freshwater fish	NRC, 1992
Silver	6.2	BAF in freshwater fish	ATSDR, 1990
Sodium	ND		
Tetrachloroethylene	49	Fish (unspecified)	ATSDR,1991
Thallium	34	Bluegill sunfish	ATSDR, 1992
Toluene	10.7	Fish (unspecified)	ATSDR, 1992
Trichloroethylene	17	Bluegill sunfish	HSDB, 1996
Vanadium	ND		
Xylenes	158	Fish (unspecified)	HSDB, 1996
Zinc	578	Log BCF = 2.762	EPA, 1989

ND No data available

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7.0 SUMMARY AND CONCLUSIONS

7.1 Summary

7.1.1 Nature and Extent of Contamination

A summary of the nature and extent of contamination at the BRP6G is the topic for this section of the report. This section will be delineated as follows: contamination in surface soils, both in and out of the pit, subsurface soils, groundwater, and sediment.

7.1.1.1 Surface Soil Contamination

Metal, semi-volatile, volatile, pesticide, PCB, dioxin/furan, and radionuclide contamination is noted in the surface samples from soil borings at this Unit. These contaminants are from the secondary release mechanism of surface contamination (i.e., bioturbation / excavation). Tables 4.7 through 4.11 present an elaboration of this contamination, separated by borings located inside the pit and outside the pit. These tables depict a fairly even distribution of contamination from both groups of borings. That is, there is little difference in the distribution of contamination between the two groups. The reason for the continuity of distribution is probably because the borings out of the pit are located no more than 50 feet from the boundary of the pit.

Metals, semi-volatiles, and volatiles have the most analytes with contamination exceeding two times the average background concentration in this medium. The boring CS6G-15, located outside the pit, has an inordinate amount of semi-volatiles that exceeded two times average background. Thirteen of the 16 semi-volatiles that exceeded two times average background concentration are detected above that concentration in the surface soil sample from boring CS6G-15. The boring CS6G-12, located inside the pit, has an inordinate amount of semi-volatiles that exceeded two times average background. Six of the 13 volatiles that exceeded two times average background concentration are detected above that concentration in the surface soil sample from boring CS6G-12. The boring CS6G-11, located outside the pit, has an inordinate amount of metal contaminants that exceeded two times average background. Twelve of the 21 metal contaminants that exceeded two times average background concentration are detected above that concentration in the surface soil sample from boring CS6G-11.

7.1.1.2 Subsurface Soil Contamination

The data from Table 4-12 indicate that the primary metals of concern (based on frequency detected above two times average background and concentration) are antimony, arsenic, cobalt, copper, cyanide, lead, manganese, mercury and zinc. These contaminants are believed to be from the primary source (i.e., waste deposited and burned in BRP6G). The maximum depth of metal contamination is approximately 17 feet except in CS6G-10; where in the 28.7 to 30.7 foot interval arsenic, chromium, lead, mercury and silver all exceeded two times average background concentrations. Antimony, arsenic, cyanide, and mercury concentrations are depicted on cross-sections both in the pit and out of the pit, and on planar isoconcentration maps, in Figures 4-1 through 4-22.

Semi-volatile organic compounds are present in the subsurface soils at concentrations exceeding two times average background as indicated in Table 4-12. The most prevalent of these contaminants are pyrene and fluoranthene, each detected 22 times in concentrations exceeding two times average background. These contaminants were found in samples collected from soil borings located both in and out of the pit boundary. These contaminants are from the primary source being the waste deposited and burned in the pit at the Central Shops Burning/Rubble Pit. Fluoranthene was detected as deep as 14.7 feet in boring CS6G-6, which is located in the pit. Pyrene's deepest occurrence above two times average background, was detected in the same boring and sample depth, 14.7 feet. The maximum concentrations for both contaminants was from the same boring and sample depth. Boring CS6G-14 from 4 to 6 feet, detected the highest concentration for both analytes. This sample also detected the highest concentration for anthracene, benzo(a)anthracene, benzo(b)pyrene, benzo(g,h,i)perlyene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, fluoranthene, fluorene, ideno(1,2,3-c,d)pyrene, and phenanthrene. Sample CS6G 1404 was collected directly at the base of the pit, probably in burned material.

Pyrene and fluoranthene concentrations are depicted in cross-section, and on planar isoconcentration maps in Figures 4-23 through 4-32.

Volatile organic compounds were detected in the subsurface samples from the soil borings. Chloroform, ethylbenzene, methyl ethyl ketone, toluene and xylenes were noted as having the most samples with concentrations above two times average background concentration. All five contaminants were detected in borings located both in and out of the pit. The maximum depth detected was 12.7 feet from sample CS6G 0602. This boring is located in the pit and was the deepest detection for chloroform, methyl ethyl ketone, and toluene. Chloroform, ethylbenzene, methyl ethyl ketone, toluene, and xylene concentrations are depicted in cross-section, and planar isoconcentration maps in Figures 4-33 through 4-56.

Octachlorodibenzo-p-dioxin was detected 13 times in concentrations above two times average background. Of the group, pesticides, PCB's, dioxins, and furans, this contaminant and p'p,-DDE are the most prevalent. The maximum depth detected above two times average background concentrations for octachlorodibenzo-p-dioxin, was 8 feet in borings CS6G 1205, and CS6G 1305. This contaminant was detected in samples from borings located both in and out of the pit. Octachlorodibenzo-p-dioxin and p'p,-DDE concentrations are depicted in cross-section and planar isoconcentration maps in Figures 4-57 through 4-63.

Non-volatile beta was detected in concentrations exceeding two times average background in only one sample. The concentration detected in CS6G 0703A was 18.5 pCi/g, from a depth of 9.5 to 11 feet. It should be noted that the sample CS6G 0703 did not record a concentration which was above two times average background.

7.1.1.3 Groundwater Contamination

Groundwater samples were collected from the three existing wells, (CBR-1D, CBR-2D, and CBR-3D) and the recently installed wells, (CBR-4, CBR-5, and CBR-6). All the monitoring wells are screened in the Water Table Aquifer. Two sampling events occurred for the recently installed wells. The last of the two sampling events occurred in late December, 1994. Groundwater contamination is brought about, per the conceptual site model, from the primary source, being waste deposited/burned in the pit, through the primary release mechanism of infiltration/leaching traveling through the vadose zone to the groundwater.

One metal analyte, lead, was detected at a concentration above the "at the tap" regulatory limit, in CBR-4 at 89.1 ug/L. A semi-volatile bis(2-ethylhexyl)phthalate in CBR-4 at 6.11 ug/L, exceeded the Primary Drinking Water Standard concentration of 6.0 ug/L. No radionuclides, pesticides, or PCB's were detected above guidelines. Each of the semi-volatiles and volatiles was detected in only one well above limits. A summary of wells with contaminants detected in the groundwater is presented in Table 4.14.

7.1.1.4 Surface Water and Sediment

Surface water and sediment contamination is brought about, per the conceptual site model, via bioturbation/excavation of the primary source, the material deposited/burned in the pit. The primary release mechanism is through dust generation, volatile emissions, direct contact or vegetation uptake.

There are no surface water impoundments in the vicinity of the BRP6G. Any water located in drainage ditches is solely from surface stormwater runoff. Because there was no water ponded in upgradient in the ditch at the time of the field investigation, no background water samples could be taken at sampling locations CS6G-26, CS6G-27, and CS6G-28. Drainage water samples were collected in the downgradient drainage ditch at five sampling locations CS6G-29 through CS6G-33. These samples indicated the presence of metals, semi-volatile organics, volatile organics, and radionuclides.

The sediment samples indicated the presence of various metals, small amounts of volatile organics, semi-volatile organics, gross alpha radionuclides, and octachlorodibenzo-p-dioxin. Sediment data greater than two times the average background are summarized in Table 4.13.

Thirteen metals were detected in the sediment samples, in concentrations exceeding two times average background. The samples from locations CS6G-24, and CS6G-25 recorded concentrations of nine and eight analytes respectively, which exceeded two times average background. These locations are downgradient of the BRP6G, as well as the large laydown yard adjacent to the Ford Building. Any stormwater runoff from these areas could accumulate sediment in these location from upgradient sources.

Four volatile organic analytes were detected in the sediment samples, in concentrations exceeding two times average background. The sample from location CS6G-29 recorded concentrations of three analytes, which exceeded two times average background.

Twelve semi-volatile organic compounds were detected in the sediment samples, in concentrations exceeding two times average background. The samples from locations CS6G-24, and CS6G-33 recorded concentrations of six and eight analytes respectively, which exceeded two times average background. Sample location CS6G-24 is situated downgradient of the BRP6G, as well as the large laydown yard adjacent to the Ford Building. Any stormwater runoff from these areas could accumulate sediment in this location from upgradient sources.

One radionuclide and one dioxin/furan were detected above two times average background concentrations. Gross alpha was detected in CS6G-24, -31, and -32. Octachlorodibenzo-p-dioxin was detected in CS6G-24.

7.1.1.5 Uncertainty in Nature and Extent of Contamination

In the discussion of the nature and extent of the contamination it is relevant to discuss the adequacy of the characterization process of the unit. The characterization of the BRP6G was such that samples from seventeen borings were taken to evaluate the principal contaminants for the BRP6G for the surface and subsurface soils. Groundwater samples were taken from the three existing wells and from the three newly installed wells. Surface sediment and surface water samples were also collected. The number of samples taken and the methodology for collecting the samples has been a well established protocol in the analysis of contamination for soils at SRS.

The procedure to scan with HNu or OVA for volatiles until two clean samples are found is a reliable screening method for volatiles and semi-volatiles. However, the question could be raised about screening for metals using this method. Metal contamination is not evaluated using this method. This screening method is utilized in order to perform the investigation as quickly as possible and maintain the sample integrity.

7.1.2 Fate and Transport

The presence of groundwater contaminants at levels above 2 times background indicates that the groundwater beneath the BRP6G has been contaminated. To date it is uncertain whether groundwater contaminant concentrations are rising or falling. Considering the presence of groundwater contaminants and the age of the unit, any contaminants which are mobile can be expected to have already leached from the soil to the groundwater. Immobile contaminants are likely bound to soils. For discussions of contaminant migration and leachability of contaminants to groundwater, see Sections 5.3 and 5.4, respectively.

Chloroform, chloromethane, arsenic and bis (2-ethylhexyl) phthalate were detected in the groundwater and were not screened out in the human health risk assessment. There is evidence that some biodegradation of chloroform may occur in soil and water; however, this does not appear to be a primary mechanism for removal from sediment (Bouwer et al., 1981b) or water (Bouwer et al., 1981a). Most chloroform is removed from these media through volatilization.

Arsenic was detected in the soil, and was not screened out in the human health risk assessment. Arsenic was noted as a contributor to the potential risk for the current groundwater sampler, and the hypothetical industrial worker (see Section 7.1.3.1).

7.1.2.1 Uncertainty in Fate and Transport of Contaminants

Contamination has reached the groundwater at the BRP6G. The contamination is the resulted of the primary source being deposited/burned in the pit. The vadose zone soil screening procedures and the assumptions involved tend to make the calculations more conservative. Also, because of the number of groundwater samples and the short history of sampling, the chronology of the contaminants and their concentrations is not available

7.1.3 Risk Assessment Summary

7.1.3.1 Human Health Risk Assessment

The screening for the human health risk assessment eliminated all but thirteen COPCs, arsenic, anthracene, beryllium, benzo(g,h,i)perylene, 2-hexanone, iron, octachlorodibenzo-p-dioxin, and PCB1254 in the soil, and aluminum, bis(2-ethylhexyl)phthalate, bromodichloromethane, chloroform, and dibromochloromethane in the groundwater. Under the current land use these COPCs do not pose a significant risk. The risk associated with the BRP6G is presented graphically in Figures 6-2, 6-3, and 6-4. Figure 6-2 presents the total risk for the two current use scenarios, that is the current groundwater sampler and current material yard worker. Figures 6-3 and 6-4 present the total risk for the hypothetical resident and hypothetical industrial worker scenarios. For current uses only the current groundwater sampler has risk exceeding 1E-06, and this risk value of 1.9E-06 is near the lower bound of the de minimus risk range (i.e., 1E-06 - 1E-

04). Under the current land use, these COPCs do not appear to pose a significant risk. Under the hypothetical land uses, both the industrial scenario and residential scenario exceeded a risk of 1.0E-06. Risk to the industrial worker was calculated to be 1.5E-05, due mainly to ingestion of groundwater. Total risk under the residential scenario was 7.9E-05 for adult and child combined and 3.2E-05 for the resident child only scenario.

As part of the RFI/RI/BRA for the Central Shops Burning/Rubble Pit, analysis of leachability to groundwater of soil contaminants was done for five chemicals of potential concern (COPC). The chemicals are analytes which failed a generic soil screening process, see Appendix L. The five chemicals consist of two metals and three organic compounds. The metals of concern are chromium and barium, and the organic compounds of concern are benzo(a)pyrene, benzo(b)fluoranthrene, and dieldrin. Spreadsheet calculations were made to estimate groundwater concentrations for the chemicals of concern. The modeled groundwater concentrations were used to determine the risk or hazard for the future adult/child and the future industrial worker scenarios. Maximum groundwater concentrations generated by the model were used to calculate risk, regardless of the time in the future at which the maximum occurred.

The hazard index for chromium III and barium for the adult/child is 0.04 for the ingestion of groundwater while it is 0.002 for dermal exposure to groundwater while showering. For the future industrial worker, the hazard index is 0.006 while ingesting one liter of water per day for chromium and barium. The hazard index above is based on the chemical being chromium III, which is the appropriate form based on the geochemical conditions at the site. If it is assumed that the chromium is in the VI or hexavalent state, which is the most toxic form of chromium, the hazard for each receptor would be greater. For the adult/child, the hazard index is 2 for the ingestion of groundwater and 0.2 for dermal exposure to groundwater while showering. For the future industrial worker, the hazard index is 0.3 while ingesting one liter of water per day.

The soil leachability results for the organic compounds are provided in Table 2 of Appendix L. Two of the compounds are polynuclear aromatic hydrocarbons (PAHs), benzo(a) pyrene and benzo(b)fluoranthene. The third is a pesticide, dieldrin. The modeled groundwater concentration for dieldrin is 2.2E-15 mg/L. In comparing the dieldrin concentration to the Risk-Based Concentration (RBC) value, 4.2E-06 mg/L, the RBC value is several orders of magnitude higher than the modeled dieldrin concentration. The RBC value for the tap water is based on a risk of 1.0E-06 which means the calculated risk for dieldrin will be much less than 1.0E-06. The modeled concentration for the two PAHs are negligible and will not reach the groundwater.

Summary and Uncertainty of Risk

The uncertainty of the risk for each receptor is discussed below. The risk assessment was developed by using recent analytical data for both the groundwater and the soils analyses. The concentration of each contaminant was assumed to be constant into future years.

Current Groundwater Sampler

A risk of 1.9E-06 for the current groundwater sampler is due to inhalation of chloroform. It is assumed that chloroform will instantly evaporate and will remain undispersed in the air around the sampler. Whereas, in reality, chloroform is a chemical that will degrade at a rapid rate over a certain period. This concentration will decrease over time and as a result the risk will decrease also.. In addition, the risk was determined on this individual without considering him being protected under the health and safety plan for SRS employees.

Hypothetical Industrial Worker

A risk of 1.5E-05 for the hypothetical industrial worker is due to ingestion of groundwater due to arsenic and beryllium being present. The method, bailed sampling, used for collecting the groundwater samples caused the samples to be high in turbidity. The high turbidity content in the groundwater is known to generate elevated metals concentrations. Arsenic was also detected infrequently (once) in the groundwater, this may be a spurious result and not a true representation of the arsenic groundwater concentrations.

Hypothetical Future Resident Adult and Child

The sum of the risk for this receptor for all pathways is 7.9E-05. However, the individual pathway risk ranged from 1.0E-06 for inhalation of groundwater with bis (2-ethylhexyl) phthalate and bromodichloromethane to 5.7E-05 for ingestion of groundwater with arsenic and beryllium. Other pathway risk drivers are arsenic and beryllium in the soil at 5.5 E-06 and octachlorodibenzo-p-dioxin and PCB 1254 in produce grown from the soil at a cumulative of 3.1 E-06. The risk range is caused by contaminants such as arsenic and beryllium which have typical background- concentrations. Also, arsenic and beryllium have been detected in the groundwater samples which were collected by the bailing method. Other constituents such as PCB 1254 were found in the soils at very low frequency of detection, 2 of 37 samples. The PCB 1254 maximum detected concentration is 0.115 mg/kg which is below residential concentration of 1 mg/kg, which is a "to be considered" guidance level.

There were several assumptions made in determining the risk associated with contaminants found at BRP6G. Some of these assumptions may lead to overestimation of risk and some may lead to underestimation of risk. Some of the factors which add some degree of uncertainty to the BRA are:

- assuming no future decrease in contaminant concentrations as a function of time
- land use assumptions
- combining of risk across pathways
- conservatism associated with RME parameters
- simplified calculation of VOC concentrations for the current groundwater sampler

- beryllium in soil is included as a COPC although a statistical analysis indicates that site-related beryllium soil concentrations are not significantly greater than background concentrations
- using bailed samples elevated levels of inorganic contaminants
- inclusion of soils at a depth of 2 feet in the surface soil exposure setting
- assuming groundwater contaminant levels have peaked and will not increase with time
- assuming that radioactive materials were not disposed of at BRP6G
- assuming that risk posed by VOCs in the air above the pit is negligible
- background samples have not been impacted by pit operations
- using only 1 well to determine groundwater background concentrations
- assuming that soils deeper than 5 feet will not be disturbed or brought to the surface where receptors can be exposed
- using provisional reference doses
- contaminants which were not evaluated because there is no RfD or SF
- assuming that contaminant concentrations in drainage water and sediment samples are lower than those found at the waste unit or are not representative of the unit

For a more detailed discussion of these uncertainties regarding the human health risk assessment refer to Section 6.2.4.

7.1.3.2 Ecological Risk Assessment

The results of the risk estimation step indicated that, of the COPCs identified in soil at the unit, lead and copper appeared to have a limited potential to pose risk to assessment endpoints based on its toxicity at the exposure point concentrations detected in surface and subsurface soil. However, further evaluation of the environmental toxicology of lead and copper and the basis of the toxicity benchmark on which its quotients were based indicated that its potential to pose ecological risk at this unit is inconsequential. In addition, two COPCs having BCF values of potential concern (PCB-1254 and cadmium) were estimated to potentially pose a risk to assessment endpoints at the BRP6G due to bioaccumulation or biomagnification. However, further evaluation of the ecological exposure levels and the limited habitat provided by the BRP6G indicated PCB-1254 and cadmium should not pose a risk to ecological receptors. Therefore, it is concluded that the levels of COPCs detected in surface and subsurface soil at the BRP6G do not have a significant potential to pose risk to ecological assessment endpoints.

7.1.4 ASCAD Applications

As discussed throughout this document, similarities have been defined between BRP6G, one of the lead units, and other BRPs. In general, the waste disposal history, nature of waste, and physical characteristics are similar. Variances between the lead unit and other BRPs will originate mainly from the composition of the subsurface, the makeup of the soil may vary greatly (i.e., sandy zones vs. clayey zones) influencing the way the contaminant may migrate through the soil to the groundwater. These soil parameters need to be defined at the other Burning/Rubble Pit units to definitively correlate BRP6G conclusions to the other BRPs.

Because this unit is one of the lead sites for Burning/Rubble Pits, the following characterization recommendations are made for secondary units:

(1) For the BRP6G, the analytical data showed that metal, VOC, and Semi-volatile constituents were most frequently detected in both soil and groundwater samples. With similar waste disposal histories, the other burning/rubble pits are likely to follow this scenario with similar constituents and concentrations. At the BRP6G, the constituents were concentrated in samples located at the base of the pit in the soils. In the other burning/rubble pits, the sample collected during characterization can be focused similarly.

(2) Groundwater and surface water analysis for PCB's, pesticides, dioxins, and furans could be, performed on a limited basis, because none of these were detected in samples at BRP6G.

(3) Groundwater analysis for radionuclides should be performed without speciation, unless indicator concentrations warrant.

7.2 Conclusions

7.2.1 Recommended Remedial Action Objectives

Based on field investigation, SRS believes that the nature and extent of contamination associated with the BRP6G are adequately defined. The risks and hazards attributable to the constituents present in the BRP6G are not above the values for an industrial area. The BRP6G is currently located within an area proposed for industrial use as supported by the proposed land use map for SRS documented in the SRS Citizens Advisory Board Recommendation No. 2, dated 1/24/95 (see Figure 7-1). This unit is currently located in an active industrial area and will continue to be an industrial area. Therefore, industrial land use is the most probable future use for this unit. Since only limited risk is present from contaminants at the site, it would be possible to move directly to a Proposed Plan and not perform the focused Feasibility Study. The only risk (1.3E-05) to the hypothetical industrial worker exceeding 1E-06 was due to ingestion of groundwater containing primarily arsenic and beryllium. Arsenic and beryllium in the groundwater are likely not present. Based on the risks and hazards calculated in the Baseline Risk Assessment and the proposed future land use, no further action is warranted.

FIGURES

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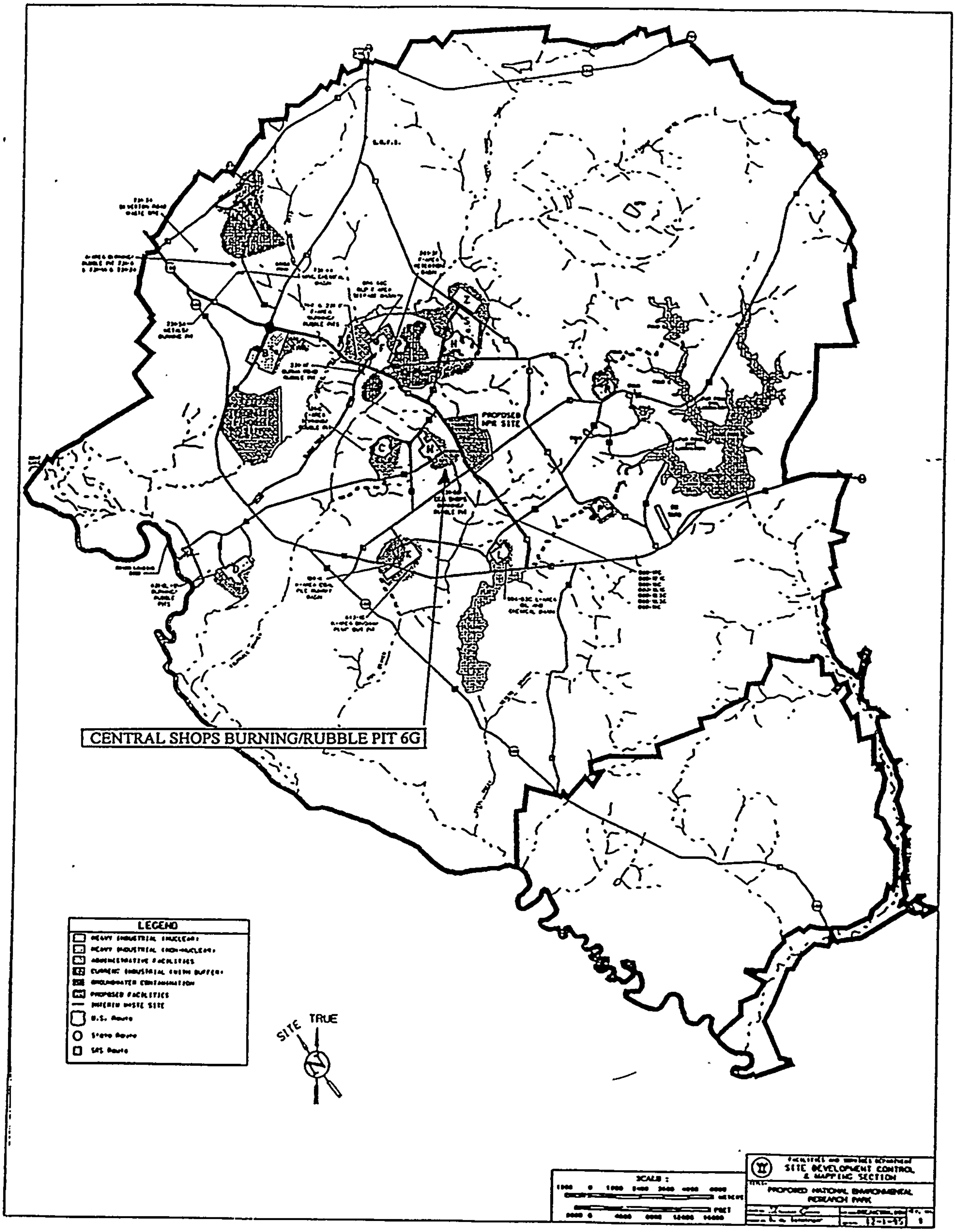

Figure 7-1 Map of SRS Depicting Current Industrial Land Use Zones

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